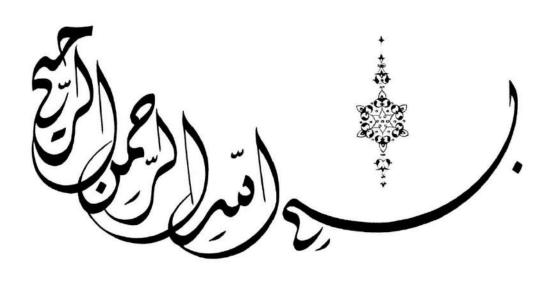


# CHALLENGES TO PROMOTE SCIENCE & TECHNOLOGY FOR SOCIOECONOMIC DEVELOPMENT IN OIC COUNTRIES

CONFERENCE PROCEEDINGS

ADNAN BADRAN
NAJWA DAGHESTANI
EDITORS

PUBLISHED BY
ISLAMIC WORLD ACADEMY OF SCIENCES
AMMAN - JORDAN



# CHALLENGES TO PROMOTE SCIENCE & TECHNOLOGY FOR SOCIO-ECONOMIC DEVELOPMENT IN OIC COUNTRIES

Proceedings of the 24<sup>th</sup> IAS Science Conference on Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries

Organized in Karachi - Pakistan 7-8 March 2023

Edited by

ADNAN BADRAN Najwa F. Daghestani

Published by



ISLAMIC WORLD ACADEMY OF SCIENCES (IAS)
AMMAN, JORDAN.

Conference sponsored by

OMSTECK!

OIC Standing Ministerial Committee on Scientific and Technological Co-operation (COMSTECH) Islamabad, Pakistan THOLY OF KARLON

International Center for Chemical and Biological Sciences (ICCBS) Karachi, Pakistan



The Higher Council for Science and Technology (HCST)
Amman, Jordan

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First published in 2023 by
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Type-setting at the Secretariat of the Islamic World Academy of Sciences, Amman, Jordan.

Jordan National Library Classification Deposit Number: 2023/11/6177
Descriptors: /Technological Change//Social Change//Economic Development//Islamic Countries/

ISBN 978-9957-412-32-6 (しょっ)

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Prof. Adnan Badran is the Chancellor of the University of Petra and the Chairman of the Board of Trustees of the University of Jordan. He is a biologist with over 166 papers presented, and 46 books, 64 research papers published and 4 patents. Badran was Prime Minister (2005), Minister of Agriculture (1989) and Minister of Education (1989) in Jordan. He was Senator and Chair of the Senate Committee on Science, Education and Culture (2006-2010). He also served as Deputy Director-General of UNESCO (1994-1998) and Assistant Director General for Science, Paris (1990-1994). Founding President of Yarmouk University and Jordan University of Science and Technology (1976-1986), President of Philadelphia University (1998-2005) and President of University of Petra (2007-2014), and Dean of the Faculty of Sciences at the University of Jordan (1971-1976). Secretary General (1986-1987) and Vice-president (2014-) of the Higher Council for Science and Technology, Jordan.

President of the National Centre of Human Rights, Jordan (2008-2011) and President of the Asia-Pacific Forum on Human Rights, Sidney (2009-2011). Member

of the Board of Trustees of the Arab Thought Forum (2012-). He is a Fellow and former Vice-president of the Academy of Sciences for the Developing World (TWAS), Fellow of the Islamic World Academy of Sciences (IAS) and President of the Arab Academy of Sciences. Chairman of the Board of the Arab Forum for Environment and Development in Beirut (2008-). President of the Higher Council of the National Centre for Curriculum development (2017-2019) and Chairman of Shoman Trust Fund for Research (2019-). Member of the Board of Trustees of the King Abdullah Ibn Al Hussein Award for Innovation (2020-). Member of the selection committee of Al-Hassan bin Talal Award for Scientific Excellence (2021-). Member of the Board of Trustees of the annual award in the name of Prince Muhammad Bin Fahd University for the best scientific production (Association of Arab Universities 2022-), President of Islamic World Academy of Sciences (2022-), and Vice President of Arab Peace Group (2022-).



**Najwa F. Daghestani** is currently the Programs Manager at the Islamic World Academy of Sciences (IAS). She earned her Master of Business Administration (MBA) from the German Jordanian University, Jordan, and her BSc in Computer Science from Princess Sumayya University, Jordan.

She works on organizing conferences and workshops, editing proceedings, newsletters and various papers and documents and acts as a liaison with international and national organizations and institutions.

She previously worked at the Royal Scientific Society as an Applications Programmer.



Some of the participants in the 24<sup>th</sup> IAS Conference, 7 - 8 March 2023, Karachi, Pakistan.

### **PREFACE**

The Organization of Islamic Cooperation (OIC) was founded in 1969 as an organization grouping Islamic countries. In 1981, the heads of state of the OIC decided to establish a number of specialized organs to enhance co-operation between the OIC-Member countries in the fields of culture, trade and science and technology. The science and technology role was assigned to the Islamabad-based COMSTECH; the Ministerial Standing Committee on Scientific and Technological Co-operation. In 1984, the heads of state of the OIC approved the launch of the Islamic World Academy of Sciences (IAS) as an independent autonomous S&T Think Tank of the OIC to be based in Amman, Jordan. Some of the issues that the IAS has been concerned with since its launch has been bridging the divide that has historically existed between the science community and the decision-making community in OIC-Member countries. Moreover, as an advocate for science, the IAS has always viewed science and technology – including the history of science – as an enterprise that can contribute to bridging divides between cultures and civilizations and has established itself as an active and vibrant player in the domain of science and technology promoting the values of science across the Islamic world. It executes its mission through programs emphasizing knowledge sharing, networking and capacity building, and sustaining stakeholder engagement. In this respect, the Academy advocates the scientific community's points of view in all facets of developmental processes. Its contribution is communicated to decisionmaking bodies at OIC, national or international levels. Among its many objectives, the IAS strives to fulfill its mission through many activities and initiatives such as conferences, webinars and workshops.

Scientific advances and technological change are important drivers of economic performance. The ability to create, distribute and exploit knowledge has become a major source of competitive advantage, wealth creation and improvements in the quality of life. Often, access to science and technology and its benefits are unevenly distributed resulting in broad inequities and social and economic gaps. Therefore, it is imperative that science and technology is directed towards meeting the basic needs of society, and contribute to having better access to the outcomes of science and technology which in turn will help reduce inequities and elevate the socio-economic status of the people and the country.

Science is universal and it's the cornerstone of creating knowledge to be turned into technology and innovation. IAS provides a platform for exchanging scientific information and sharing it for development and self-reliance.

The main purpose of socio-economic development is to maintain the social and material well-being of a nation and its people with the aim of achieving the highest

possible level of human development and dignity. It is a progressive support of a country's qualitative and quantitative dimension, to achieve a high level of efficiency, well-being and justice at all levels and to increase the economic standards of living and human capital through improved education, income, skills development and employment.

To achieve socio-economic development, a solid science and technology infrastructure is needed. In addition, the involvement of the public in science, technology and innovation policies would help improve regulatory science and technology assessment.

Under the high patronage of His Excellency President of Pakistan, the Islamic World Academy of Sciences (IAS) convened its 24<sup>th</sup> international scientific conference in Karachi, Pakistan during 7-8 March 2023 in collaboration with the Organization of Islamic Cooperation Ministerial Standing Committee on Scientific and Technological Cooperation (COMSTECH), and the International Center for Chemical and Biological Sciences (ICCBS). The theme of the conference was Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries.

The conference was held at the International Center for Chemical and Biological Sciences (ICCBS) (H.E.J. Research Institute of Chemistry and Dr. Panjwani Center for Molecular Medicine and Drug Research), University of Karachi, Pakistan.

The major focus of the conference was to discuss the challenges for the establishment of Socio-Economic Development in OIC Countries and to come up with policy documents on different subjects. The aim was to introduce new global trends and technologies in science and educational policies for the OIC member countries.

Linkages were also established at the intra-OIC as well as regional and international levels to strengthen institutional capacity and human resource development in the Member States through targeted capacity-building and financial assistance.

This publication includes the majority of the speeches, keynote addresses and presentations that were delivered during the 24th IAS Conference

Adnan Badran Najwa Daghestani

### **ACKNOWLEDGMENTS**

The Islamic World Academy of Sciences (IAS) is grateful to His Excellency President of Pakistan Dr. Arif Alvi for his high patronage and support of the conference.

We extend our gratitude to the International Center for Chemical and Biological Sciences (ICCBS) in Karachi, Pakistan for hosting the IAS 24<sup>th</sup> conference and for their generous hospitality and organization, and to the staff of the ICCBS for their cooperation and effort that paved the way to make this conference a successful event.

We would also like to thank all the organizations that have sponsored the conference including the OIC Standing Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan and the Higher Council for Science and Technology (HCST), Amman, Jordan.

We are very grateful to Prof. Dr. M. Iqbal Choudhary, Coordinator General, COMSTECH and Director, ICCBS for all his relentless efforts during the conference and attention to all details and for making all the participants feel welcome.

The dedicated staff of the IAS in Amman including Ms. Taghreed Saqer, all deserve our thanks and appreciation.

Adnan Badran Najwa F. Daghestani

### SPONSORS OF THE IAS 2022 CONFERENCE



# Islamic World Academy of Sciences (IAS) Amman - Jordan www.iasworld.org

The nascent idea of establishing the Islamic World Academy of Sciences (IAS) first appeared in the plan of action developed by the OIC Standing Committee for Scientific and Technological Cooperation (COMSTECH). Upon the invitation of Jordan, the Founding Conference of the Academy was held in Amman (Jordan) in October 1986. IAS came into being as an independent, non-political, non-governmental and non-profit organization of distinguished scientists dedicated to the promotion of all aspects of science and technology in the Islamic world.

The IAS seeks to act as functional platform for improving, facilitating and nurturing interaction, collaboration, networking and enhancing knowledge sharing in a bet to address pressing challenges facing socio-economic development in OIC member states.

The IAS aspires to avail its capacity and capability to serve as Islamic Brain Think Tank and to respond effectively and timely to current and futuristic needs for advancing and promoting developmental goals and objectives to realize aspirations of the Ummah.

### Main objectives of the Academy are:

- 1. Enabling inter-Islamic world connections among scientists and academies to advance STI.
- 2. Acting as legitimate, scientifically-based voice for the cause of STI on behalf of scientists in the Islamic World.
- 3. Promoting the development of ecosystem that nurtures science and values education and research as a vehicle for socioeconomic transformation in the Islamic World.
- 4. Providing science-informed advice and recommendations through its various activities to local, regional and international levels.



### International Center for Chemical and Biological Sciences (ICCBS) Karachi – Pakistan

www.iccs.edu

The International Center for Chemical and Biological Sciences (ICCBS), among the developing world's finest centers of excellence, is located in Pakistan's financial center and largest city, Karachi. Its reputation for scientific research and graduate training extends far beyond the country's borders. The Center is comprised of H.E.J. Research Institute of Chemistry, and Dr. Panjwani Center for Molecular Medicine & Drug Research.

The large complex of ICCBS is comprised of 17 research buildings that house some of the region's most sophisticated laboratory facilities. The ICCBS scientists carry out research, training, product development, and service delivery in the chemical, biological, and biomedical sciences. The degree-granting programs have served as the focal points of ICCBS efforts to provide world-class training to young researchers, coming primarily from developing countries, including those belonging to the Organization of Islamic Cooperation (OIC), an international network comprised of 57 Muslim countries.

In 2004 and 2010, the ICCBS received the prestigious IsDB (Islamic Development Bank) prize for the best science institution in the entire Islamic world, which is an unprecedented honor to any science institution in OIC region. Additionally, the institute has also been selected as one of the three library centers of the World Academy of Sciences (TWAS). The center has been designated as the W.H.O. Center for Pesticide Analysis for the Eastern Mediterranean Region. The center is also a UNESCO Category II Center, IUCN-International, WAITRO, and COMSATS Center of Excellence. More recently the center is designated as the OIC Center of Excellence in Chemical Sciences. Through these international recognitions, the center is playing a key role in global capacity building.



### OIC Standing Ministerial Committee on Scientific and Technological Co-operation (COMSTECH) Islamabad - Pakistan

www.comstech.org.pk

COMSTECH the Ministerial Standing Committee on Scientific and Technological Cooperation of the OIC (Organization of Islamic Cooperation) was established by the Third Islamic Summit of OIC held at Makkah, Saudi Arabia in January 1981. The President of Pakistan is Chairman of COMSTECH. The core mandate of COMSTECH is to strengthen cooperation among OIC Member States in science and technology (S&T), and enhance their capabilities through training in emerging areas, undertake follow-up-actions and implementation of the resolutions of the OIC, and to draw up programs and submit proposals designed to increase the capability of the Muslim countries in science and technology (S&T). The ultimate aim is to build and nourish a scientific culture in addition to using S&T as a major contributor to socio-economic development and rapid industrialization.

### The objectives of COMSTECH include

- 1. Assessment of human and material resources of Member States and identification of scientific and technological needs and requirements of the Ummah,
- 2. Building indigenous capabilities of Member States in the fields of science and technology through cooperation and mutual assistance,
- 3. Enhancement of cooperation and coordination in scientific and technological fields amongst the OIC member states with a view to achieving collective competence in science and technology for solution of the problems of the OIC member states,
- 4. Creation of an effective institutional structure for planning, research, development and monitoring of scientific and technological activities at national, regional, and international levels.

COMSTECH works in close collaboration with various Standing Committees and other organs of the OIC, Member States of the OIC and their major Scientific and Technological Institutions, in addition to some international organizations. The latter include The World Academy of Sciences (TWAS), Islamic Scientific, Educational and Cultural Organization (ISESCO), Islamic World Academy of Sciences (IAS), Islamic Development Bank (IDB), Global Environment Facility (GEF), United Nations Environment Program (UNEP), United Nations Development Program (UNDP), International Foundation for Science, Stockholm (IFS), Eastern Mediterranean Regional Office of the World Health Organization (WHO–EMRO). In addition, protocols are being prepared for collaboration with the Lindau Council and IIASA in the EU.



## The Higher Council for Science and Technology (HCST) Amman – Jordan

www.hcst.gov.jo

The Higher Council for Science and Technology was established in 1987 as a public independent institution and acts as a national umbrella for all science & technology (S&T) activities in Jordan.

The objective of the Higher Council is to build a national science and technology base to contribute to the achievement of development goals, through increasing awareness of the significance of scientific research and development, granting the necessary funding and directing scientific and research activities, within national priorities, in line with development orientations.

The Higher Council was also entrusted with the establishment of specialized centers for R&D activities, the support of innovation and entrepreneurship to contribute to commercialize scientific and technological ideas into products and businesses, the conclusion of agreements relating to cooperation with Arab, regional and international parties, the representation of the Kingdom in scientific and technological activities, at the Arab, regional and international levels.

The Higher Council is chaired by HRH Prince El Hassan Bin Talal, who has been instrumental to the progress of science and technology in Jordan from the beginning.

## The 24<sup>th</sup> Islamic World Academy of Sciences Conference

## "Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries."

### **Conference Declaration**

Adopted at Karachi, Pakistan on Sha'ban 16, 1444 Hijri Wednesday, 8 March 2023

The Islamic World Academy of Sciences (IAS), the International Center for Chemical and Biological Sciences (ICCBS), the Ministerial Standing Committee on Scientific and Technological Cooperation of the OIC (COMSTECH), and the Higher Council for Science and Technology (HCST) extend their appreciation and gratitude to His Excellency the President of Pakistan for his high patronage of the conference and to His Royal Highness Prince El Hassan bin Talal, the Founding patron of IAS.

- 1. Whereas, seeking knowledge is upheld in Islam.
- 2. Whereas, knowledge is derived from research observation and development on our planet sphere, geosphere, biosphere and ecosphere and cybersphere.
- 3. Whereas, the delivery of R&D in science, technology and innovation (STI) ecosystem is used for promotion of socio-economic development.
- 4. Whereas, OIC member states recognized education, science and technology as a vehicle for socio–economic transformation in 2020, reconfirmed in 2021 OIC summit conference.
- 5. Whereas, OIC countries and humanity in general are facing global, natural and man-made disasters; *i. e.*, earthquakes, floods, hurricanes, droughts, climate change, pollution of (drinking water, oceans, land and biosphere) resulting in loss of biodiversity, disrupting food chain supply, energy deficiency, poor health and hence increase in poverty.

We the Fellows of the IAS and participants in the IAS 24<sup>th</sup> conference entitled "Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries." Held in Karachi on 7-8 March 2023 in partnership with ICCBS;

- 1. Call on OIC member states for the inclusion of enquiry-based education to enhance creativity, curiosity and problem solving for building-capacity in STI and enriching human resources.
- 2. Call on OIC member states to formulate and implement National Innovation Policies in order to promote entrepreneurship targeted at manufacture and export of high technology goods.
- 3. Call on OIC member states to identify centers of excellence for the IAS network STIs leading to regional R&D delivery or **commons** scientific application, innovation and leading to socio-economic development and digital transformation.
- 4. Bridge the academia and industry for joint R&D leading to socio-economic development.
- 5. Create social and technology parks and incubators to commercialize the delivery of research and innovations into start-up SMEs and enhance diversification of new materials and quality control.
- 6. Create a consortium for a sustainable **triangle of energy-water-food security** linked to IAS platform to network reputable research centers in OIC countries for self-reliance and meeting the SDGs, and call on COMSTECH to increase their mobility grants to scientists from LDCs to centers of excellence for training and research in combating poverty and hunger.
- 7. Strengthen world class research institutions, such as the International Center for Chemical and Biological Sciences, at Karachi University, and use them for human resource development in frontier fields of science and technology in the OIC region.
- 8. Align cooperation and collaboration with private sector on achieving a sustainable triangle of food, water and energy security, for future generations.
- 9. Promote cooperation and collaboration of the private sectors for health security of vaccines and drugs to embark across borders, a joint enterprise of manufacturing vaccines and needed drugs for emerging pandemics in the OIC member states.
- 10.Academia and research centers of OIC member states should encourage interdisciplinary research to deal with "common" problems of the Islamic

- world, including fields of humanity and social sciences such as climate change, the triangle for sustainability, population, poverty, Medicare etc.
- 11.Urge the OIC member states to invest at least 1% of their GDP in research in science, technology and innovation (STI) for socio-economic development.
- 12.Encourage the OIC member states to provide sustained support to the OIC S&T institutions, such as COMSTECH and IAS so that they can fulfil their assigned mandate.
- 13.Encourage the OIC member states to venture into getting benefits of game changing technologies like nanotechnology. Artificial Intelligence (AI), and other emerging technologies, including radionuclide medical technology leading to the 4<sup>th</sup> Industrial Revolution.

### 24th Islamic World Academy of Sciences Conference

on

### Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries

### CONFERENCE REPORT

7 - 8 March 2023

Under the high patronage of His Excellency President of Pakistan, the Islamic World Academy of Sciences (IAS), which is patronized by H.R.H. Prince El-Hassan bin Talal, convened its 24<sup>th</sup> international scientific conference in Karachi, Pakistan during 7-8 March 2023 in collaboration with the Organization of Islamic Cooperation Ministerial Standing Committee on Scientific and Technological Cooperation (COMSTECH), and the International Center for Chemical and Biological Sciences (ICCBS). The theme of the conference was **Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries.** 

The conference was held at the International Center for Chemical and Biological Sciences (ICCBS) (H.E.J. Research Institute of Chemistry and Dr. Panjwani Center for Molecular Medicine and Drug Research), University of Karachi, Pakistan. It was an open activity in which around 150 local and international participants attended from 20 countries. Among the participants were Fellows of the IAS and local scientists from various universities and institutions. The conference was a hybrid event where some speakers and participants joined via zoom. After the conference, the 25th meeting of the General Assembly of the IAS as well as the 45th meeting of the IAS Council were convened.

The conference was co-sponsored by; OIC Standing Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan, International Center for Chemical and Biological Sciences (ICCBS), Karachi, Pakistan and the Higher Council for Science and Technology (HCST), Amman, Jordan. Conference partner institutions from Pakistan were the Pakistan Academy of Sciences (PAS), Dr. Panjwani Memorial Trust, the Husein Ebrahim Jamal Foundation and the Government of Sindh.

The inaugural ceremony started with the National Anthem of Pakistan and a recitation from the Holy Qur'an followed by a welcome address by **H.E. Prof. Muhammad Iqbal Choudhary**, Coordinator General, COMSTECH/ Director ICCBS, University of Karachi, Pakistan.

The ceremony included a message from H.E. President of the Islamic Republic of Pakistan and Patron of the Islamic World Academy of Sciences (IAS) that was delivered by H.E. Prof. Iqbal Choudhary, His Royal Highness Prince El-Hassan bin Talal, Founding Patron of the IAS sent a message to address the conference participants and was delivered by H.E. Prof. Adnan Badran and address of the Chief Guest H.E. Syed Murad Ali Shah, Chief Minister, Government of Sindh, Pakistan and an address of H.E. Prof. Adnan Badran, President, Islamic World Academy of Sciences (IAS), Jordan.

The ceremony also included addresses from H.E. Prof. Atta-ur-Rahman, Patronin Chief, UNESCO Science Laureate, International Centre for Chemical and Biological Sciences, University of Karachi, Pakistan, remarks from Mr. Aziz Latif Jamal, Chairman, Husein Ebrahim Jamal Foundation, Pakistan followed by Remarks of Ms. Nadira Panjwani, Chairperson, Dr. Panjwani Memorial Trust, Pakistan and Remarks from Prof. Khalid Mahmood Iraqi, Vice Chancellor, University of Karachi. Prof. Mukhtar Ahmad, Chairman, Higher Education Commission of Pakistan addressed the conference virtually on Zoom.

The first academic session of the conference included keynote presentations starting with a presentation by Prof. Atta-Ur-Rahman FIAS, UNESCO Science Laureate and Professor Emeritus, International Centre for Chemical and Biological Sciences, University of Karachi, Pakistan entitled Higher Education, Science and **Technology - Imperatives for Socio-Economic Development**; a presentation by Mr. Michael Wadleigh, Founder, The Homo Sapiens Foundation (UNESCO), Science Activist, Oscar-winning Director, USA entitled UNESCO Open Data to Stop Trends to Global Socio-economic Collapse; a presentation by Prof. Zakri Abdul Hamid FIAS, Founding Fellow, International Science Council, Science Advisor to the Sixth Prime Minister of Malaysia, Chairman, Atri Advisory, Malaysia on The Role of Science, Technology and Innovation in Achieving the SDGs in OIC Countries. Prof. Syed Qaim FIAS, Institute of Neuroscience and Medicine, Nuclear Chemistry, Forschungszentrum Jülich, Germany, presented on the Standardisation of Production Data of Medical Radionuclides under German-Pakistan Cooperation. Next, Prof. Ahmed Azad FIAS, Former Chief Research Scientist, CSIRO Division of Biomolecular Engineering, Melbourne Australia, presented on Producing Affordable Biotech Medicines for the Islamic World: Opportunities and Requirements. Last keynote speaker of the session was Prof. Zulfigar Bhutta, Professor and Founding Director of the Institute for Global Health and Development and the Centre of Excellence in Women and Child Health, Aga Khan University and Co-Director, Centre for Global Child Health, Hospital for Sick Children, Toronto, Canada who presented virtually through Zoom on Status and Progress in Health and Health-related Sustainable Development Goals in the Islamic World; Challenges and Opportunities.

The second day of the conference started with the second session of the conference with a presentation by Prof. Adnan Badran, President, IAS and Chancellor, University of Petra and Chairman of the Board of Trustees of the University of Jordan, Jordan, on Digital Transformation: Technology and Innovation for Socio-Economic Development followed by Prof. M. Iqbal Choudhary FIAS, Coordinator General COMSTECH/Director ICCBS, Pakistan, with a presentation on Combating the Drug Development Challenges with Sustainable and Inclusive Drug Discovery and Development - An Emerging Paradigm. Next was a presentation entitled Halal Products Biomolecular Science and Healthy Life by Prof. Ali Moosavi-Movahedi FIAS, Professor of Biophysics, University of Tehran, Inst of Biochem Biophys, Iran. Last in the session was a presentation by Prof. Ilkay Erdogan Orhan FIAS, Dean, Faculty of Pharmacy, Gazi University, Türkiye, on Drug Research Through Nature - From Lab to Patent.

Session 3 started with a presentation by **Prof. Mohammed Besri**, Emeritus Professor, Hassan II Institute of Agronomy and Veterinary Medicine, Morocco, entitled **The Montreal Protocol and the Ozone Depleting Substances Phase-Out: Impact on Human, Plants and Environment**; then a presentation on **Plant Sciences: A Tool to Achieve Targets of SDGs** by **Prof. Zabta Shinwari** FIAS, Vice President, IAS and National Professor and Professor Emeritus, Quaid-i-Azam University, Pakistan. Next was a presentation on **Health as an Ethical Issue: Lessons from the COVID-19 Pandemic** by **Prof. Liaquat Ali** FIAS, Honorary Chief Scientist & Advisor, Pothikrit Institute of Health Studies (PIHS), Bangladesh. Last presentation in this session was by **Prof. Abdullah Al Musa,** Secretary General, Higher Council for Science and Technology (HCST), Jordan, who presented on the topic of **Biodiversity Economics**.

Session 4 started off with a presentation entitled Metamaterials and their Applications by Prof. Hala El-Khozondar FIAS, Professor, Islamic University of Gaza, Palestine followed by a presentation on Research and Innovation for Economic Development by Prof. Irfan Ahmad, Assistant Dean for Research, Carle Illinois College of Medicine, University of Illinois at Urbana-Champaign, USA. Prof. Irshad Hussain, Professor, Department of Chemistry & Chemical Engineering, SBA School of Science & Engineering (SSE), Lahore University of Management Sciences (LUMS), Pakistan delivered a presentation on Functional Nanomaterials for Biomedical Applications. Prof. Jackie Ying FIAS, Founding Executive Director, NanoBio Lab, Institute of Materials Research and Engineering, USA joined the conference from Singapore through Zoom and presented on the topic of Design and Synthesis of Nanomaterials for Biomedical and Energy Applications. The last presentation of the session was by Prof. Noor M. Butt FIAS, Professor & Chairman, Preston Institute of Nano Science & Technology (PINSAT), Preston University Kohat, Pakistan on The Multidisciplinary BS Degree in Nanoscience and Nanotechnology: Its growing Academic and Socio-Economic Importance.

Lastly, the conference included a Panel Discussion Session on **How STI can meet** the Challenges of Socio-economic Development in OIC Countries, chaired by Prof. Adnan Badran FIAS (Jordan) with panelists Prof. Atta-Ur-Rahman (Pakistan), Prof. M. Iqbal Choudhary FIAS (Pakistan), Prof. Hasan Mandal (Turkey) joining on Zoom & Mr. Michael Wadleigh (USA).

At the conclusion of the Conference, Prof. Atta-ur-Rahman made some closing remarks and read the adopted IAS 2023 Karachi Declaration on **Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries.** 

The declaration of the conference (approved by the Fellows of the IAS and participants in the IAS 24<sup>th</sup> Conference):

Called on OIC member states for the inclusion of enquiry-based education to enhance creativity, curiosity and problem solving for building-capacity in STI and enriching human resources.

Called on OIC member states to formulate and implement National Innovation Policies in order to promote entrepreneurship targeted at manufacture and export of high technology goods.

Called on OIC member states to identify centers of excellence for the IAS network STIs leading to regional R&D delivery or **commons** scientific application, innovation and leading to socio-economic development and digital transformation.

Bridge the academia and industry for joint R&D leading to socio-economic development.

Create social and technology parks and incubators to commercialize the delivery of research and innovations into start-up SMEs and enhance diversification of new materials and quality control.

Create a consortium for a sustainable **triangle of energy-water-food security** linked to IAS platform to network reputable research centers in OIC countries for self-reliance and meeting the SDGs, and call on COMSTECH to increase their mobility grants to scientists from LDCs to centers of excellence for training and research in combating poverty and hunger.

Strengthen world class research institutions, such as the International Center for Chemical and Biological Sciences, at Karachi University, and use them for human resource development in frontier fields of science and technology in the OIC region.

Align cooperation and collaboration with private sector on achieving a sustainable triangle of food, water and energy security, for future generations.

Promote cooperation and collaboration of the private sectors for health security of vaccines and drugs to embark across borders, a joint enterprise of manufacturing vaccines and needed drugs for emerging pandemics in the OIC member states.

Academia and research centers of OIC member states should encourage interdisciplinary research to deal with "common" problems of the Islamic world, including fields of humanity and social sciences such as climate change, the triangle for sustainability, population, poverty, Medicare etc.

Urge the OIC member states to invest at least 1% of their GDP in research in science, technology and innovation (STI) for socio-economic development.

Encourage the OIC member states to provide sustained support to the OIC S&T institutions, such as COMSTECH and IAS so that they can fulfil their assigned mandate.

Encourage the OIC member states to venture into getting benefits of game changing technologies like nanotechnology. Artificial Intelligence (AI), and other emerging technologies, including radionuclide medical technology leading to the 4<sup>th</sup> Industrial Revolution.

Lastly, the IAS through its declaration extended its appreciation and gratitude to His Excellency President of Pakistan for his patronage of the 24<sup>th</sup> IAS scientific conference and to all organizations and institutions that extended sponsorship for this conference, these are; OIC Standing Committee on Scientific and Technological Cooperation (COMSTECH), Pakistan, International Center for Chemical and Biological Sciences (ICCBS) and Higher Council for Sciences and Technology (HCST), Jordan.

As part of the follow-up action to the conference, the Academy will circulate the IAS 2023 Karachi Declaration to concerned individuals and relevant agencies throughout OIC and developing countries, so that measures are taken to put into action the ideas proposed at the conference.

The presentations delivered at this conference are published on YouTube; <a href="https://www.youtube.com/@iccbs.pakistan5655/streams">https://www.youtube.com/@iccbs.pakistan5655/streams</a>

The IAS will also publish the complete proceedings of the conference online and will be distributed internationally.

### **ADDRESS OF**

### HIS EXCELLENCY PROF. MUHAMMAD IQBAL CHOUDHARY, COORDINATOR GENERAL, COMSTECH AND DIRECTOR, ICCBS, PAKISTAN



Honorable Syed Murad Ali Shah, The Chief Minister

Prof. Atta-ur-Rahman FRS Patron in Chief

Prof. Adnan Badran, President of the Islamic World Academy of Sciences

Prof. Khalid Mahmood Iraqi, The Vice Chancellor

Mr. Aziz Latif Jamal Chairman Husein Ebrahim Jamal Foundation

Ms. Nadira Panjwani, Chairperson Dr. Panjwani Memorial Trust Mohtaram Mureed Rahimon sahib

Dignitaries, Diplomats, Distinguished Fellows *Ladies and Gentlemen* 

### Assalam o alaikum

- 1. I am very pleased to welcome the Honorable Chief Minister, distinguished fellows of the Islamic World Academy of Sciences, and other valued guests on behalf of the ICCBS and OIC-COMSTECH.
- 2. The theme of the event "sciences for sustainable development" is timely and important. The foundational tenant of scientific enterprise is to benefit the human society, while protecting the ecosystem we live in. It is now globally recognized that only science and technology can help the world to meet the enduring challenges of climate change, poverty, and hunger.
- 3. We are fortunate to have with us outstanding scholars to speak on various aspects of the topic (Dr. Michael Wadliegh Oscar winning film maker and climate activist as the representative of UNESCO).
- 4. Science and technology has played a central role in global transformation. On the brighter side scientific breakthroughs, such as Green revolution and biotechnology has protected us against widespread famine, and antibiotics and antivirals have saved millions of lives. According to McKincy's report on "Next Big Things", post-industrial economies of the world will be driven by 12 emerging technologies, including big data, block chain, robotics, IOT, advanced energy storage devises, autonomous vehicle, third generation genomics, etc. These disruptive technologies will drive massive economic transformation and collectively generate wealth of 14 to 33 trillion USD by 2028.
- 5. On the other hand, in many cases the fruits of human ingenuity have not reached to the people who needed them the most. This has led to unprecedented inequality, and social

distortion. Dissymmetry in scientific development and their applications has created an inherent conflict between the haves and have-nots.

- 6. Therefore, development in science and technology is important but more important is to develop a science which is socially responsible, economically inclusive, and environmentally sustainable. Science with values of benefiting humanity, bringing ease in the lives of masses, and ensuring lasting peace and prosperity, while in complete harmony with the nature.
- 7. Unfortunately, the OIC region, home to over 1.9 billion people, is faced with daunting challenges of conflicts, poverty, and environmental degradation. Despite these challenges, it is the youthful population that would provide unprecedented opportunities and hope if their creative potential is fully unleashed.
- 8. The International Center for Chemical and Biological Sciences, established in 1966, is an excellent example of private-public partnership where leading philanthropic organizations have generously contributed in the development of world's finest research infrastructure. The ICCBS, since its inception, has contributed in global human resource development in frontier fields of science. Its thousands of alumni in five continents of the world are the permanent ambassadors of Pakistan. Currently over 600 Ph. D. students from home and abroad are benefiting from the excellence of the ICCBS. The center is also serving the industrial sector and federal and provincial governments in critical areas of national needs.

#### 9. Ladies and Gentlemen

I also serve as the Coordinator General of the OIC Standing Committee COMSTECH. The COMSTECH, comprise of 57 Ministers. In my tenure, COMSTECH has initiated major programs including:

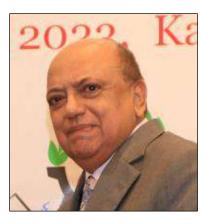
- 1. OIC's largest research fellowship programs
- 2. Health Africa initiatives
- 3. Capacity building in food security
- 4. 500 Fellowships for Palestinians
- 5. Program for refugee scientists
- 6. OIC Technology Portal
- 7. Research grant programs with IFS and ICGEB
- 8. Yemen, Sudan, Somalia, Kirghizstan, and Somalia programs

COMSTECH has established various institutions, including the Islamic World Academy of Sciences and 13 inter-Islamic networks for the S&T development in different fields.

At the end I would like to express my gratitude to our Chief Minister for the sustained support he has provided to the ICCBS for all these years, and our distinguished and valued guests for their presence here this morning.

Assalam o alaikum Wa rahmatullah

# REMARKS OF MR. AZIZ LATIF JAMAL S I. CHAIRMAN, HUSEIN EBRAHIM JAMAL FOUNDATION PAKISTAN



Honorable Chief Minister Syed Murad Ali Shah Vice Chancellor Prof. Dr. Khalid Mahmood Iraqi

Prof. Dr. Atta-ur-Rahman FRS, Patron in Chief ICCBS

Prof. Dr. Adnan Badran, President of the Islamic World Academy of Sciences

Prof. Dr. Muhammad Iqbal Choudhary, Director ICCBS and Coordinator General COMSTECH

Mohtarma Nadira Panjwani sahiba, Chairperson Dr. Panjwani Memorial Trust

Distinguished Delegates

Excellencies

Ladies and Gentlemen

#### Assalam o alaikum

- 1. It is with greatest pleasure that I welcome the Honorable Chief Minister, and all of you to the inauguration ceremony of the 24<sup>th</sup> International Conference on Science and Technology for Sustainable Socio-economic Development of the OIC Region.
- 2. This major event is jointly organized by the OIC Standing Committee on Science and Technology (COMSTECH) and International Center for Chemical and Biological Sciences. Over 50 participants, including over 30 fellows of the IAS from some 19 countries, are here to attend this important event.
- 3. The IAS is one of the key organizations established by COMSTECH General Assembly. I am pleased to learn that IAS is working closely with the COMSTECH and ICCBS for the capacity building of the young scholars from OIC countries for the science and technology based socioeconomic development of the OIC region.

#### 4. Ladies and Gentlemen

National capacity in science and technology has strategic importance, and thus establishing, nurturing, and strengthening worked class research institutions are imperative for sustainable science based socioeconomic development. With this vision, my late father Mr. Latif Ebrahim

Jamal, has decided to invest in the establishment of Husein Ebrahim Jamal Research Institute of Chemistry, an institution which is now a global center of excellence in frontier research in the field of chemical and biochemical sciences. The HEJ Foundation since then has continued the traditions of legendary Latif Ebrahim Jamal sahib, and has established another two large centers at the International Center for Chemical and Biological Sciences. Our commitment remains firm and strong, as we fully appreciate that magnificent institution, led by three generations of most committed eminent scientists, is helping our beloved country Pakistan at every time of need. This institute has laid a strong skill base for the nation and produced much needed Ph. D. level manpower. In the future too, I and next generation of Jamal family will continue to support this magnificent institution for the greater good of the country.

- 5. There are three major contours of this S&T capacity building initiatives. First and foremost is the human capacity building for which the Husein Ebrahim Jamal Foundation has established a myriad of institutions, from schools to colleges, vocational training centers, as well to university campuses. The second important contour is the establishment of high quality research and development institutions in frontier technologies. We are glad that along with the world famous H. E. J. Research Institute, we have also contributed a research building for the nanotechnology center, the only one of its kind in the country. The third is the linkages between the academic research with industrial sector. For this purpose, our foundation is working very hard to bring top industrialists of the country to the ICCBS and providing them platform to benefit from the excellence of this premier research establishment.
- 6. At the end I would like to express my gratitude to the leadership of the ICCBS Prof. Dr. Atta-ur-Rahman FRS and Prof. Dr. M. Iqbal Choudhary, for their life long struggle to strengthen, nurture and protect this world class institution. We are committed to stand by them at all turbulent times as this institution is both a national asset and national pride.
- 7. I would like to thank once again Excellency the Chief Minister for gracing the occasion and for his sustained support and patronage to the ICCBS.
- 8. Ladies and Gentlemen

I am indebted to your presence here this morning as well.

Assalam o alaikum

# REMARKS OF MS. NADIRA PANJWANI CHAIRPERSON, DR. PANJWANI MEMORIAL TRUST, PAKISTAN



Excellency Syed Murad Ali Shah Sahib, Dr Azra Fazal Pecheou Sahiba, Distinguished Panel Ladies & Gentlemen,

Assalamun Alaikum & Good Morning

On behalf of myself and all members of the Panjwani Trust which is the founding body of the Dr Panjwani Center for Molecular Medicine & Drug Research at ICCBS, it is my pleasure, it is my privilege to welcome all of you to today's inaugural session for the 24th Scientific Conference of the Islamic Academy of Sciences.

As you know, and this is also for the information of our foreign guests here, this center is one of the premier scientific establishments of Pakistan and a hub for frequent scientific gatherings.

The opportunity of hosting this prestigious international event of the Muslim World of science is indeed a unique honour for all of us.

Ladies & Gentlemen,

On the subject of Muslims and Science, it is customary to take great pride in our past and to talk about the grandeur of the Golden age of Islamic science which roughly speaking was at its peak from the 8th to the 13th century AD.

This was a period of unprecedented discovery and learning in all major capital cities of Islam like Baghdad, Cairo and Cordoba, which became citadels of science, philosophy, medicine and education.

However, the intellectual decline that set in after the Mongolian invasions, the splintering of the Abbasi dynasty, the misplaced religious intolerance towards the spirit of scientific inquiry, the shifting of focus from science to religious dogma and the consequent surge in the political power of religious leaders, gradually converted the blossoming garden of Islamic science into a dry desert which has remained parched and barren to this day.

There may be the occasional examples of personal or organizational excellence here and there, but this does not address the larger problem of our failure in the fields of technology, innovation, R & D and the production of ideas.

57 Muslim countries of the world since 1901 have received only 3 Nobel awards in the fields of science and all three did their award-winning research outside their home countries.

Muslim countries on average spend far less than 1% of their GDP on research and development and their contribution to global scientific literature is a meagre 1.2%.

Today we are in a state of permanent dependence on the West which thrives on the dynamism of its scientific and technological advancements.

It is evident that lack of political will, lack of a futuristic vision and the failure to keep up with the rapid pace of change are responsible for this disappointing situation.

Whenever a speech is censored, whenever a thought is forbidden and whenever a freedom is denied, the chains of intellectual captivity are cast. To break these chains, we need to awaken our minds, our hearts and our collective conscious.

To those of you, who are thought leaders and decision makers, I submit that the time for a ruthless introspection is upon us.

Today, a nation of 230 million and more, like Pakistan, is pleading for handouts from international lenders.

Looking further afield, with a few notable exceptions, majority of the Muslim states are in a state of neo-colonial and indirect subjugation. Even the economically affluent Muslim countries are client states of the major foreign powers for their protection and survival. This disgrace is a testimony of our collective failure.

The theme of this conference is Socio-Economic Development in OIC Countries therefore Assemblies such as this must be used to cut through the chase and confront our existential challenges.

We need to rethink the reason and the purpose for our existence.

In closing let us draw inspiration from the words of our Holy prophet, may peace be upon him, "Whoever walks in the pursuit of knowledge, Allah facilitates for him the way to heaven".

Ladies and Gentlemen, I wish you a great conference with meaningful and productive outcomes for the greater good of the Ummah.

Thank you very much.

# STI FOR SOCIO-ECONOMIC DEVELOPMENT IN OIC MEMBER STATES OPENING ADDRESS HIS EXCELLENCY ADNAN BADRAN PRESIDENT, IAS



Dear Fellows of the Academy, Ladies and Gentlemen,

Since our 23<sup>rd</sup> IAS conference which was held in Rabat under the Patronage of His Majesty King Mohammad VI of Morocco, two fellows of our academy Prof. Abdul Salam Majali of Jordan and Prof. Abdul Latif Ibrahim of Malaysia, have passed away, our condolences and God bless their souls. May I ask for a moment of silence.

Our academy is back with vigour after its interruption by the pandemic. Our world is passing through crisis of fragmentation. Wisdom is so badly needed to meet the interconnected challenges. We are encountering a global economic crisis, climate change, income inequality, tension between East and West, loss of trust and lack of resilience.

As stated in Davos 2023 declaration, that the world more than ever needs, smart thinking, wise leaders, honest decision makers, academia responsible citizens to forge the pathways to cooperation, dialogue, building bridges of peace and stability, rather than destroying bridges of our fragmented world.

With the power of collaboration, innovation and ingenuity, we have the capacity to turn challenges into opportunities particularly in the Islamic world.

UNESCO after world war II in 1945 was created to end all wars, with preamble of its constitution stating: "If wars start in the minds of men and women, then we can build the defences of peace in the minds of men and women through the pillars of **education**, **science**, **culture** and **communication**.

One great pillar of education is "Learning to live with others", respect other cultures, other traditions and other values, and respect differences among human beings. Diversity is the virtue of

<sup>&</sup>lt;sup>1</sup> The 24th Conference of the Islamic World Academy of Sciences (IAS) on "Challenges to Promote Science & Technology For Socio-Economic Development In OIC Countries"

life diversity of fauna and flora of our planet, diversity of minds and thought and expression, not to discriminate against others' beliefs, color, gender, ethnicity or who differs in his thought accept differences.

So, science is the **common ground,** is the **meeting place** for us in the Islamic world as pathway to socio-economic development. Cooperation and collaboration among scientists and scientific centers are essential to achieve progress and to migrate OIC countries from developing into a developed world.

Such cooperation to become effective requires governance and management of STI to speed up the catalysis to its climax for socio- economic development.

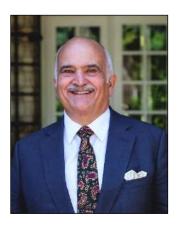
A consortium of centers of excellence in OIC countries is required to work on a **common problem** shared and cared by all countries as for example, **energy-water-food security** for a sustainable triangle, and this is for one and cooperation and collaboration in **frontier area of sciences**, and this is for two.

In the Islamic world we should bridge the delivery of R&D into socio-economic development. The linkage between academia and industry is absent and there is a gap in most member states. Partnership with the private sector is essential for commercialization.

Finally, with those remarks, I wish you a successful conference of deliberations and declaration.

# BUILDING BRIDGES IN THE OIC COUNTRIES STATEMENT BY

# HIS ROYAL HIGHNESS PRINCE EL HASSAN BIN TALAL FOUNDING PATRON OF THE ISLAMIC WORLD ACADEMY OF SCIENCES



Dear Fellows of the Academy,

Dear Guests,

Disasters, whether elemental, foreseeable, deliberate, or accidental, carry incalculable harm to individuals, families, towns, cities, regions, and entire countries on a physical, social, emotional, and economic level that numbers and statistics cannot convey, as exemplified by the devastating floods in Pakistan and the earthquakes that have hit Syria and Turkey.

In memory of those who have passed away, let us observe a moment of silence. God almighty bless them all.

Man-made and natural disasters are transboundary and complex, and therefore require us to develop a critical mass of interdisciplinary and multidisciplinary science.

Even if emissions meet the 2015 Paris Agreement reduction pledges, children born after 2020 will, on average, face seven times more scorching heatwaves, almost three times more droughts, three times as many crop failures and river floods, and twice as many wildfires during their lives than their grandparents.

Choosing solidarity, interdisciplinary cooperation, and multilateralism is vital for the betterment of all. There is, therefore, a collective and intergenerational responsibility to advocate for the advancement of *regional commons* through evidence-based *policy*, rather than *politics*.

As a consequence, I encourage policy makers and members of the scientific community of OIC countries to recognise that science transcends political boundaries, making it an effective tool for collaboration.

As such, it is essential to encourage collaboration between centres of excellence in OIC member states.

Whether in the context of climate change, food security, biodiversity, or poverty reduction, all things falling under the umbrella of the water-energy-food security nexus, human welfare and dignity must be the guiding principles for collaboration.

Partnerships and cooperation within this nexus may contribute to self-reliance and quality of life, particularly for the most vulnerable and marginalized.

It may be tempting to view the pandemic or natural disasters as one-off events, but both shocks to the global system demonstrate that in the absence of intra-independence, interdependence and interconnectedness are just a recipe for fragility and insecurity.

For decades I have called for the development of a Zakat Foundation to coordinate the collection of zakat and direct it across borders to individuals and communities in urgent need. By institutionalizing Zakat, a transboundary cultural and religious duty, we can strengthen the resilience of vulnerable groups while creating a sense of cultural affinity.

The concept of human dignity, or karama insaniya (in Arabic), does not discriminate; it embraces the richness of diversity. Zakat, too, does not discriminate and would equally help anyone in need, regardless of their race, religion, social status, or anything else.

There is no doubt that science, technology and innovation all play a key role in socioeconomic development of OIC countries, but policies must always be made with reference to human dignity and cultural affinity in order to improve people's lives in the long-term.

It is also essential that the "commons" for socio-economic development are created through an inquiry-based learning environment that encourages cooperation, critical thinking, and innovation.

My best wishes go out to you in this crucial endeavour, to which we are all dedicated.

# 10

### Message from Dr Arif Alvi President of the Islamic Republic of Pakistan

Message on the occasion of the 24th International Scientific Conference of the Islamic World Academy of Sciences (IAS) on "Challenges to Promote Science and Technology for Scio-Economic Development in OIC Countries"

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I would like to warmly welcome all of you to the 24th International Scientific Conference of the Islamic World Academy of Sciences on "Challenges to Promote Science and Technology for Socio-Economic Development in OIC Countries" which is being jointly organized by the Islamic World Academy of Sciences (IAS), Organization of Islamic Cooperation Ministerial Standing Committee on Scientific and Technological Cooperation (COMSTECH) and the International Centre for Chemical and Biological Sciences (ICCBS).

I would like to express our deep gratitude and thanks to His Royal Highness Prince El-Hassan bin Talal for his gracious patronage of the Islamic World Academy of Sciences. I also wish to convey our appreciation to COMSTECH and ICCBS for hosting the Conference of the Islamic World Academy of Sciences on a subject of increasing importance for the Muslim Ummah.

As you are aware, Muslim Ummah is facing major challenges in promoting sustainable and inclusive socio-economic development. These challenges relate to poverty alleviation, food security, low literacy, youth employment, health and well-being and the impacts of climate change. These challenges could be overcome successfully by making joint and coordinated efforts by the Muslim countries by harnessing the potential of science, technology and innovation for the benefit of the entire OIC region. The growing severity of these challenges demands efficient and effective actions based on strengthening capacity in the fields of science, technology and innovation.

For this purpose, we need to increase linkages and active collaborations among academia, industry, governments and organizations like COMSTECH, IAS, and ICCBS. Business communities, IT professionals, scientists, and youth of OIC countries must be given more opportunities to interact, share their experiences, and learn from each other. Furthermore, they must undertake joint initiatives and projects in the field of Science and Technology, particularly in emerging fields of IT, like Artificial Intelligence, Cyber Security, Data Analysis, and Cloud Computing.

It is a matter of great satisfaction that COMSTECH has initiated a large number of programs for the development of science, technology and innovation in the Islamic countries. In this endeavour, COMSTECH has made valuable contribution in establishing the Islamic World Academy of Sciences. Another noteworthy action by COMSTECH is to align its programs with the Sustainable Development Goals (SDGs) of the 2030 Development Agenda.

In the end, I would like to call on distinguished fellows of the Islamic World Academy of Sciences to support COMSTECH in this noble mission to speed up scientific and technological progress in the Islamic countries as per COMSTECH's mandate of enhancing cooperation in science and technology and creating institutional structures for research, and development.

The challenges of promoting socio-economic development in the Muslim Ummah are significant. But I am confident that you will succeed in your objectives. I wish you a productive and successful meeting.

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### REMARKS OF PROF. DR. KHALID MAHMOOD IRAQI VICE CHANCELLOR, UNIVERSITY OF KARACHI PAKISTAN



Honorable Chief Minister Syed Murad Shah, Chief Minister Sindh Prof. Dr. Atta-ur-Rahman FRS, Patron in Chief ICCBS Prof. Dr. Adnan Badran Former Prime Minister of Jordan, and President of The Islamic World Academy of Sciences Prof. Dr. M. Ighal, Choudhary, Coordinator, General, OIC-

Prof. Dr. M. Iqbal Choudhary, Coordinator General OIC-COMSTECH and Director ICCBS

Mr. Aziz Latif Jamal, Chairman Husein Ebrahim Jamal Foundation Ms. Nadira Panjwani, Chairperson Dr. Panjwani Memorial Trust Diplomats

Distinguished Delegates *Ladies and Gentlemen*,

### Assalam o alaikum

- 1. On behalf of the University of Karachi, I am pleased to welcome the Honorable Chief Guest Syed Murad Ali Shah, distinguished fellows of the World Academy of Sciences, and valued guests at the inauguration of this prestigious pan Islamic event.
- 2. Science and technology are important aspects of our lives as the play a central role in socioeconomic development of any nation.
- 3. I am happy to note the IAS is organizing its 24<sup>th</sup> international conference on the application of science and technology for sustainable socioeconomic development in the OIC region.
- 4. The Muslim world faces numerous challenges, including food, energy and water scarcity, overwhelming disease burden, and huge negative impact of climate extremities. As a result, poverty, conflicts, deprivation and unemployment are effecting the lives of millions of people all across the Muslim lands.
- 5. In such a gloomy situation, science and technology and modern day innovation are the only way towards a sustainable and inclusive socioeconomic development.
- 6. In this context the event like this with brightest minds of the Muslim world, present at one platform, can guide the policy makers, politicians, production sector and universities towards coherent, bipartisan, and long term policies and plans of action.

### 7. Ladies and gentlemen,

The International Center for Chemical and Biological Sciences of University of Karachi is committed to not only build human capacity but also to provide necessary technological basis for science based development of Pakistan. The ICCBS is premier institution of

- excellence with global recognition. We at the University of Karachi are proud to host this world class institution which is also playing key role in global capacity building.
- 8. The excellence of the ICCBS is internationally recognized, and impact of its services for the nation is far beyond the scope of these short remarks. This legendary institution owes its phenomenal success to tireless, and sincere leadership of Prof. Salim uz zaman Siddiqui to Prof. Atta-ur-Rahman, and now my dear brother Prof. Muhammad Iqbal Choudhary and their outstanding teams.
- 9. Ladies and Gentlemen,
  - Allow me at this moment to recognize The Islamic World Academy of Sciences, COMSTECH and ICCBS for jointly organizing this major international event at the University of Karachi. The largest public sector and second oldest university of Pakistan.
- 10. As I conclude I wish this event an immense success and looking forward to the outcome which I promise to highlight at all the major fora.
- 11. Thank you very much Honorable Chief Minister and Ladies and Gentlemen for you presence here this morning.

Pakistan Zindabad.

### ADDRESS OF HIS EXCELLENCY. SYED MURAD ALI SHAH CHIEF MINISTER OF SINDH PAKISTAN



Memorial Trust Distinguished Fellows of the IAS Foreign and Local Delegates

**Diplomats** 

Ladies and Gentlemen

Assalam o alaikum

Prof. Dr. Adnan Badran, President of the World Academy of Sciences

Prof. Dr. Atta-ur-Rahman, Patron in Chief

Prof. Dr. Muhammad Iqbal Choudhary, Coordinator General COMSTECH

Prof. Dr. Khalid Mahmood Iraqi, Vice Chancellor, University of Karachi

Mr. Aziz Latif Jamal, Chairman Husein Ebrahim Jamal Foundation

Ms. Nadira Panjwani, Chairperson Dr. Panjwani

It is indeed a great pleasure for me to inaugurate the 24<sup>th</sup> Conference of the IAS on, "Challenges to Promote Science and Technology for Socio-economic Development in OIC Countries" at the International Center for Chemical and Biological Sciences. I am pleased to see a large number of distinguished fellows participating in this international event. This major science event is an important step forward towards a better understanding how science and technology can be effectively deployed to solve enduring problems of poverty, food insecurity, climate change, in the Muslim world. This gathering represents the growing interest and commitment of Muslim Ummah towards the science and technology for human wellbeing. Personally, for me, participation in the events of this type is always a reassuring and gratifying experience.

I am pleased to learn that this 24<sup>th</sup> Scientific Conference of the IAS is organized under the patronage of the HE President of Pakistan and HRH Prince Hasan bin Talal. I have been told that IAS, established by the COMSTECH, is rendering excellent services to science in several years through promoting understanding and appreciation of the role of science and technology in sustainable development of the Muslim world. The IAS is a world renowned science Academy based in Amman Jordan, established by the COMSTECH the OIC's Ministerial Standing Committee for Sciences and Technology Cooperation. It comprises 57 Ministers of Science & Technology of the 57 OIC member states, chaired by the President of Pakistan. I congratulate the IAS, COMSTECH, and the host institution ICCBS for their collective efforts in moving towards creating a renaissance of science and technology in the Muslim world.

Being a professional Engineer, I am very much aware of the importance of the need of research in science and technology. It is only through the applications of science and technology that we can handle the enduring challenges of poverty, climate change, food insecurity, increasing disease burdens, that world faces today. We need to not only solve many local issues, but also partner with other nations in handling global challenges. The theme of the event is therefore timely and significant.

### Ladies and Gentlemen

In the enterprise of science and technology, strong research and development institutions play a key role. I am pleased to see that our premier research institution, the International Center for Chemical and Biological Sciences constantly is striving to upgrade its capacity and human resources for frontier research and graduate training in chemical, biomedical and biochemical sciences. This center is an excellent example of the strong commitment of our private sector, Federal and Provincial Governments, International donors and our scientists and researchers towards the science and technology based development in Pakistan.

It is heartening to learn that the International Center for Chemical and Biological Sciences has been recognized as the UNESCO and OIC Center of Excellence, as well as the WHO collaborating center. The ICCBS has received Best Science Institution in Muslim World Prize from the Islamic Development Bank twice in 2004 and 2010. The ICCBS is also the only center where over 200 scientists from all over the world, including western countries, are annually visiting for research training and joint projects. These are indeed unique honors on which our nation take pride. I understand that it was only possible through the internationally recognized academic status and excellent leaderships of Prof. Atta-ur-Rahman and Prof. Iqbal Choudhary. I must acknowledge here the vision and patriotism of Nadira Panjwani Sahiba, Chairperson Dr. Panjwani Trust, and Mr. Aziz Latif Jamal, Chairman Husein Ebrahim Jamal Foundation, which led to the establishment of the world research centers at the ICCBS. Their role in the promotion of higher education and scientific research in Pakistan will always be cherished. Personally, for me, visiting a center of excellence of this stature is always a reassuring and gratifying experience.

We at the Sindh Government have placed the ICCBS in the center of our science and technology based initiatives. Various Ministries of my government are working closely with the ICCBS management to establish research centers, upgrade existing laboratory infrastructure of the province, as well to conduct some of the enduring issues in health and agriculture which province is facing today. This includes the establishment of Sindh Serology and DNA Forensic lab., upgradation of Chemico-bacterial lab in Karachi, and establishment of Traditional Medicine Research Center. I am also delighted to learn that my idea of the establishment of seamless learning platform for the universities has been implemented as the SIREN (Sindh Innovation, Research, and Education Network) by the ICCBS which connects leading universities of Sindh. My Government has also decided to declare five centers of the ICCBS as Sindh Health Care Research facilities in fields such as regenerative medicine, disease genomics and pharmaceutical research.

At the end I must thank the COMSTECH, with Prof. Iqbal Choudhary as its Coordinator General, for organizing this major international event at the ICCBS in collaboration of the Islamic World Academy of Sciences and the ICCBS, University of Karachi, for having me invited to this

prestigious occasion. I also assure you of the firm commitment of my Government towards protecting and strengthening Universities and research centers in the province and linking them to production sector for the benefit of common people.

Ladies and Gentlemen

Thank you very much for your presence here this morning.

Pakistan Pa'indabad *Allah Hafiz* 

### HIGHER EDUCATION, SCIENCE AND TECHNOLOGY-IMPERATIVES FOR SOCIO-ECONOMIC DEVELOPMENT

### ATTA-UR-RAHMAN FRS

UNESCO Science Laureate and Professor Emeritus, International Centre for Chemical and Biological Sciences, University of Karachi, Pakistan

### **ABSTRACT**



The remarkable developments in the higher education sector, triggered by the higher education reforms introduced by us during 2002-2008, have led to an unprecedented growth in high quality research publications in Pakistan. The focus of the HEC reforms was to improve the quality of higher education and research, provide greater access to higher education, and provide education relevant to national needs and international demands. The establishment of the Pakistan Education and Research Network (PERN) in 2004 brought a revolution by providing free access of

65,000 textbooks and 25,000 international journals to students, teachers and researchers (1). The single biggest contribution to the improvement of the higher education research environment was the emphasis of the HEC programmes on the development and absorption of high-quality faculty. About 11,000 of our brightest students were selected and sent abroad for training at PhD and post-doctoral levels to leading universities of the world in USA, UK, Germany, France, Sweden, Australia and Austria. The world's largest Fulbright program was initiated with 50% of the funds being invested by Pakistan. Pakistan was about 400% behind India in research output on a per capita basis but overtook India in 2017 and was about 20% ahead of India by 2018---- no mean achievement. A satellite (Paksat 1) was placed in space with some of its capacity directed to education. These remarkable transformations in the higher education, science and technology sections were applauded by neutral international experts and agencies (2-8) leading to many international awards (9-14).

The role of higher education, science and technology has now become central to socio-economic development. The stunning developments in artificial intelligence, new materials, energy storage systems, gene editing, regenerative medicine, and other disruptive innovations are changing the landscape of businesses of today and tomorrow. Some of these developments will be described

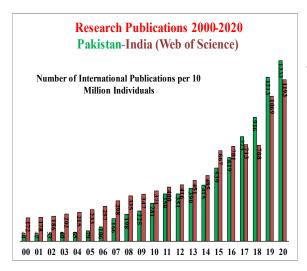


Fig.1: Research publications per capita in international journals, Pakistan versus India. Green bars indicate the number of international publications from Pakistan per 10 million population during the year 2000 (extreme left) to the year 2020 (extreme right). The red bars show the same data for India. As can be seen, Pakistan overtook India in the year 2018. The data is taken from the Web of Science and was kindly supplied by Prof. Raheel Oamar, former Rector COMSATS.

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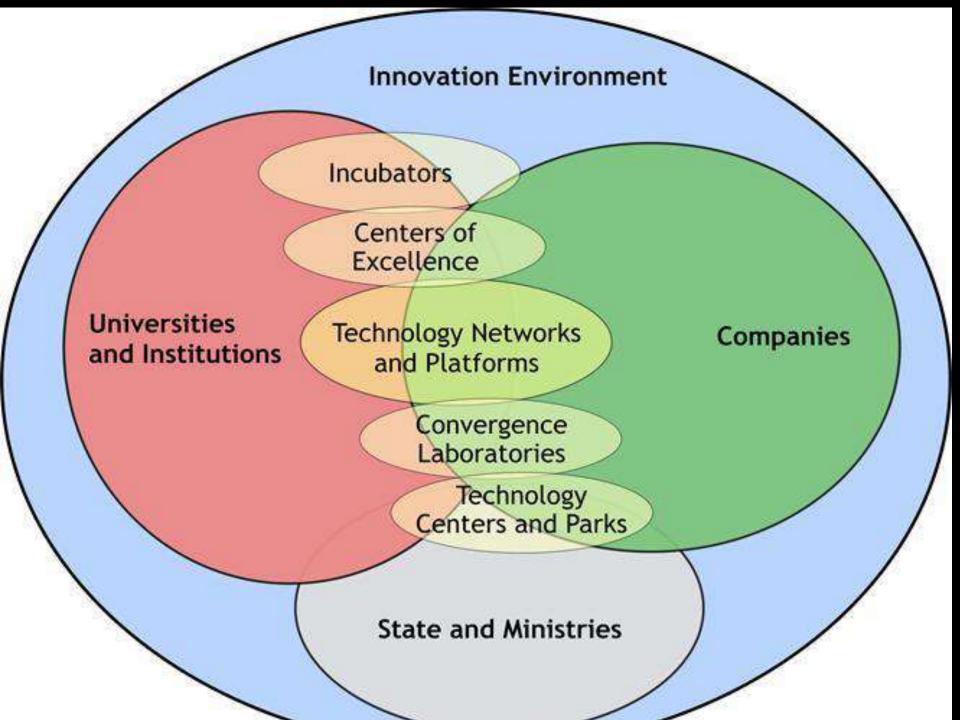
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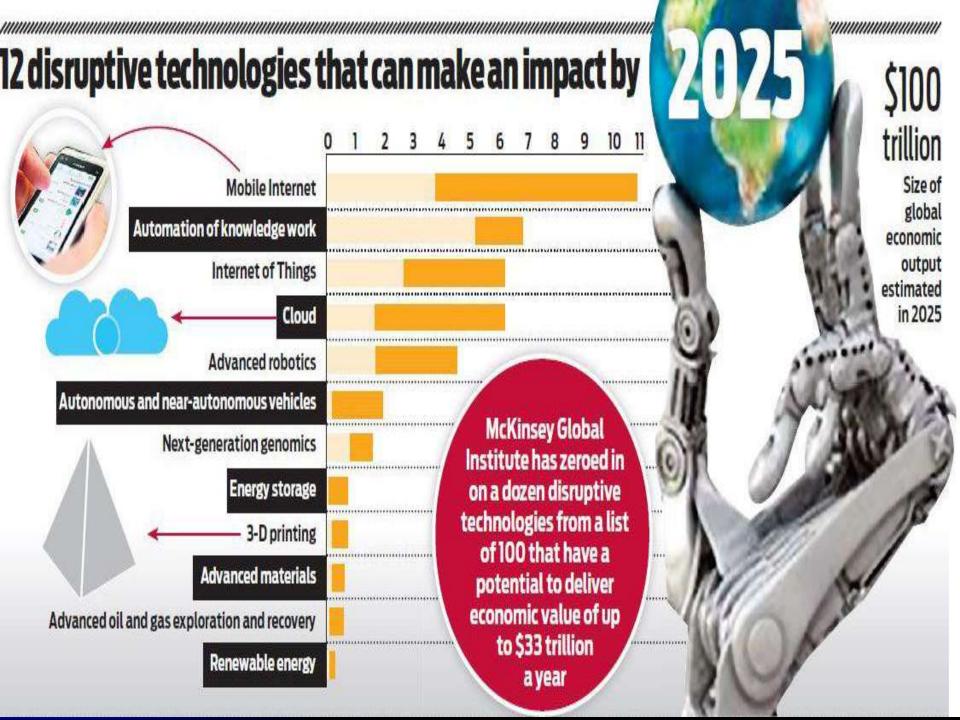
geography.org/af/Geography/Asia/Pakistan/Special Information/Report on some top Pakistani scienti sts

# Higher Education, Science & Technology: Imperatives for Socio-economic Development

Atta-ur-Rahman FRS

N.I., H.I., S.I., T.I.
UNESCO SCIENCE LAUREATE





### Innovation Determines Progress

Socio-economic development is no longer dependent on natural resources (eg.Japan, European countries)

KNOWLEDGE is now the main driving force of world economies

China
Singapore
Korea
Taiwan

### The Triple Helix: Knowledge Economy: Singapore

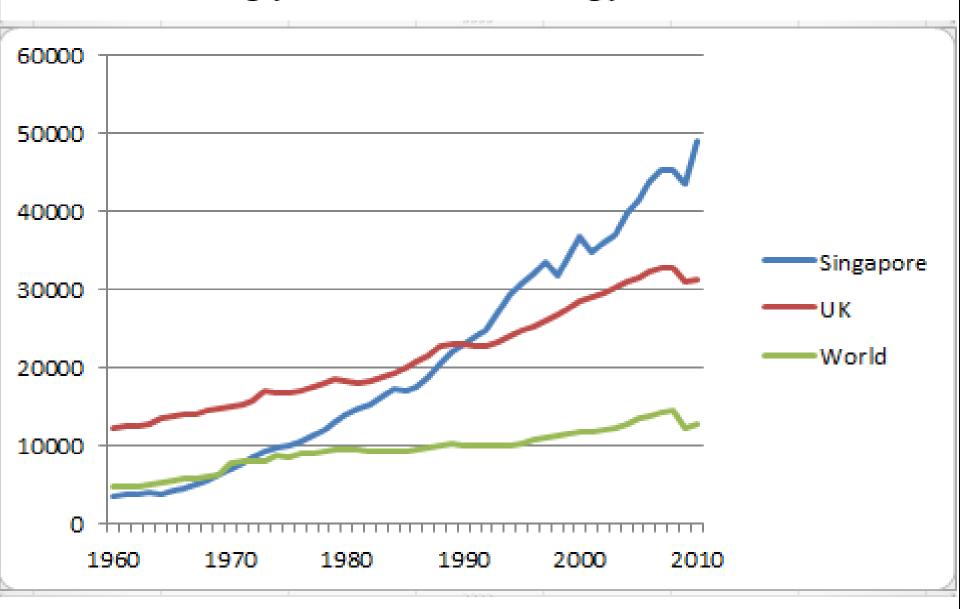
- Small country ---865 sq km (population 5 million)
- No natural resources: focus ONLY on human resources and high tech manufacturing/exports

Lee Kwan Yew: Leadership !!!!!!

### Mobilization of its human capital

- Exports: \$ 400 Bln
- GDP: \$ 467 Billion Through extensive growth in its high technology manufacturing industries

### GDP per capita (adjusting to inflation) - 1960 to 2010 Singapore vs fomer colonial ruling power UK



### Korean & Austrian Strategies

 Korean Minister of Education/Science is Deputy Prime Minister of Korea

 Austrian Minister of Science is also Minister for Economic Affairs as well as Deputy Prime Minister of Austria

### Pakistan---An Exciting Beginning !!

- My appointment as Federal Minister of Science & Technology/Information Technology& Telecom (2000) and later Chairman Higher Education Commission (2002-2008)
- 6000% Increase in Development Budget of Science & Technology/IT Telecom Ministry and later 3500% increase in Dev. Budget of Higher Education

- HEC an autonomous body reporting to PM
- Challenges: Quality, Access, Relevance

- Excite young minds about the wonders of science!
- Select and train the Brightest in top universities abroad
- Attract them back--- by creating an enabling environment :
- Salaries
- Research Funding
- Access to Literature
- Free Access to Sophisticated Instrumentation
  - Jobs on Arrival

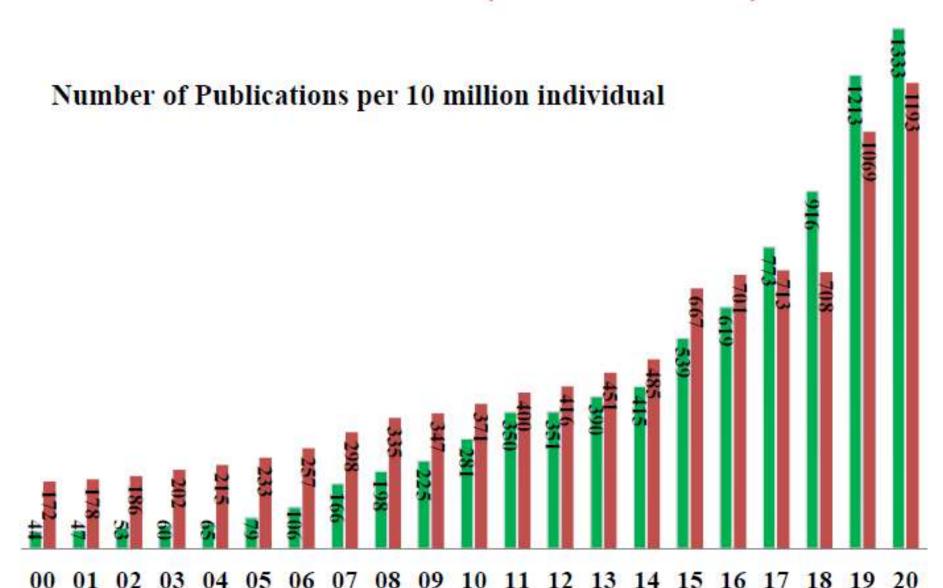
### Comparative analysis of TTS/BPS faculty . 4 KPIs

Total faculty BPS 28106 (PhD 8377, Non PhD 19729) TTS faculty 3599 (All PhDs)

+ TTS-BPS Analysis for Years 2014-2018

Key Performance Indicators	TTS (3599 PhDs)	BPS (8377 PhDs)
Intl. Publications	6171	2086
Intl. Citations	84280	23822
MPhil/PhDs Supervised	4164	2180
Research Grant Projects Secured	3032	681

### Research Publications 2000-2020 Pakistan-India (Web of Science)



Prof. Michael Rode, Chairman UN CSTD: "In no other country has the higher education sector seen such spectacular positive developments as that in Pakistan during the last six years."

Thomson Reuters (2016): "Pakistan has emerged as the country with the highest percentage of Highly Cited Papers compared with the BRIC countries (Brazil, Russia, India and China)."

ip-science.interest.thomsonreuters.com/incites-pakistan/

### Presentation to Indian PM

### "Pak threat to Indian science" ---Hindustan Times

Neha Mehta New Delhi, July 23, 2006

"Pakistan may soon join China in giving India serious competition in science. Science is a lucrative profession in Pakistan".

### Book Published 2022 (Chapter 5 on Pakistan Transformation)



Fostering Institutional Development and Vital Change in Africa and Asia

Fred M. Hayward



### Defying Gravity!

- National IT Policy formulated within 3 months of my appointment as Federal Minister (year 2000)
- E Governance Programs Initiated
- 15 Year Tax holiday given for IT industry
- Engineering Sciences given priority --NUST, UET Lahore and COMSATS Inst
  Inf Tech among top universities in
  Pakistan

### **Using Technology to Leap-Frog!**

Pakistan Educational Research Network

- Digital Library Program
- PAKSAT 1 (Pakistan's Educational Satellite)
- Pakistan's International Videoconferencing Network

### New Kind of *Hybrid*Engineering/Technology University

- Fchhochscule! (BS and MS in Applied Industrial Engineering)—combined with:
- Postgraduate Engineering University with Centers of Excellence in Selected Fields
- Technology Park with Industrial R and D
   Centers
- Split in 8 Portions (3 Austrian 5 Chinese Universities) each being developed in Partnership with different Foreign University
- Students must spend 500 hours in industry

# Engineering/Technology Hybrid University

- Cherry Picking: Benefitting with the strengths of different specialised universities
- Responsibilities of Foreign Partners:
- a) Train Faculty and Technicians
- b) Ensure Quality Assurance (quality of lectures, research exams etc)
- Provide Foreign Faculty for Lectures and Research
- d) Ensure Linkages with Foreign Industry

## Pak Austrian Fachhochschule at Haripur, Hazara



### **Disciplines & Partners of PAF-IAST**

No.	Disciplines (Fachhochschule)	Austrian Partners
1	Electrical and Computer Engineering	University of Applied Sciences, Joanneum, Graz
2	Computer Science Software Engineering	University of Applied Sciences, Joanneum, Graz
3	Chemical Engineering (Environment, Process and Energy Engineering)	University of Applied Sciences (MCI), Innsbruck
4	<b>Biomedical Sciences</b>	University of Applied Sciences, Joanneum, Graz
5	Information Design	University of Applied Sciences, Joanneum, Graz

No.	Disciplines (Research Centers)	Chinese Partners
1	Artificial Intelligence	Shenzhen Institute of Advanced Technology Guangdong University of Technology Johannes Kepler University (Linz, Austria)
2	Railway Engineering	Beijing Jiao Tong University, Beijing
3	Mineral Resource Engineering	China University of Mining and Technology, Xuzhou
4	Agriculture Food Technologies	Jiangsu University, Jiangsu

### The University in Sialkot will be a hybrid model with two portions.

One portion will be the Fachhochschule (BS and MS) in collaboration with Austria.

The other portion will be a postgraduate research portion (Mphil and PhD/postdoctoral) in collaboration with China, Austria and other countries.

THE GOLDEN INDUSTRIAL TRIANGLE ---- SIALKOT---- GUJRANWALA----GUJRAT !!!!!!

# Knowledge Economy Task Force

- There has been a 600% increase in Development Budget of MoST as a result of our Knowledge Economy Task Force Projects
- Significant increases in budgets of HEC (Projects worth about Rs. 42 bln added), and MoITT
- After 4 years of stagnant recurring budgets of universities/HEC ((65bln) due to poor advocacy, PM has agreed to increase recurring budget this year by Rs.15 Bln
- NRPU being revived with over 1200 grants being given this year as compared to only 100 grants/year

# Knowledge Economy Task Force

26 Major National Projects Under Way:

Artificial Intelligence

Internet of Things

Advanced Agriculture

High Speed Railways Engineering

**Energy Storage Systems** 

National Scholarships

Distance Education etc

# Knowledge Economy Task Force

- Tenure track system was allowed to decay over the last decade--- now 35% and 100% increases agreed to after my THREE presentations to PM and Finance Minister
- Faculty Development program is the heart of quality higher education. It had been severely curtailed, with only about 200-300 scholarships been given annually. Now plan to award 1200 scholarships this year
- MatricTech Program initiated

### **Blended Education:**

- A 6 billion rupee project begun at Virtual University, Lahore is for introducing a system of blended learning in our universities.
- This will result in students in our universities learning not just from their teachers but using Massive Open Online Courses (MOOCs) they will be able to benefit from lectures available at MIT, Stanford, Harvard and other top universities.
- This should result in a major improvement in educational standards.

### Foreign Scholarships:

• A 13 billion rupee scholarship project of the Knowledge Economy Task Force has been approved. The project is aimed at strengthening the faculty in our universities by sending large number of our brightest students to top universities abroad.

400% Increase in Budget of MoST

### MatricTech Programme:

• To produce citizens with specialized skills, a special Matric Tech programme has been launched as a pilot in about 500 schools so that in the last 3 years of their education, the matric students are trained in certain specialized skill sets.

# Artificial Intelligence and Other Emerging Technologies:

 Selected key areas that are being given a high national priority in order for Pakistan include Industrial Biotechnology, Regenerative Medicine, Information Technology, Artificial Intelligence, Machine Learning, Robotics, Big Data, Internet of Things, Block Chain Technologies.

# NADRA'S TAX PROFILING BROADENING AND ESTIMATION SYSTEM

Using NADRA 's (limited) transaction records with

innovative Artificial Intelligence (AI) Protocols, our

model identified 3.8 million non filers - each with a tax

liability of more than Rs 100,000 who should have paid

an estimated Rs 1.6 trillion in Income Tax in the fiscal

year ended 30 June 2017.

### TEST RESULTS AND EXPERIENCES

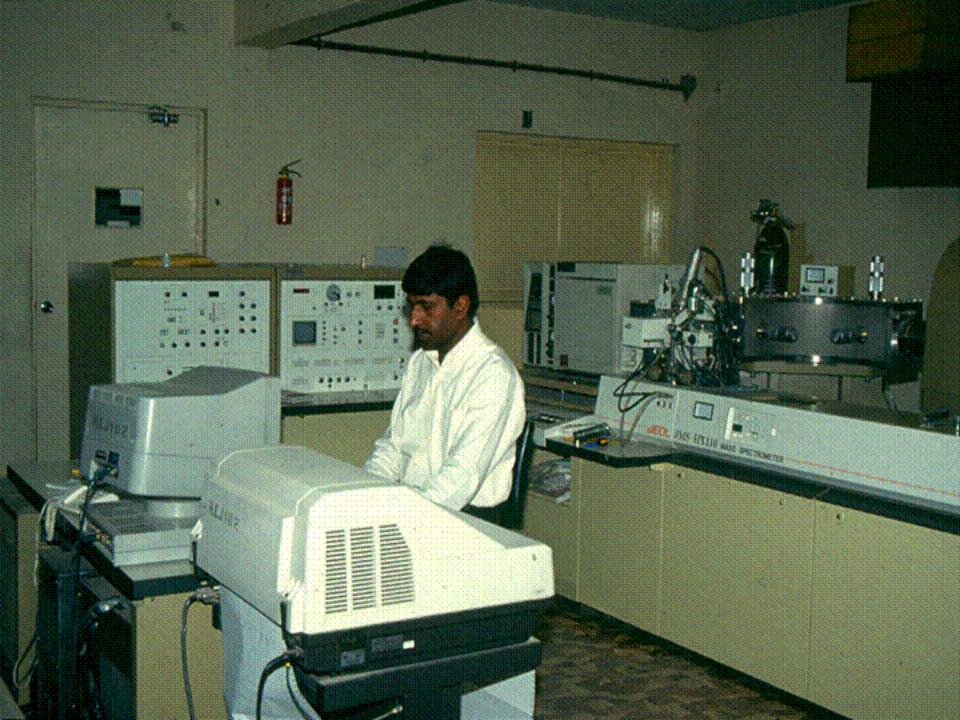
- After 21 June the number of declarations went above 141,000 in the following 6 weeks
- Resultantly, total declared Assets moved sharply up to Rs 3 Trillion and actual taxes paid to Rs 65 Billion.
- More than 90,000 non filers became filers and Total tax returns for the year ending 30 June 2018 crossed 2 million persons--- far the highest number ever in the history of FBR.

### i-MOOCs

- Integrated Approach to MOOCs
- All courses integrated and arranged according to levels (school, college, university) and disciplines
- www.lej4learning.com.pk



NUCLEAR MAGNETIC RESONANCE SPECTROMETERS





### **ICCBS – Awards and Honors**

<ul> <li>Fellow of Royal Society (FRS)</li> </ul>	2
Mustafa (PBUH) Prize 2021	1
UNESCO Science Prize	1
32 CIVIL AWARDS :	
Nishan-e-Imtiaz	1
Hilal-e-Imtiaz	5
Sitara-e-Imtiaz	13
Tamgha-e-Imtiaz/Pride of Performance	13
• D. Sc.	10
Khwarizmi International Award	5
ECO Award and Prize	3
IDB Prizes for Best Science Institution	2

### **INTERNATIONAL GRANTS**

I. International grants worth over \$ 37 million were won:

(a) Germany DM 5.7 million

(b) USA \$ 8.0 million

(c) UK £ 1.0 million

(d) Japan \$ 23.0 million

(e) Others \$ 3.0 million

2. Research projects worth another \$ 12.5 million from WHO, OPCW, USAID, ONR, NSF (USA) and British Council have been completed.



# Academician Atta-ur-Rahman Belt and Road Traditional Medicine Research Center, Changsha, Hunan, China



# Atta-ur-Rahman Institute of Natural Product Discovery, Malaysia



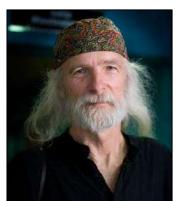
# Thanks

### UNESCO OPEN DATA TO STOP TRENDS TO GLOBAL SOCIO-ECONOMIC COLLAPSE

#### MICHAEL WADLEIGH

Founder, The Homo Sapiens Foundation (UNESCO) Science Activist, Oscar-winning Director, USA

#### **ABSTRACT**



CLOSED MASS. All humans, all life, all products are exclusively made from ever more rapidly degraded, depleted natural resources. Earth is closed mass, sunlight enters but there are NO meaningful material imports, exports or emigrations to other celestial bodies likely in any millennium soon, probably never. Earth was supplied once with finite material resources including the atmosphere - we've got what we got - and for socio-economic development anywhere in our globalized world we must make the best of them, but we are NOT.

CONSUMPTION. The cause of nature destruction including 90% of biodiversity loss is humanity's relentlessly accelerating natural resource

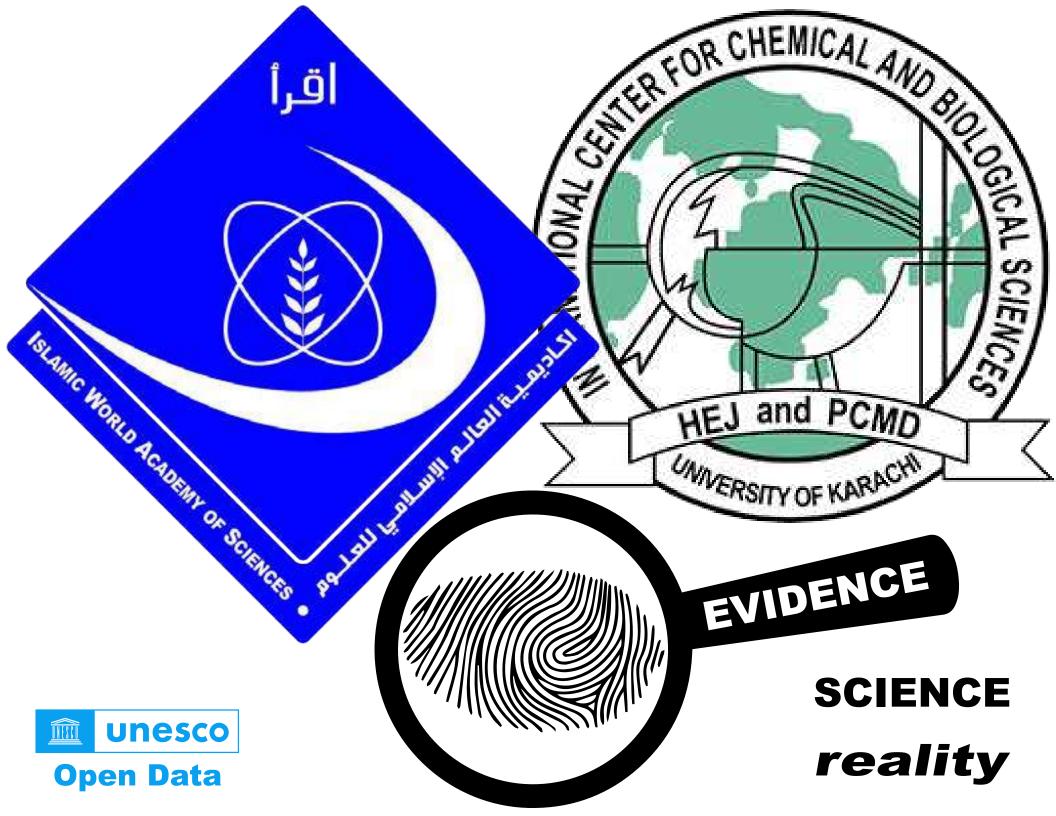
consumption (IRP), the greatest human activity, 103 billion tonnes of biomass, metals, minerals and fossil fuels extracted annually. On IRP trends just the next 35 years of natural resource consumption will equal the last 300,000 years, by 2100 annual consumption will be six times IRP's sustainable limit.

CLIMATE. The cause of climate change / global warming is humanity's ever increasing greenhouse gas emissions. At IPCC's best 83% likelihood, on current policies and pledges in just 4 years the carbon budget for dangerous 1.5°C global warming will be emitted, in only 17 years for disastrous 2°C, and by 2100 - when today's children should be alive -the budget for catastrophic 4°C will be emitted.

COLLAPSE. Combined with 6 times the sustainable natural resource consumption limit, 4°C global warming will cause massive global changes including shortages of every essential for human life - food, water, medicines, shelter - social-economic collapse with potentially hundreds of millions dead, billions forced from lands rendered uninhabitable.

RESPONSIBILITY. UN Ultra High developed nations (red in maps) the most educated, healthiest and wealthiest set the <u>standards</u> for all countries. Just 12% of humanity have 64% of global wealth, cause 50% of emissions and 37% of consumption cumulatively - and both are increasing, not decreasing. Ultra High lead humanity in "NOWISM, everything for the present nothing for the future, maintain and increase living standards for us now".

ULTRA HIGH CITIZENS must be accurately, impartially, effectively informed now - "if electorates don't demand it governments won't do it" - so they can demand <u>responsible</u> government action to set the global standard, stop collapse and secure the future.







POLITICAL REALITY. "a state of things as they don't actually exist" - is part of democracy, to be <u>popular</u> and stay elected governments tend to convey "good news, positive stories" NOT reality, accurate, unbiased scientific evidence.

unesco

**Open Data** 





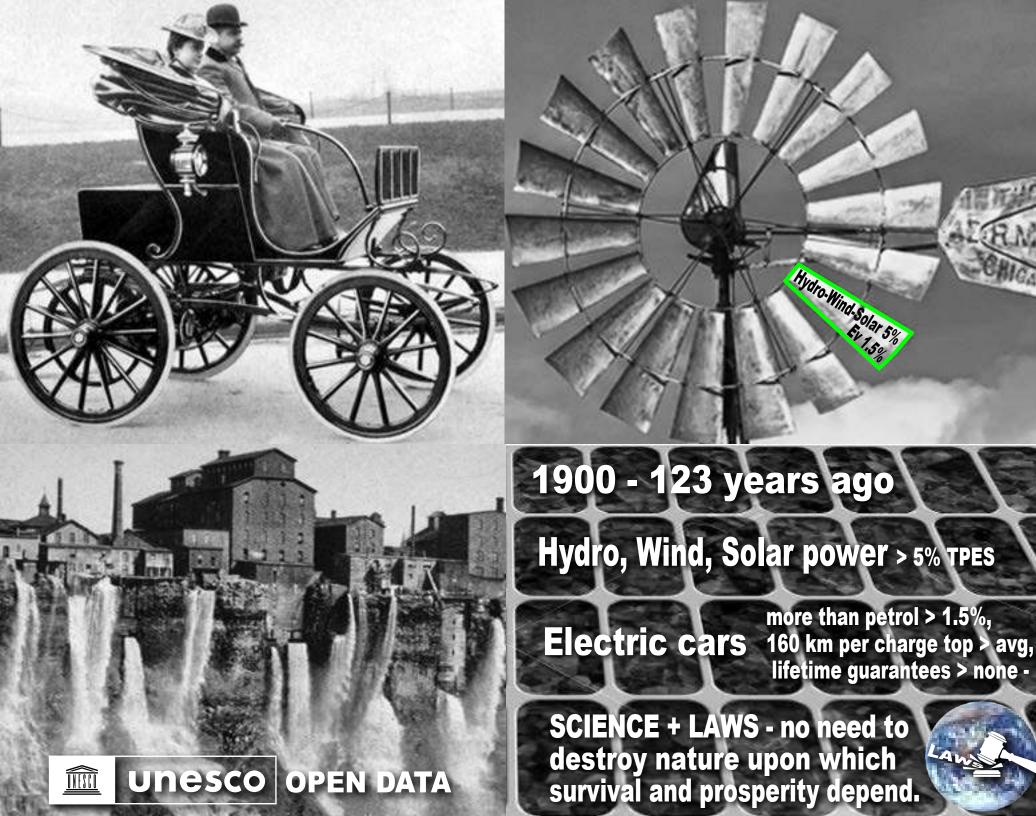


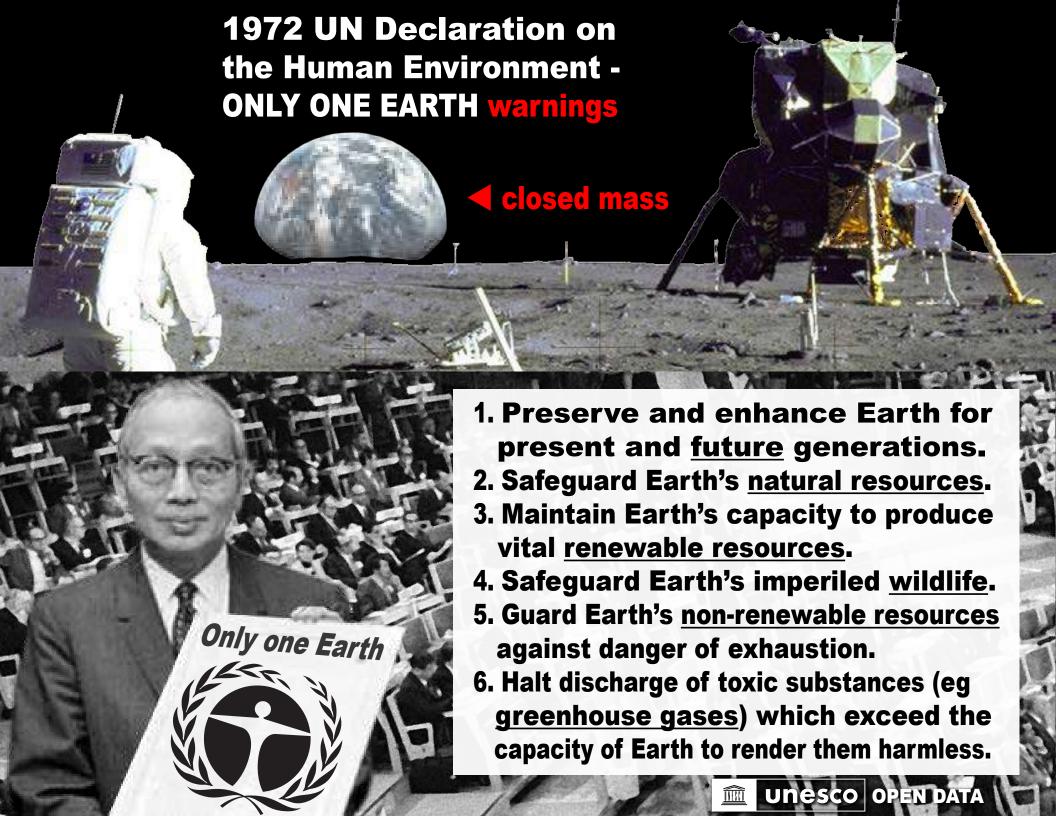


## REALITY. "the state of things as they actually exist", accurate, unbiased scientific evidence, not popularity -

reviewed with public communication supported by IPCC Co-Chairs Dr Valérie Masson Delmotte, Dr Panmao Zhai, Dr Hans Pörtner, Dr Debra Roberts, Dr Jim Skea; UNEP Emissions Gap Reports' "intellectual leaders" Dr Bert Metz, Dr John Christensen; IRP Co-Chairs Dr Janez Potocnik, Dr Izabella Teixeira, founding Co-Chairs Dr Ashok Khosla, Dr Ernst Weizsaecker... this UN Only One Earth Science is considered "an important contribution to the UN 75th Anniversary Initiative"\*, public communication supported by Dr Jian Liu, Chief Scientist UNEP, Dr Pavel Kabat, Chief Scientist WMO, Dr Soumya Swaminathan, Chief Scientist WHO, Dr Youba Sokona, Vice Chair IPCC, Dr Shamila Nair-Bedouelle, Director General Science UNESCO, Dr Guido Schmidt-Traub, Executive Director UNSDSN, Dr Elizabeth Mrema, Executive Secretary CBD, Dr Stefan Swartling Peterson, Director Health UNICEF.

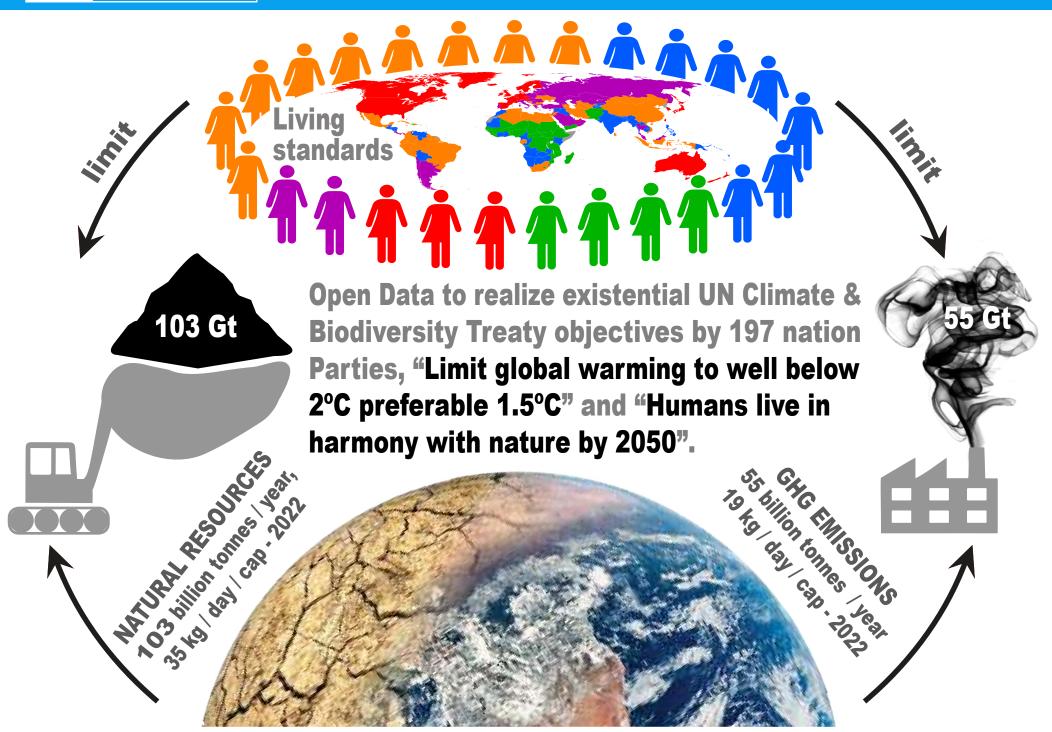
\* Fabrizio Hochschild, UN Technology Envoy, UN 75th Anniversary Special Advisor.... PLUS ????



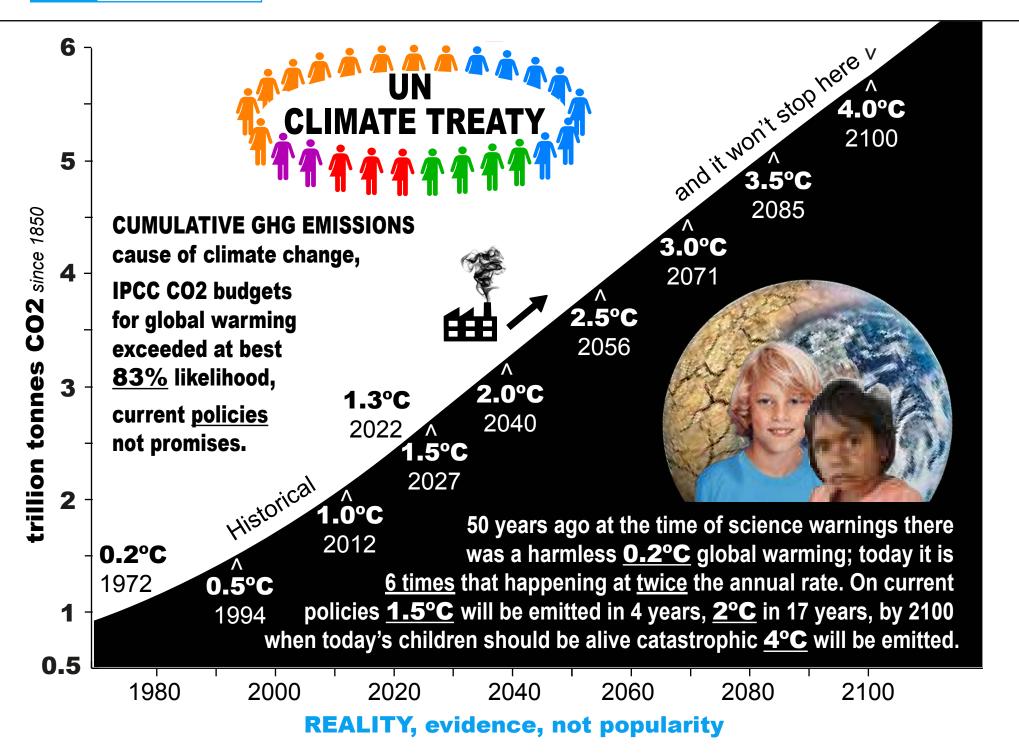


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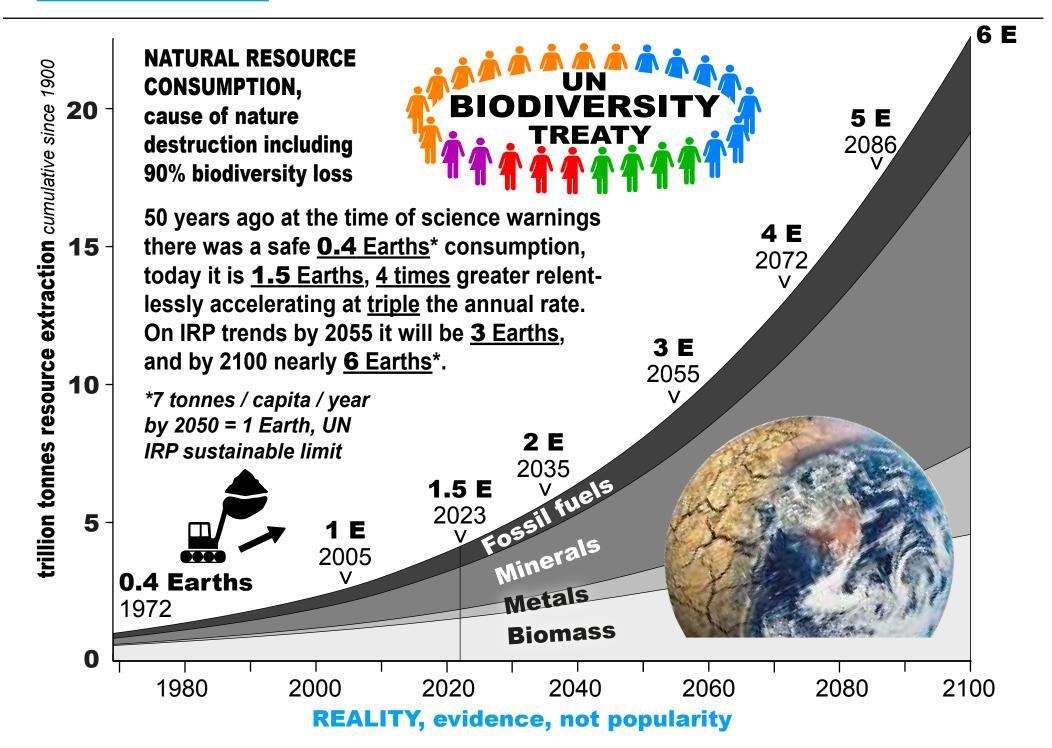
### **OPEN DATA to stop social-economic collapse**

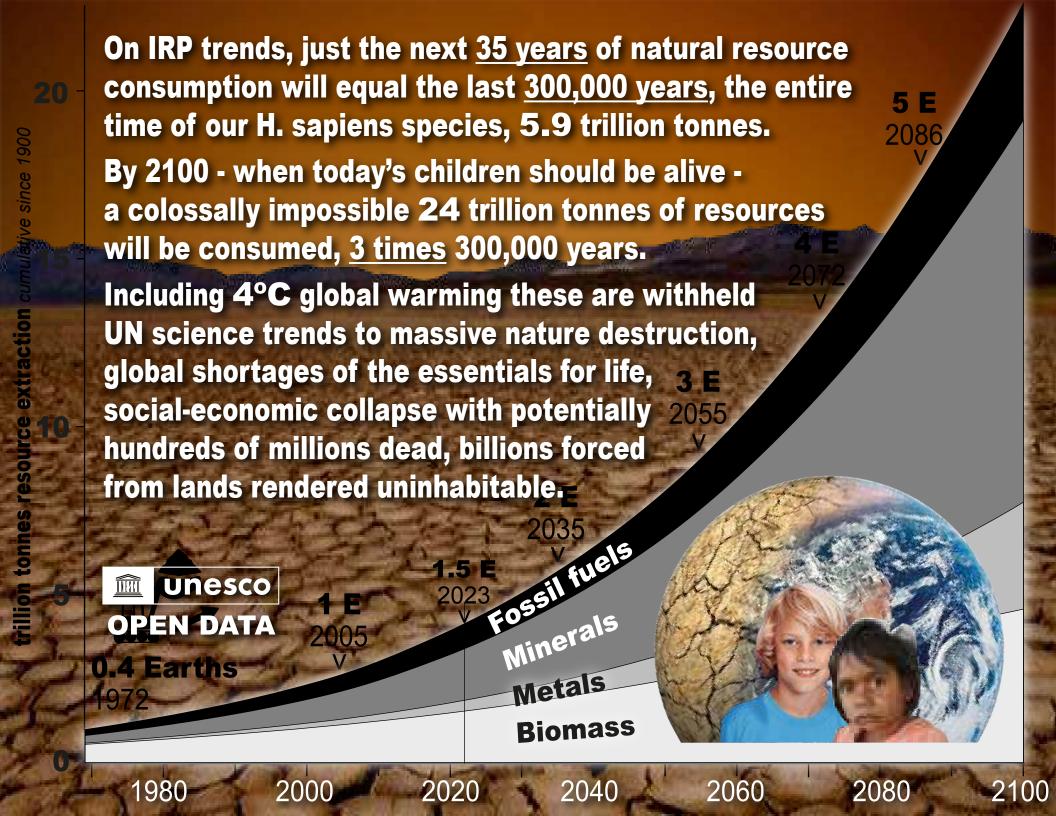


### OPEN DATA to stop social-economic collapse



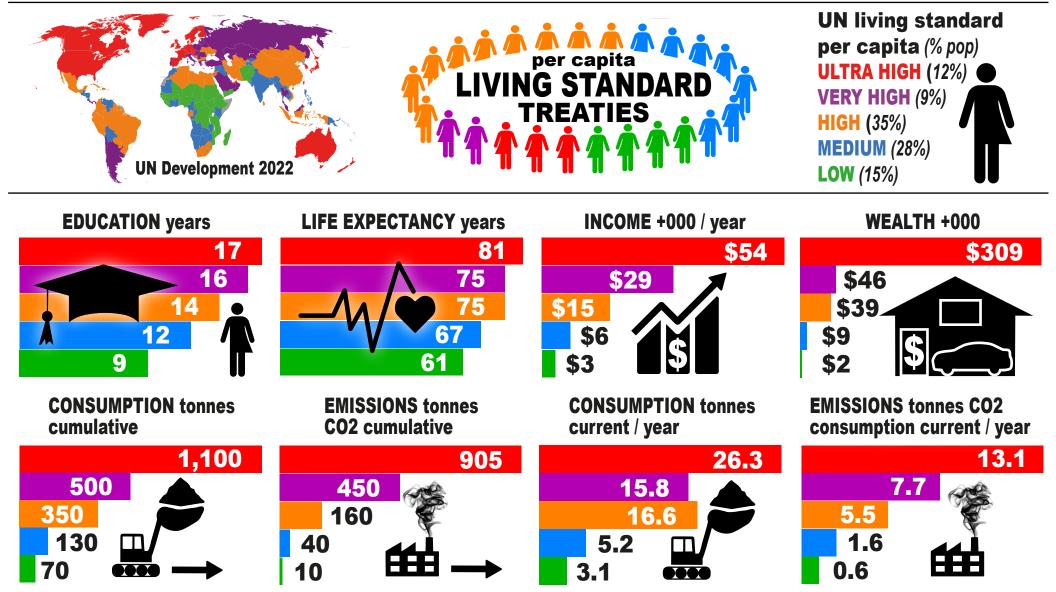
### **UNESCO OPEN DATA** to stop social-economic collapse







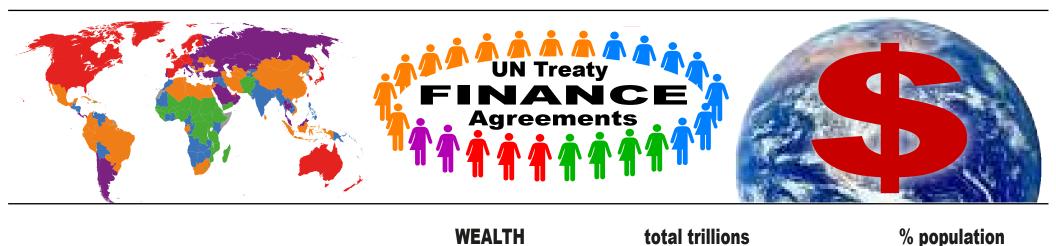
### **OPEN DATA** to stop trends to social-economic collapse - 197 nation Parties' data UN Climate & Biodiversity Treaties

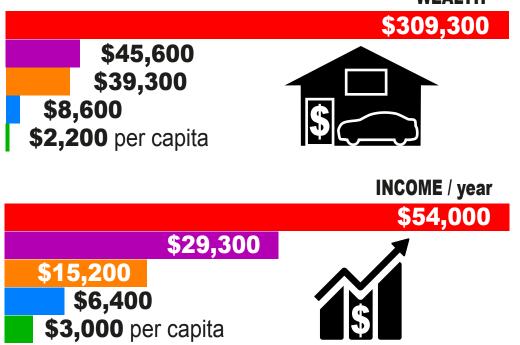


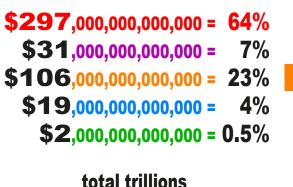
• The 8 UN widely varying LIVING STANDARD PER CAPITA indicators for UN Biodiversity & Climate Treaty agreements by 197 nation Parties - which ELECTORATES must know to demand RESPONSIBLE action by GOVERNMENTS NOW. All 197 nations' living standards are attached.



### **OPEN DATA** to stop trends to social-economic collapse







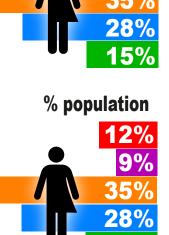
**\$52**,000,000,000,000 = **39**%

**\$20**,000,000,000 = **15**%

**\$42**,000,000,000,000 = 32%

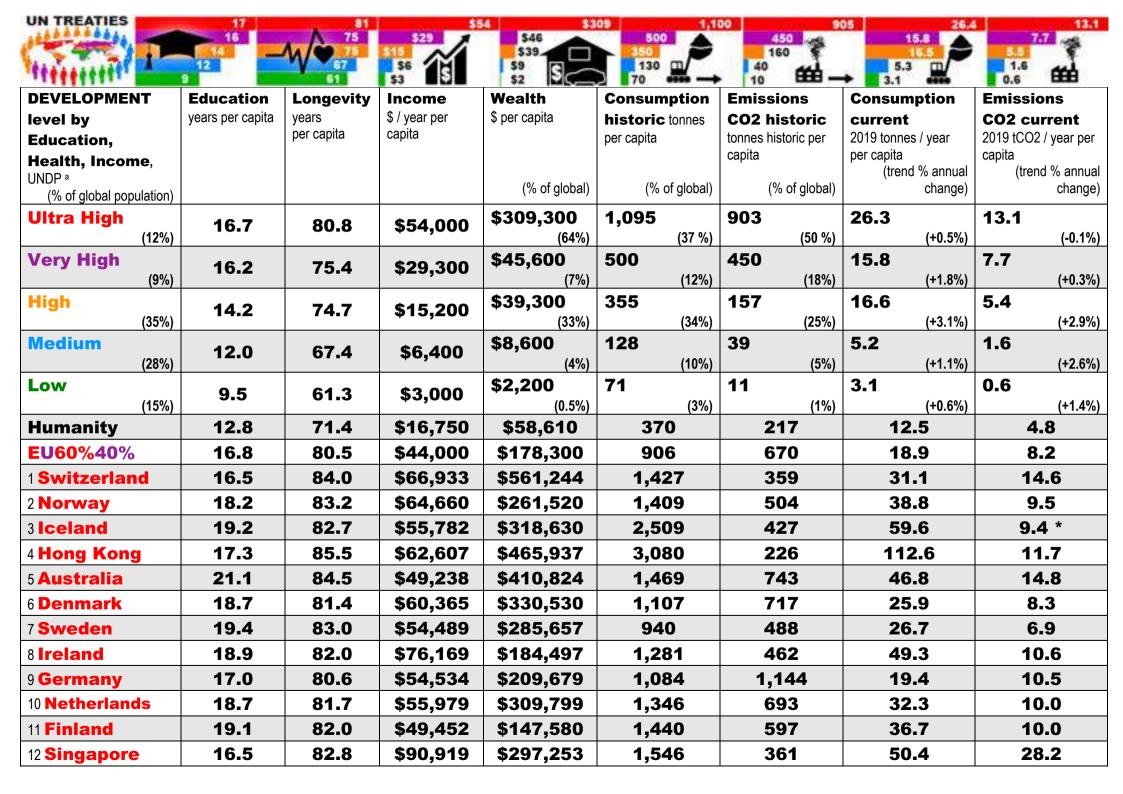
**\$14**,000,000,000,000 = 11%

**\$4**,000,000,000,000 = **2.7**%



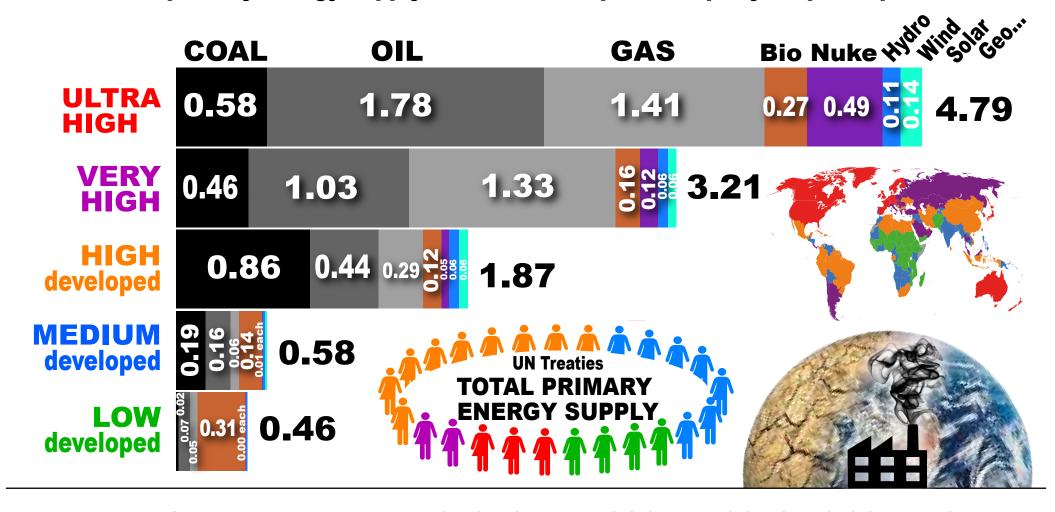
12%

• EXISTENTIAL FINANCE. To fund the entire \$100 billion annual UN Climate Fund would cost Ultra High about 1 / 500<sup>th</sup> of annual income 1 / 3,000<sup>th</sup> of their wealth. Ultra High are 12% of humanity with \$297 trillion (64%) of wealth, \$52 trillion (39%) of income - start with them for existential finance.





### TPES Total primary energy supply in tonnes oil-equivalent per year per capita (IEA 2020)



### ULTRA HIGH (red) LEAD ALL NATIONS TOWARD SOCIAL-ECONOMIC COLLAPSE

- Ultra High Developed per capita COAL use alone equals ALL energy used by Medium and Low; Ultra High COAL+OIL+GAS fossil fuel use is 2x, 6x, 10x ALL High, Med, Low energy use.
- After 50 years of warnings to change, Ultra High's emitting energy is 85% non-emitting, nuclear is 10%, hydro 2% (difficult to expand), wind-solar-geo-tidal-etc. is only 3% TPES.



Total primary energy supply, Medium & Ultra High developed - biomass labour to <u>natural</u> gas leisure - to which all <u>naturally</u> aspire.\*

\* <u>Natural</u> gas has more than half the CO2 of coal - don't use it.



EMISSIONS tonnes CO2 cumulative 90

40 10

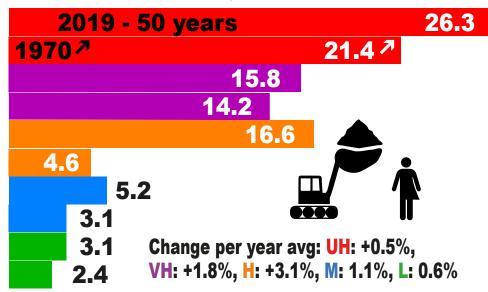


UNESCO OPEN DATA HERE

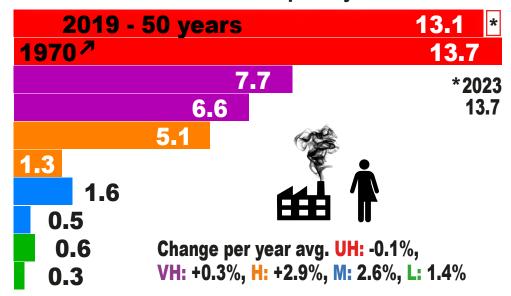
#### **OPEN DATA** to stop trends to social-economic collapse







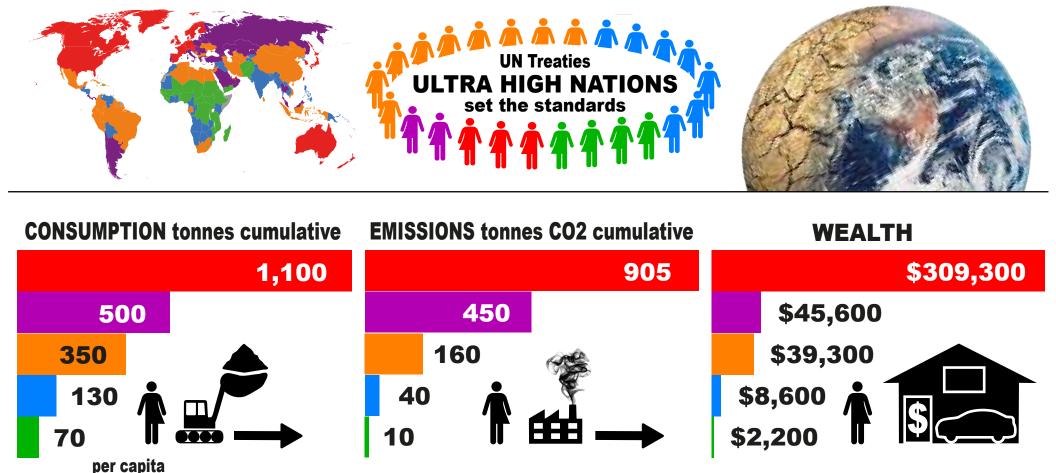
#### EMISSIONS tonnes CO2 consumption / year 2019 & 1970



#### **ULTRA HIGH (red) LEAD HUMANITY TOWARD SOCIAL-ECONOMIC COLLAPSE**

- UN Ultra High the most educated, healthy and wealthy set the STANDARDS; 12% of humanity have 64% of wealth and cause 50% of emissions and 37% of consumption cumulatively.
- In the <u>50 years</u> of science warnings (above) though they said they could, would and must Ultra High have NOT reduced emissions or consumption and are INCREASING both now.

#### **OPEN DATA** to stop trends to social-economic collapse



#### **ULTRA HIGH (red) LEAD HUMANITY TOWARD SOCIAL-ECONOMIC COLLAPSE**

- Ultra High per capita cumulatively consume 1,100 tonnes of natural resources and emit 905 tonnes CO2 to realize their current \$309,300 wealth, 142 times greater than Low developed (green).
- To attain desired Ultra High living standards, 169 less developed nations, 88% of global population are rapidly INCREASING their consumption and emissions toward the standard of Ultra High these are trends to imminent global SOCIAL-ECONOMIC COLLAPSE.







consumption

COLLAPSE

Ultra High lead humanity in "NOWISM, everything for the present nothing for the future maintain and increase living standards for me now".



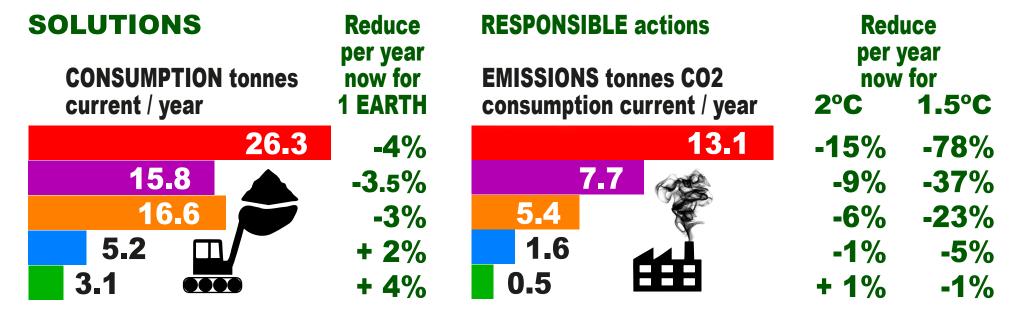
**Future** 

# **NOWISM - everything for the present UN TREATIES** nothing for the future - ENDED 222222222 2,000 years 15 years NOWISM - "Me More New Now" - ENDED









UN agreement is that action is by RESPONSIBILITY for "contribution to environmental degradation" - above are reductions / increases to be on UN IRP and IPCC LIMITS:

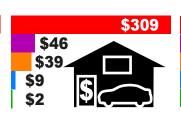
- IRP limit for sustainable natural resource extraction is 7 tonnes per year per capita by 2050.
- IPCC limit (best 83% likelihood) for 1.5°C / 2°C is 29 / 96 tonnes CO2 per capita 2021 onward.

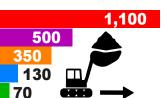
All 197 nation Parties' data and action by current emission-consumption responsibility follows.

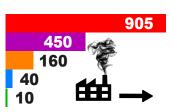














DEVELOPMENT	LIVING	BIODIVERSITY		BIODIVERSITY	CLIMATE		CLIMATE	CLIMATE TREATY		
level by Education,	STANDARD,	LOSS, 90% caused		TREATY, 7 tonnes	CHANGE,		TREATY	for 1.5°C / 2°C, CO2		
Health, Income, UNDP a 2022/10/30	Wealth, Credit Suisse b	<b>by consumption</b> of extracted natural resources, IRP °		consumption per year per capita by 2050, "1 Earth" science limit, IRP d	emissions CO2 from consumption, GCP •		<b>pledges</b> Climate Resource <sup>f</sup>	reductions required, 29 / 96 tonnes per capita 2022 - 2100, science limit, IPCC <sup>9</sup>		
Development UH Ultra High, VH Very High, H High, M Medium, L Low	Wealth \$ / capita	Consumpt year / capita	ion Tonnes / 15 years trend % / yr	Consumption  - CUT or + ADD % per year now	Emission ( year / capita	CO2 Tonnes / 15 years trend % / yr	Pledge as average % per year 2021 - 2030		Emission CO2 – CUT or + ADD % per year now, for 1.5°C for 2°C	
Ultra High Developed	\$ 309,300	26.3	+0.5%	-4.4%	13.1	-0.9%	-4.0%	-77.8%	-15.3%	
Very High Developed	\$ 45,600	15.8	+1.7%	-2.8%	7.7	+1.3%	+0.4%	-36.3%	-8.8%	
<b>High Developed</b>	\$ 39,300	16.6	+4.5%	-2.7%	5.5	+4.5%	+1.0%	-20.8%	-5.5%	
<b>Medium Developed</b>	\$ 8,400	5.2	+3.7%	+2.0%	1.6	+5.2%	+3.2%	-5.4%	-1.0%	
Low Developed	\$ 2,200	3.1	+4.4%	+5.3%	0.6	+4.2%	+1.2%	-0.9%	+1.5%	
Humanity	\$ 58,600	12.5	+2.6%	-1.2%	4.7	+1.7%	+0.3%	-19.0%	-5.1%	
<b>European Union</b>	\$ 178,300	18.9	+0.0%	-3.7%	9.2	-1.7%	-3.3%	-44.9%	-10.4%	
1 Switzerland	\$ 561,200	31.1	+0.5%	-4.7%	14.0	+0.3%	-4.5%	-87.7%	-16.5%	
2 Norway	\$ 261,500	38.8	+1.9%	-5.2%	9.3	+0.6%	-8.8%	-45.7%	-10.5%	
3 Iceland	\$ 318,600	59.6	+0.6%	-7.0%	10.2 *	+0.9%	-9.1%	-39.9%	-9.4%	
4 Hong Kong	\$ 465,900	112.6	-0.2%	-9.2%	14.9	+1.4%	na	overlimit **	-18.0%	
5 Australia	\$ 410,800	46.8	+2.4%	-5.7%	15.3	+0.5%	-2.4%	overlimit **	-18.2%	
6 Denmark	\$ 330,500	25.9	+1.3%	-4.3%	8.5	-2.5%	-2.0%	-39.5%	-9.4%	
7 Sweden	\$ 285,657	26.7	+2.5%	-4.2%	6.8	-1.7%	-2.1%	-29.3%	-7.4%	
8 Ireland	\$ 184,500	49.3	+2.6%	-6.2%	8.7	-3.2%	-3.1%	-40.7%	-9.6%	
9 <b>Germany</b>	\$ 209,700	19.4	-1.2%	-3.7%	10.3	-1.7%	-4.6%	-52.7%	-11.7%	
10 Netherlands	\$ 309,800	32.3	+0.7%	-5.3%	8.8	-1.6%	-4.7%	-42.0%	-9.9%	
11 Finland	\$ 147,600	36.7	+1.6%	-5.8%	11.7	-2.4%	-3.1%	-65.0%	-13.5%	
12 Singapore	\$ 297,300	50.4	+1.6%	-6.5%	19.6	-0.1%	+1.3%	overlimit **	-24.6%	
13 Belgium	\$ 296,300	33.5	+1.1%	-5.2%	15.4	-1.6%	-5.0%	overlimit **	-18.7%	
13 New Zealand	\$ 334,500	30.7	+1.7%	-4.6%	8.4	+0.1%	-1.8%	-38.2%	-9.2%	







Open Data to Secure the Future



### Responsibility App, equitable emission-consumption

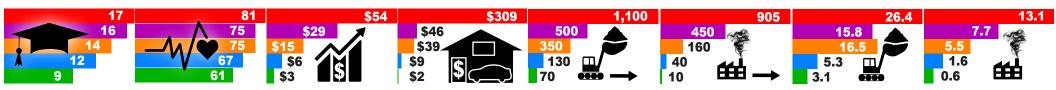
Using science - responsibility apps - by law within and between nations ▶ emissions and consumption can be limited fairly, ▶ costs to do so be paid responsibly, ▶ staying within 1.5°C / 2°C / 1 Earth science limits, ▶ equitably securing everyone's future.



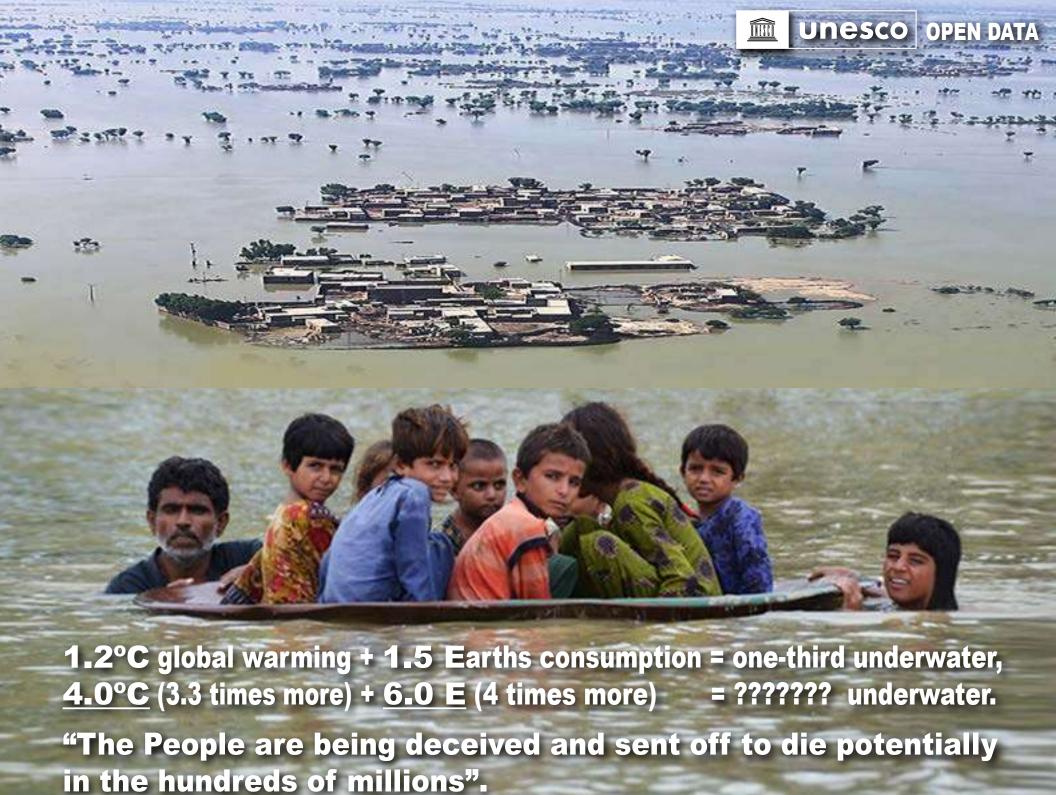
#### LIVING STANDARD UN Ultra High developed

- University degree, 81 years longevity, \$54,000 income,
- 26 tonnes consumption plus 13 tonnes CO2 per year =

- 4°C+ global warming,
- 6 Earths+ consumption = COLLAPSE



- "If electorates don't demand it governments won't do it". INFORM Ultra High citizens of RESPONSIBLE consumption-emission reductions required to realize UN Climate & Biodiversity Treaties, so they can demand adequate GOVERNMENT ACTION NOW -
- If Ultra High act responsibly, ALL NATIONS will likely follow, relentlessly accelerating trends to social-economic collapse will be stopped, children's future will be secured.



**EVERY 1 HOUR: 5 million tonnes CO2, EVERY YEAR 40 billion tonnes -**

## Dangerous 1.5°C global warming in 4 years



Disastrous 2°C in 17 years Catastrophic 4°C by 2100 -

per year now 2°C

**-15% -78%** 

1.5°C

-9% -37%

Unesco OPEN DATA

**UN Climate Treaty** 

**-6% -23%** 

Responsible action NOW

-1% -5%

+ 1% -1%





**EVERY HOUR: 12 million tonnes consumption, EVERY YEAR 104 billion tonnes -**

## Dangerous 1.5 Earths consumption now Ruinous 3 Earths 2055 Uninhabitable 6 Earths 2100 -

per year now 1 Earth

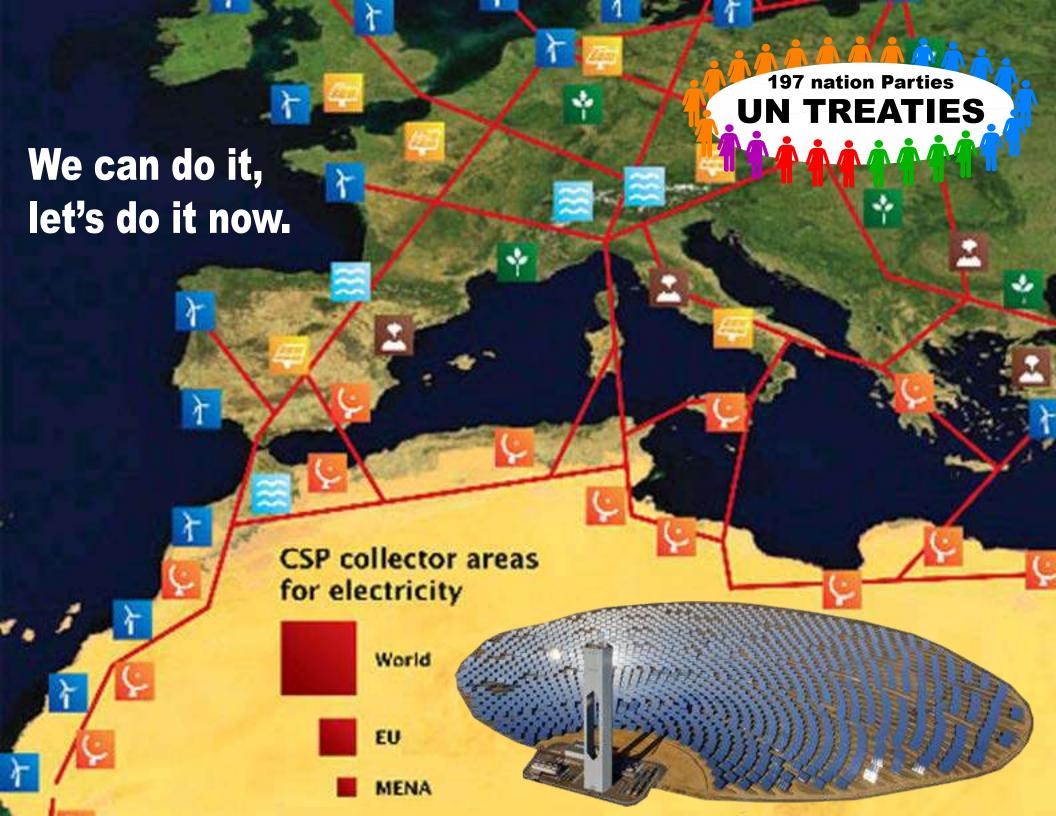
-4%

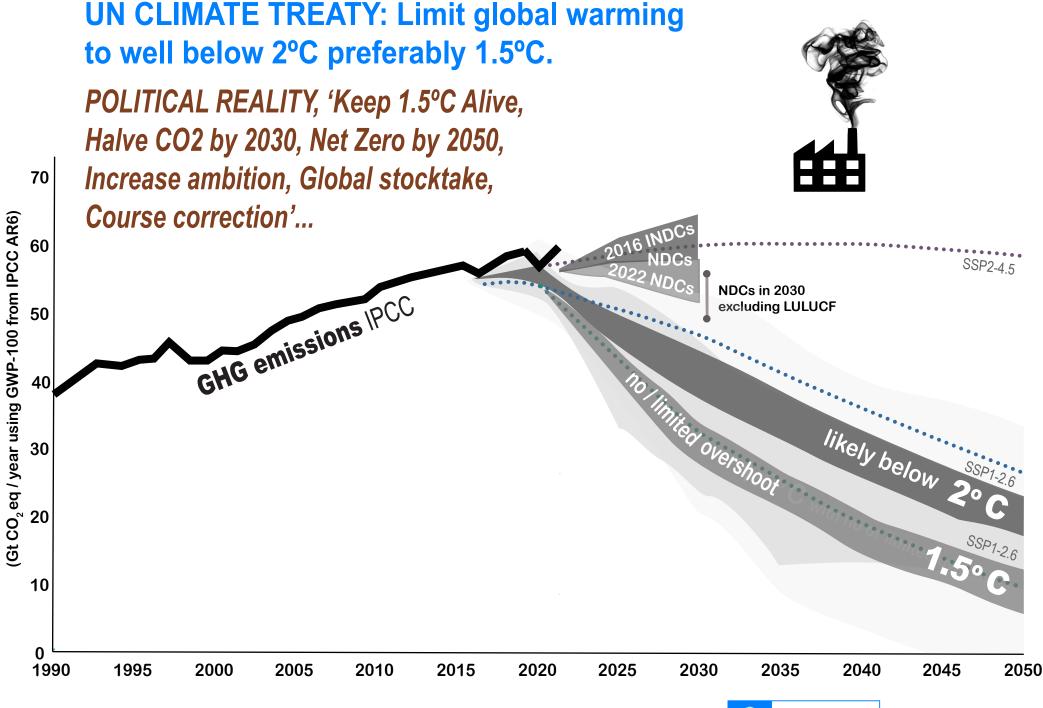
-3.5%

**UN Biodiversity Treaty** 

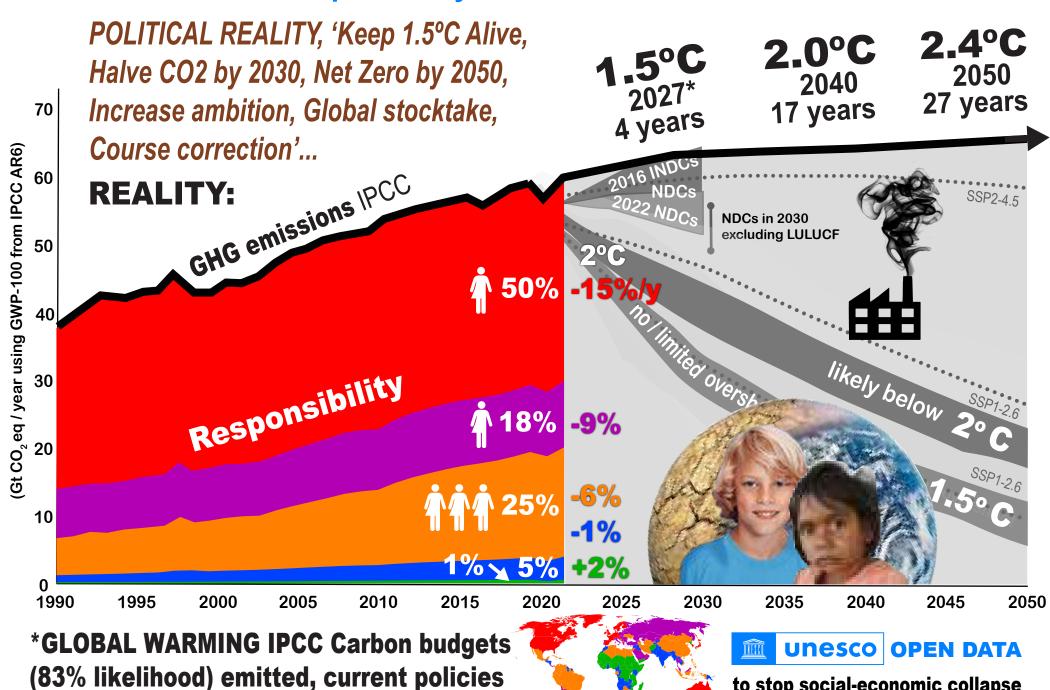




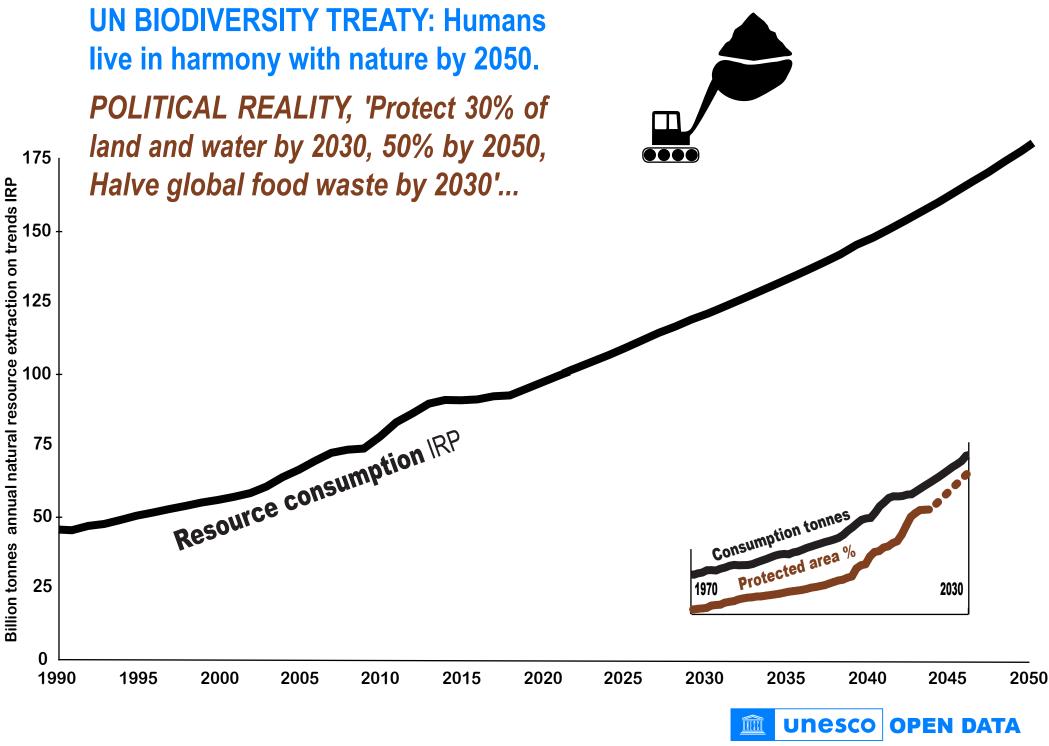




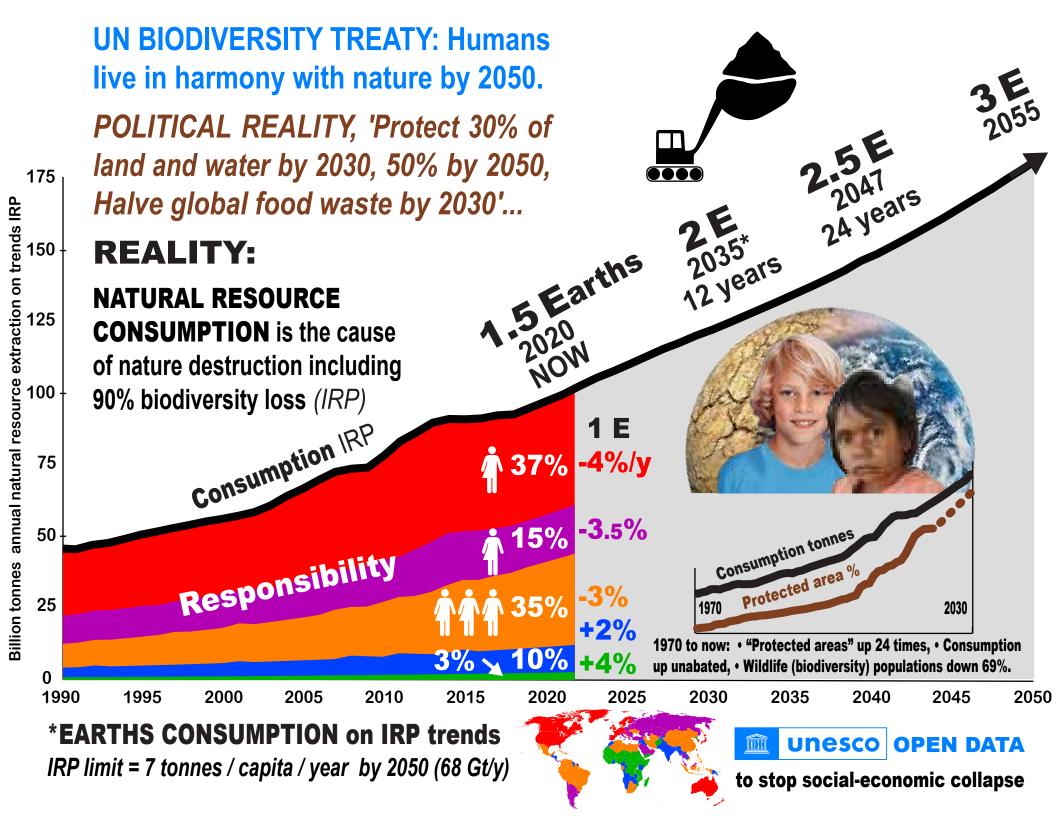
**UN CLIMATE TREATY: Limit global warming** to well below 2°C preferably 1.5°C.

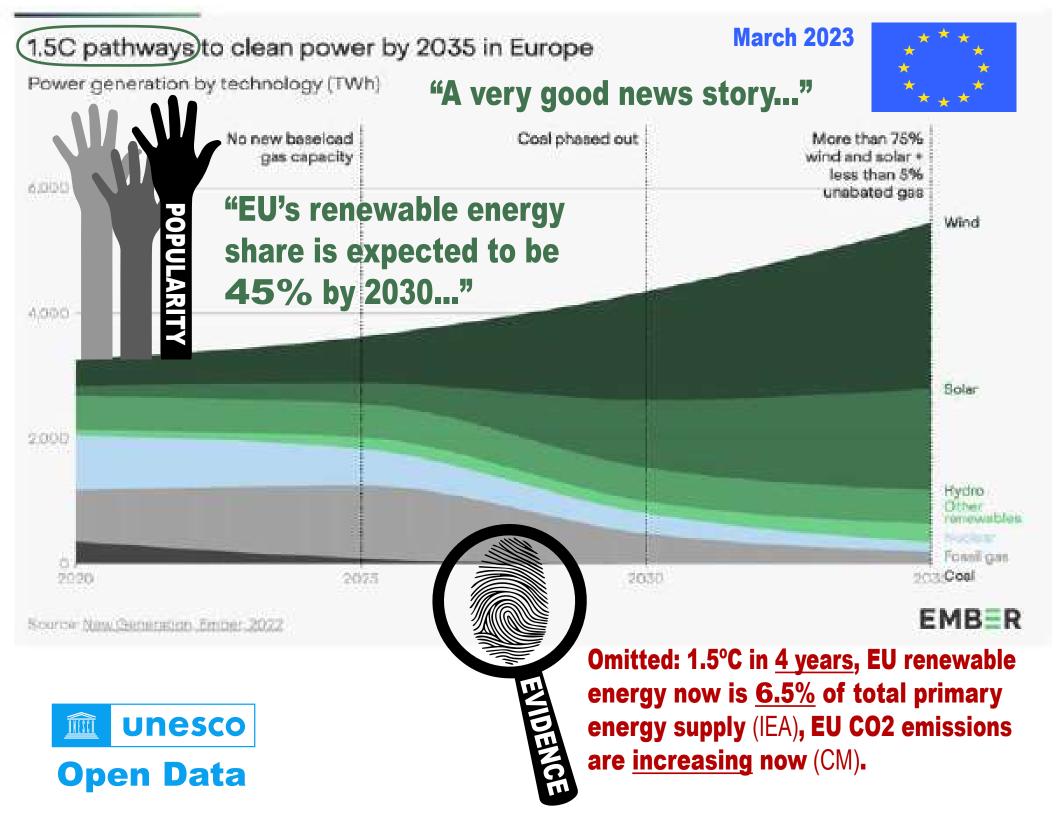


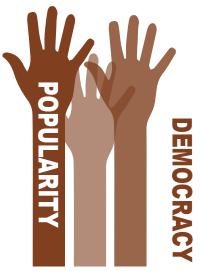
to stop social-economic collapse



to stop social-economic collapse







The laws of nature must obey the laws of humans or we won't be reelected.

## POLITICAL REALITY, "a state of things as they don't actually exist", popularity, good news, positive stories.

UN Ultra High Developed Nations: Swiss Academy of Sciences, Norwegian Academy of Sciences & Letters, Australian Academy of Science, Royal Danish Academy of Sciences & Letters, Royal Swedish Academy of Sciences, Royal Irish Academy, German National Academy of Sciences Leopoldina, Union of German Academies of Sciences & Humanities, Royal Netherlands Academy of Arts & Sciences, Council of Finish Academies, Singapore National Academy of Sciences, Royal Academies Sciences & Arts of Belgium, Royal Society of New Zealand, National Research Council of Canada, Luxembourg National Research Fund, Royal Society United Kingdom, Science Council of Japan, Korean Academy of Science & Technology, National Academy of Sciences United States, Israel Academy of Sciences & Humanities, Slovenian Academy of Sciences and Arts, Austrian Academy of Sciences, Royal Academy of Exact, Physical & Natural Sciences of Spain, Royal France Academy of Sciences, European Academy of Sciences & Arts, European Academies Science Advisory Council... PLUS UNFCCC, CBD, UNEP, UNDP, WMO, IPCC, IRP, IPBES...



The laws of humans must obey the laws of nature or humanity will not survive.



## REALITY, "the state of things as they actually exist", accurate, unbiased scientific <u>evidence</u>.

INDIVIDUAL SCIENTISTS: IPCC Co-Chairs Dr Valérie Masson Delmotte, Dr Panmao Zhai, Dr Hans Pörtner, Dr Debra Roberts, Dr Jim Skea; UNEP Emissions Gap Reports' "intellectual leaders" Dr Bert Metz, Dr John Christensen; IRP Co-Chairs Dr Janez Potocnik, Dr Izabella Teixeira, founding Co-Chairs Dr Ashok Khosla, Dr Ernst Weizsaecker. Only One Earth Science UN 75th Anniversary, Dr Jian Liu, Chief Scientist UNEP, Dr Pavel Kabat, Chief Scientist WMO, Dr Soumya Swaminathan, Chief Scientist WHO, Dr Youba Sokona, Vice Chair IPCC, Dr Shamila Nair-Bedouelle, Director General Science UNESCO, Dr Guido Schmidt-Traub, Executive Director UNSDSN, Dr Elizabeth Mrema, Executive Secretary CBD, Dr Stefan Swartling Peterson, Director Health UNICEF.... PLUS...?

SCIENCE ORGANIZATIONS: UNESCO Open Data... PLUS...?





#### THE ROLE OF SCIENCE, TECHNOLOGY AND INNOVATION IN ACHIEVING THE SDGs IN OIC COUNTRIES

#### ZAKRI ABDUL HAMID FIAS

Founding Fellow, International Science Council Science Advisor to the Sixth Prime Minister of Malaysia Chairman, Atri Advisory, Malaysia

#### **ABSTRACT**



The three pillars of sustainable development (economic, social and environment) are underpinned by STI. Any country that aspires to achieve the 17 SDGs must equip itself through investment in the institutional structures of science and technology and earmarking funds for R&D. Three 2nd WW2-ravaged countries that strongly demonstrate this prerequisite are Germany, Japan and South Korea. Their average spending in R&D hover around 3% of their GDP. In contrast, no OIC country could even come close to that figure. At best, our spending on R&D is around 1%, and many of the LDCs among OIC members do not even allocate funds for R&D.

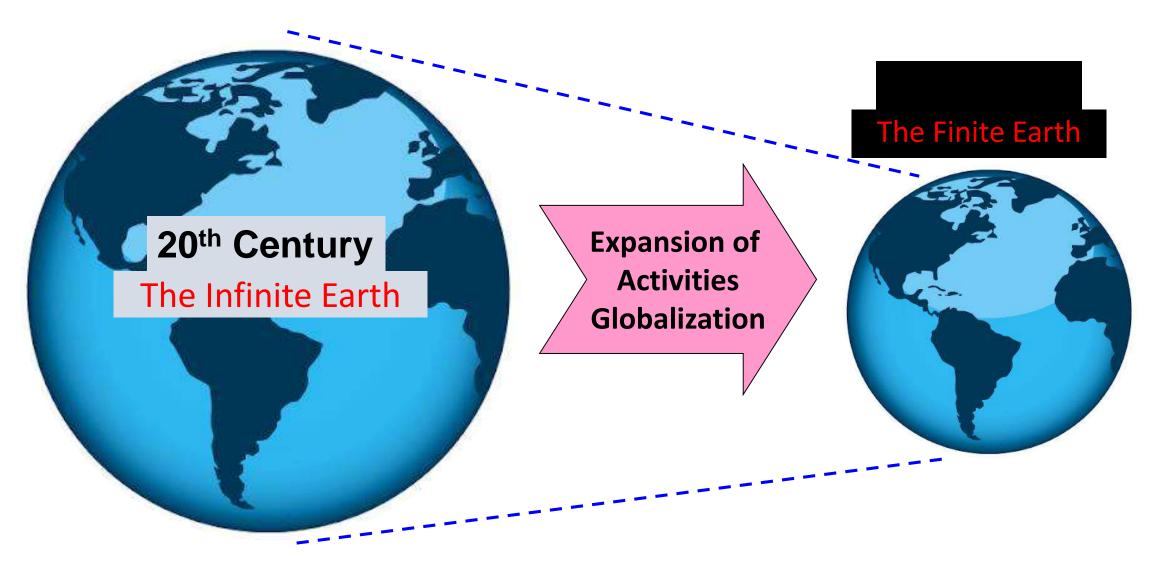
To exacerbate matters, the laggard countries do not have a proper institutional structure to support the advancement of STI, e.g. academies of sciences, science advisory mechanisms, and capacity building with an emphasis on science, technology, engineering and mathematics (STEM). SDG#17 calls for international collaboration. This is where relevant bodies like the IAS, COMSTECH, OIC, IsDB and TWAS must band together to develop a Programme of Work based on STI to lift our sister countries out of this socioeconomic underdevelopment.



# ACHIEVING THE SDGS THROUGH SCIENCE, TECHNOLOGY AND INNOVATION

Zakri Abdul Hamid, FIAS, FISC

Founding Director, International Institute for Science Diplomacy and Sustainability, UCSI University



#### Human-Dominance – Anthropocene Epoch





Humans as agent of geological change

For the first time in human history, our technologies and the ways people use them have the capacity to transform the biosphere itself



## Climate Change



## Climate Change

### Climate Action

The world is on the brink of a climate catastrophe and the window to avert it is closing rapidly. To limit warming to 1.5 Celsius, global greenhouse gas emissions must decline by 43% by 2030

However, under current global net-zero commitments, emissions are still projected to increase by almost 14% over the next decade

Therefore, immediate and deep reductions are needed to meet obligations agreed in the Paris Agreement



## Biodiversity Loss

- Biodiversity and ecosystem services are declining at an unprecedented rate
- We're well acquainted now with the startling prospects: 1 of every 8 birds, 1 of every 4 mammals and 1 of every 3 amphibians is threatened with extinction.
- The same is true of 6 of every 7 marine turtles, and of onethird of our reef-building corals
- Some 75% of genetic diversity of agricultural crops has been lost
- Three-quarters of world fisheries are fully or over-exploited
- According to IPBES, one million species are now threatened

### Biodiversity loss



## Plastic Pollution



## Main Problems in Our Unsustainable World **Food Security Jrbanisation** Global Challenges **Climate Change Poverty** Energy **Biodiversity** Water



## SUSTAINABLE GALS DEVELOPMENT GALS

17 GOALS TO TRANSFORM OUR WORLD





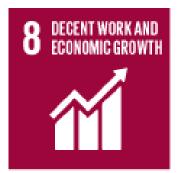
































#### SCIENCE DIPLOMACY IN ACTION



## UNSG Ban Ki-moon's Scientific Advisory Board

- Analyzes the role of science, the data revolution, the sciencepolicy-society interface, and efforts to reduce inequalities and makes recommendations on addressing them.
- Science "deserves to be valued more highly, employed more widely, and used more effectively by decision-makers at all levels,"
- All nations must invest more in science, technology and innovation (STI), saying they "can be a game changer" in dealing with "nearly all the most pressing global challenges" and that STI should play a key role in achieving the Sustainable Development Goals (SDGs).

## Ban's Scientific Advisory Board's findings

- Only 12 countries invest over 2.5% of their gross domestic product (GDP) on research and development (R&D)
- It calls on all countries, including the poorest, to invest a minimum of 1% of their GDP on research
- The most advanced countries should spend at least 3% of their GDP on R&D, it argues, underscoring the role of such investment in reinforcing science education and improving girls' access to science courses
- The Board observes that science can help narrow economic and opportunity gaps, and recommends bringing together indigenous and local knowledge with science to provide appropriate solutions for sustainable development, particularly when implementing the SDGs at local levels.

## Ban's Scientific Advisory Board's findings

- The Board recommends that political leaders give science more consideration in decision-making, pointing out that nearly 25 years elapsed between the scientific community's first warning about climate change and the adoption of the Paris Agreement on climate change in 2015
- "Decisions are often taken in response to short-term economic and political interests, rather than the long-term interests of people and the planet."

#### How do we fare in the OIC countries?

Prerequisite for productive and innovative research

State of the art infrastructure

Well-educated and highly trained scientists

Comprehensive management system for research monitoring

Enough provision of funds for research and development

Taking practical measures to implement the research policies by removing the cultural, political and security hurdles

## Top-10 countries in research productivity for 2018 (n=39,46,933)

<ul> <li>1 United States</li> </ul>	6,83,003 17.30
2 01 :	F 00 006 4 F 40

• 2 China 5,99,386 15.18

• 3 United Kingdom 2,11,710 5.36

• 4 Germany 1,80,608 4.57

• 5 India 1,71,356 4.34

• 6 Japan 1,31,198 3.32

• 7 France 1,20,908 3.06

• 8 Italy 1,19,405 3.02

• 9 Canada 1,11,561 2.82

• 10 Australia 1,06,228 2.69

• Total 24,35,363 61.70

## Top-10 OIC member countries in research productivity for 2018 (n=3,27,555)

•	16	Iran	60,	268
			/	

• 19 Turkey 45,582

• 23 Malaysia 33,295

• 24 Indonesia 32,456 32

• 32 Saudi Arabia 23,469

• 35 Egypt 22,018

• 38 Pakistan 20,548

• 49 Nigeria 9,299

• 51 Tunisia 8,706

• 52 Iraq 8,486

## Higher Education and Number of Researchers

- Higher education institutions and universities have been playing an important role in knowledge creation and research productivity.
- THE world university ranking 2020 has been used to find out the share of OIC members.
- A total of 1,396 universities of 92 countries are included in the ranking, University of Oxford, UK is the top-ranked university of the world, followed by California Institute of Technology, USA and University of Cambridge, UK.
- In the top 50 universities, 23 universities of US, 7 from UK, 3 each from Germany and Canada are included. There is not even a single university by OIC members reached in the top 200 universities of the world.

## Numbers of researchers per one million people

- The highest numbers, 8,250 researchers in one million people are found in Israel, followed by Sweden (7593) and South Korea (7514).
- There 4652 researchers among the one million people in the USA, 4377 in UK and 1235 in China.
- In the list of the highest number of researchers among OIC member countries, UAE has been ranked first with 2407 researchers among OIC countries, followed by Malaysia (n=2358), Tunisia (n=1965), Turkey (n=1386), Egypt (n=669), Iran (n=671), Jordan (n=601) and Pakistan (n=354)

### OIC countries in global research

- The share of OIC countries in global research output has 3,27,555 (8.29%), and 1,087 (3.41%) journals and source publication published are indexed in SJR in 2018
- There are 14 universities from the Muslim world in the top 500 universities in the THE world university ranking 2020
- OIC member countries average spend less than 0.5% of their GDP on R & D, while the rest of the world spends 1.78% and most advanced countries spend up to 3% on R & D

#### OIC countries...

- The indicators of research productivity, global university rankings and average number of researchers showed that OIC members need to improve their allocation for R & D to compete with the rest of the world
- Most of OIC members have already reformulated the education policy and making sure that every citizen of their countries has equal opportunities to get basic to advanced level and education
- The QUESTION is can we do more, in particular to the Least Developed Countries

## Parting words

- The long-term and sustainable growth of the OIC group depend on the educational, scientific and technological development of all member countries
- All OIC member countries should seriously sit together to resolve their internal and external issues and pay more attention to the development of knowledge, science and technology
- The literacy ratio is getting amplified in resource-rich countries, and they should provide necessary financial and technological assistance to deprived and less developed OIC countries
- It would be a great initiative if OIC countries could attract their native but non-resident scientists with lucrative packages to overcome the brain drain dilemma and hire foreign researchers to train young scholars in developing analytical thinking and research skills

# THE EMPIRES OF THE FUTURE ARE THE EMPIRES OF THE MIND



# STANDARDISATION OF PRODUCTION DATA OF MEDICAL RADIONUCLIDES UNDER GERMAN-PAKISTAN COOPERATION

#### SYED M. QAIM<sup>1,2</sup> FIAS AND MAZHAR HUSSAIN<sup>2</sup>

<sup>1</sup>Institute of Neurosciences and Medicine: INM-5 (Nuclear Chemistry), Forschungszentrum Jülich (FZJ), Jülich, Germany <sup>2</sup>Department of Physics, Government College University Lahore (GCUL), Pakistan

#### **ABSTRACT**



Good cooperation had existed between the Forschungszentrum Jülich (FZJ), Germany, and several universities and research institutes in Pakistan since the 1970s. However, from 2003 onwards, with the appointment of Syed M. Qaim from Jülich as an Honorary Professor of Physics at the Government College University Lahore (GCUL), the cooperation was intensified, especially in the field of medical radionuclides. Besides a large number of specialized lectures held at GCUL, which led to the development of M. Phil. courses in Applied Radioactivity as well as in Medical and Radiation Physics, a Ph.D. programme on standardisation of nuclear data related to accelerator-based production of

medical radionuclides was initiated. The first two research scholars (Mazhar Hussain and Naveed Aslam) played pioneering roles in this endeavour. Under the distance guidance from Jülich and with financial support of the Higher Education Commission (HEC) of Pakistan, they got experience in nuclear model calculations and data evaluation methodology at the University of Debrecen, Hungary, and at the International Atomic Energy Agency (IAEA), Vienna, Austria. On completion of standardisation work on several important radionuclides, like Cu-64, Pd-103, I-124, Re-186, etc., they were awarded Ph.D. degrees in 2010. Through further guidance and international collaborations, particularly with ATOMKI Debrecen in Hungary and LBNL Berkeley in USA, two other persons also completed doctoral work. This way, data for a large number of potentially useful radionuclides could be evaluated in Pakistan, leading to about 20 publications in international journals, a few of which are listed below [1-5]. The group was invited by the IAEA to participate in a 5-year Coordinated Research Project (CRP) - a great recognition for scientists working in a developing country. The GCUL and COMSATS in Lahore appointed each a tenured Faculty Member in this field, and the University of Education in Lahore established a tenure-track position. The work concentrates now on novel positron emitters and therapeutic radionuclides which are presently attracting great attention because of their theranostic applications, also known as "Personalized Medicine". In the meantime, a network has been formed, and today this type of nuclear data work is carried out in five public sector institutions in Pakistan, namely, the three universities in Lahore mentioned above as well as the National Centre for Physics (NCP) and the Pakistan Nuclear Regulatory Authority (PNRA) in Islamabad. Furthermore, good contacts have been established between GCUL and a few nuclear medical centres in the vicinity of Lahore. The development of the nuclear data field in Pakistan has been recently described in a review article [6].

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- 3. H. Zaneb, M. Hussain, N. Amjed, S.M. Qaim, Appl. Radiat. Isot. 104, 232 (2015).
- 4. N. Amjed, A.M. Wajid, N. Ahmed, M. Ishaq, M.N. Aslam, M. Hussain, S.M. Qaim, Appl. Radiat. Isot. 165, 1 (2020).
- 5. S.M. Qaim, M. Hussain, I. Spahn, B. Neumaier, Frontiers in Physics 9, 639290 (2021).
- 6. M. Hussain, W. Ali, N. Amjed, A. M. Wajid, M. N. Aslam, Radiochim. Acta 110, DOI: 10.1515 / RACT-2022 0012 (2022).

# Standardisation of Production Data of Medical Radionuclides under German-Pakistan Cooperation

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Keynote Lecture given at the 24<sup>th</sup> International Science Conference of the Islamic World Academy of Sciences (IAS), Karachi, Pakistan, 7-8 March 2023





# **Outline**



- General introduction
  - brief overview of cooperations
  - medical radionuclides and radiotracers
  - institutions GCUL and FZJ
- Cooperation between FZJ (Germany) and GCUL (Pakistan)
  - development of new courses
  - research on radionuclides
  - highlights of research results
- New directions in radionuclide applications
- Concluding remarks and applications



# **General Introduction**

#### **Brief Overview of Cooperations**

- Peaceful applications of nuclear sciences (1970 1994) (Ishfaq Ahmad, Noor M. Butt) mainly with FZK and FZJ
  - neutron scattering
  - analytical methods
  - radionuclides in medicine and agriculture
- Development of natural medicinal drugs (1965 to date) (Salimuzzaman Siddiqi, Atta-ur-Rahman, Iqbal Chowdhary) mainly with Univ. Tübingen
  - structure analysis
  - chemical synthesis
  - biological effects, toxicity, etc.
- Higher education and research (2000 onwards)
   with several German institutions (Atta-ur-Rahman)
  - Indigenous scholarships under HEC
  - foreign faculty/scientist programme of HEC
  - Georg Förster fellowship for experienced scientist

Individual cooperative projects have been constantly running under mutual agreements between participating institutes



# **Medical Radionuclides**



#### Areas of Work

Production of radionuclides (using reactors and accelerators)

- Development of radiotracers
   (physical, chemical and pharmaceutical aspects)
- Radiation physics (organ imaging, radionuclide-targeted therapy, dosimetry)

Emphasis in this talk is on production of radionuclides



# Radiotracers

**Definition:** Radionuclide in a well-defined chemical form

#### Significance:

- Dynamic studies from outside of the system
- Investigation of physiological function
- Biological equilibrium undisturbed (organ imaging at real molecular level)
- Quantitative uptake studies through PET

#### Status of use:

- 60 million patients/year undergo routine diagnosis (via SPECT/ PET) or therapy using radiation.
- PET is a fast expanding imaging technology; Presently > 1000 cyclotrons are under construction.
- Novel radiotracers are opening new vistas in medical research.



# **Novel Radionuclides in Medicine**

COURAGE TO KNOW

- Non-standard positron emitters
  - to study slow metabolic processes
  - to quantify targeted therapy
- Novel low-range highly ionising radiation emitters for internal radiotherapy
  - for targeted therapy

# Emphasis is on accelerator-produced metal radionuclides



# Four Pillars of Radionuclide Development Work



- Nuclear data
  - decay properties
  - production cross sections
- High current targetry
- Chemical processing
  - isolation of radionuclide and recovery of enriched target material
- Quality control
  - radionuclidic, radiochemical, chemical, specific activity
  - Purity requirements are stringent
  - Special organometallic chemistry needs to be developed

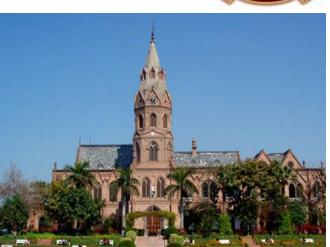


# Government College University, Lahore (GCUL), Pakistan



- Oldest educational institution in Pakistan
- Great personalities educated or worked here
  - Muhammad Iqbal (National Poet / Philosopher)
  - Abdus Salam (Nobel Prize in Physics)
  - Har Gobind Khorana (Nobel Prize in Physiology)
- Many leading scientists and officials educated here
- Good tradition in natural sciences and humanities (Physics: Small accelerator in 1950s; Rafi M. Chaudhri)
- College raised to the status of a university (2002)
- Several foreign faculty members appointed through HEC
- Syed M. Qaim appointed Honorary Professor of Physics (2003)

## Fast strides towards development





# Forschungszentrum Jülich (FZJ), Germany

- Member of Helmholtz-Gemeinschaft
- Largest research centre in Germany (> 7200 employees; about 900 guest scientists from 65 countries)
- Multidisciplinary (cooperation with > 15 universities); budget: 109 Euro
- INM-5 world leader in development of accelerator-based radiotracers; close contacts with University of Cologne







# Cooperation between FZJ and GCUL

(since 2002)

## **Development of Curricula in Physics**

Contact Persons at GCUL: Khalid Aftab; Hassan A. Shah; M. Rafiq;

Riaz Ahmad; from 2012 onwards also Mazhar Hussain

- Advanced condensed lecture courses held on:
  - Applied radioactivity
  - Nuclear data for science and technology
  - Nuclear methods of analysis
  - Radiotracers in medicine
  - Interdisciplinary utilization of accelerators
  - Scientific and environmental aspects of energy production

#### Hundreds of students attended (many from other universities as well).

- Advanced lectures helped establish three new courses at different levels
- a) Medical Physics
- b) Applied Nuclear Physics and Nuclear Data Applications
- c) Nuclear Data for Science and Technology

B.S.

M.Phil.

Ph.D.



## Research on Radionuclides: Nuclear Data

#### Theme

 Evaluation and standardisation of fundamental production data



#### **Emphasis on**

- Non-standard positron emitters for PET (e.g. <sup>64</sup>Cu, <sup>86</sup>Y)
- Novel radionuclides for internal radiotherapy (e.g. <sup>103</sup>Pd, <sup>67</sup>Cu)

#### Scope

- Advanced nuclear model calculations
- Use of statistical fitting procedures
- Recommend data for optimum production of radionuclides
- Validation of evaluated data through integral tests

Intercomparison of evaluated data at international level would establish the quality of work



# **Nuclear Model Calculations**

## **Statistical Model (Code: STAPRE)**

- Formation of compound nucleus
- Decay of compound nucleus (considering angular momentum and level structure: Hauser-Feshbach formalism)

#### **Precompound Exciton Model (Code: ALICE-IPPE)**

- Penetration of the projectile, formation of particles and holes, denoted as exciton number
- particle emission probability calculated for each exciton number

Codes combining statistical and precompound model: EMPIRE, TALYS

All codes are available at GCUL





# **Evaluation Methodology of Medical Data**

- Compilation and normalization of data for experimental conditions
- Comparison of normalized data with the results of nuclear model calculations (ALICE-IPPE, STAPRE, EMPIRE-2.19, TALYS 1.9) over a given energy range

**Basic consideration** 
$$\sigma_{ev}(E) = f(E) \sigma_{model}(E)$$

where  $\sigma_{ev}(E)$ ,  $\sigma_{model}(E)$  and f(E) are the evaluated cross section, model calculated cross section and the energy-dependent normalization factor, respectively.

- Ratio of experimental to calculated data plotted as a function of energy, followed by a polynomial fitting to estimate the f(E).
- Evaluation procedure repeated with all model calculations.
- Recommended data generated by averaging the normalized model calculations.



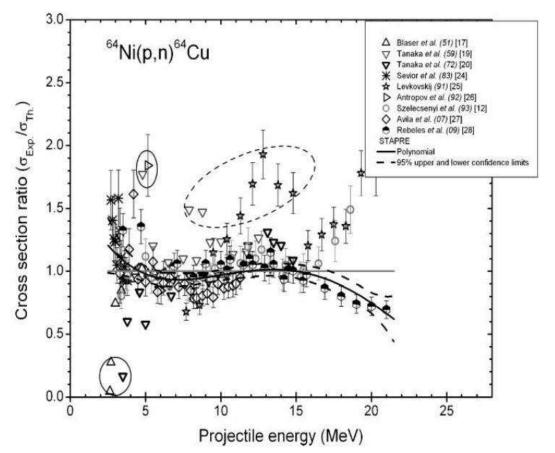
# **Example: Copper-64**

 $T_{1/2} = 12.7 \text{ h}; E_{\beta^+} = 0.65 \text{ MeV}; I_{\beta^+} = 17.8 \%)$ 

#### Organo-metallic chemistry of Cu is very advantageous

Production reaction: <sup>64</sup>Ni(p,n)<sup>64</sup>Cu

Evaluation of production data: Aslam et al, RCA 97, 669 (2009)



Variation of  $\sigma_{exp}/\sigma_{theor}$  as a function of  $E_p$  estimation of f(E)



# Excitation Function of <sup>64</sup>Ni(p,n)<sup>64</sup>Cu Reaction

64Ni(p,n)64Cu

800

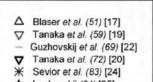
600

400

200

Cross section (mb)





★ Levkovskij (91) [25]
 ▷ Antropov et al. (92) [26]
 ○ Szelecsenyi et al. (93) [12]

Avila et al. (07) [27]

Rebeles et al. (09) [28]
 EMPIRE

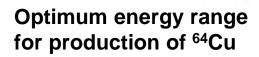
- STAPRE

---TALYS

Aslam et al, RCA 97, 669 (2009)

Comparison of experimental data with results of three nuclear model calculations.

Based on optimized data, clinical scale production technology developed at FZJ.



 $E_p: 12 \rightarrow 8 \text{ MeV}$ 

Yield: 304 MBq/µAh

Production methodology adopted by industry



15

Projectile energy (MeV)

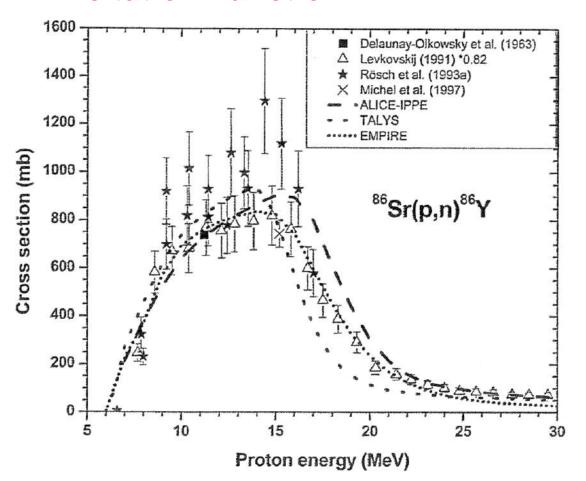
# **Example: Yttrium-86**

 $(T_{\frac{1}{2}} = 14.7 \text{ h}; E_{\beta+} = 1.6 \text{ MeV}; I_{\beta+} = 34 \%)$ 



Trivalent metals form good metallic complexes (peptide and antibody targeting)

#### **Excitation Function**



Production technology developed at FZJ; adopted by industry

Data evaluated by Zaneb et al, ARI **104**, 232 (2015)

Considerable discrepancy revealed need of more precise measurement.

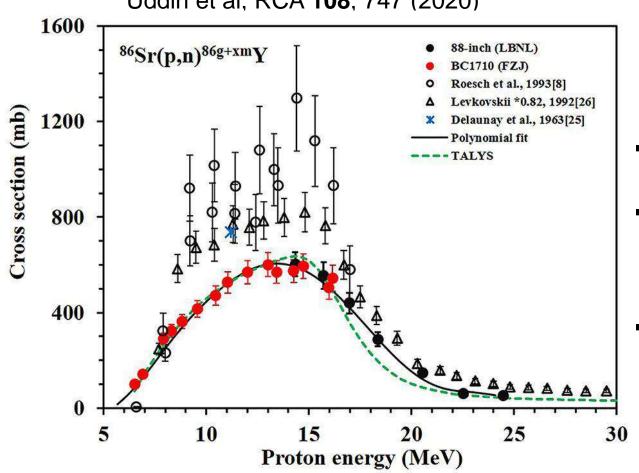


# **New Precise Measurement of Excitation Function**

GCUI SEE

under international cooperation (FZJ, LBNL, Debrecen, Dhaka, GCUL)





- Good agreement between experiment and theory
- Good agreement between calculated integral yield and batch production yield
- Discrepancy removed



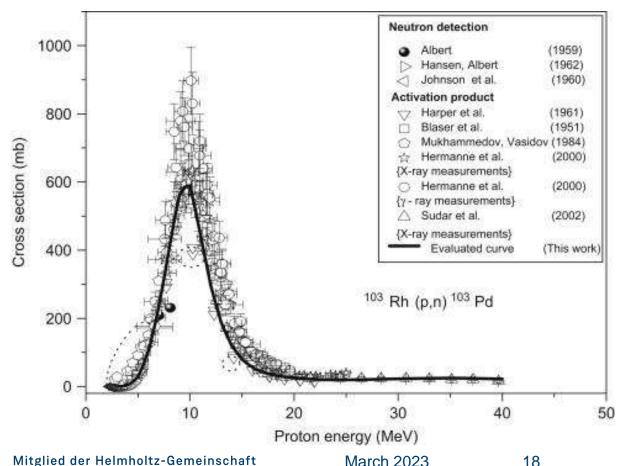
# **Example: Palladium-103**

 $(T_{1/2} = 17.0 \text{ d}; EC = 100 \%; Avalanche of X-rays and Auger electrons)$ 

#### Extensively used in prostate cancer therapy

Production reaction: <sup>103</sup>Rh(p,n)<sup>103</sup>Pd

## **Excitation Function**





Cross sections measured using neutron, γ-ray and X-ray counting

Data **evaluated** by Hussain et al, ARI 67, 1842 (2009)

- Standardised data are based on X-ray measurement
- Good agreement between calculated and production yield achieved



# **Example: Copper-67**

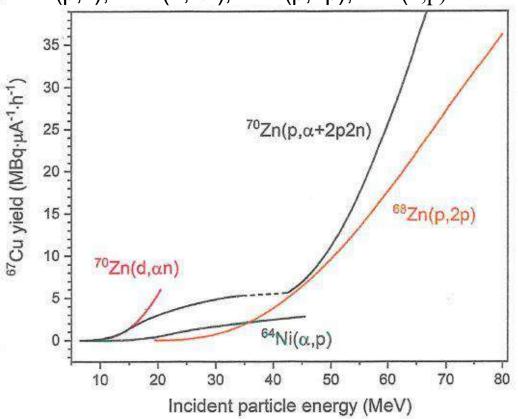
 $(T_{1/2} = 17.0 \text{ d}; EC = 100 \%; Avalanche of X-rays and Auger electrons)$ 



Useful for targeted radionuclide therapy

#### **Charged particle production**

 $^{70}$ Zn(p,x);  $^{70}$ Zn(d, $\alpha$ n);  $^{68}$ Zn(p,2p);  $^{64}$ Ni( $\alpha$ ,p)



(Jülich, Ispra, Nantes, Brookhaven, Chiba, etc.)

Qaim, Hussain, Spahn, Neumaier, Frontiers in Physics (2021), Vol. 9, Article 63290

For large scale production, E<sub>p</sub> = 80 → 40 MeV is needed.

# **Highlights of Research Results Achieved**

- 6 scholars completed Ph.D.; therefrom 3 hold now faculty positions (Mazhar Hussain; Naveed Aslam; Nouman Amjed)
- Published about 20 papers in international journals (for details cf. Hussain et al, RCA 100, 645 (2022))
- Group on "Medical Nuclear Data Analysis" established. Participation in a "Coordinated Research Program (CRP)" of the IAEA, 2013-2018 (Leader: Mazhar Hussain). This is an exceptional recognition of a group from a Developing Country.
- Mazhar Hussain awarded the prestigious Alexander von Humboldt Fellowship to work at FZJ (2023/2024).
- Links established between this research group and radiotracer specialists at nuclear medical centres in Lahore and Gujranwala. A network of nuclear data specialists in Pakistan has also been created.



# Award of Medal of Honour of GCUL to Syed M. Qaim on 22 November 2018





# New Directions in Radionuclide Applications



Theranostic approach

(combination of PET/Therapy: Personalized medicine)

<sup>64</sup>Cu/<sup>67</sup>Cu, <sup>86</sup>Y/<sup>90</sup>Y, <sup>68</sup>Ga/<sup>177</sup>Lu, etc.

("matched" or "analogous" pair)

Radiation dose assessment via PET

Radionuclide targeted therapy is of great timely interest

**Multimode imaging** 

(combination of PET/CT and PET/MRI)

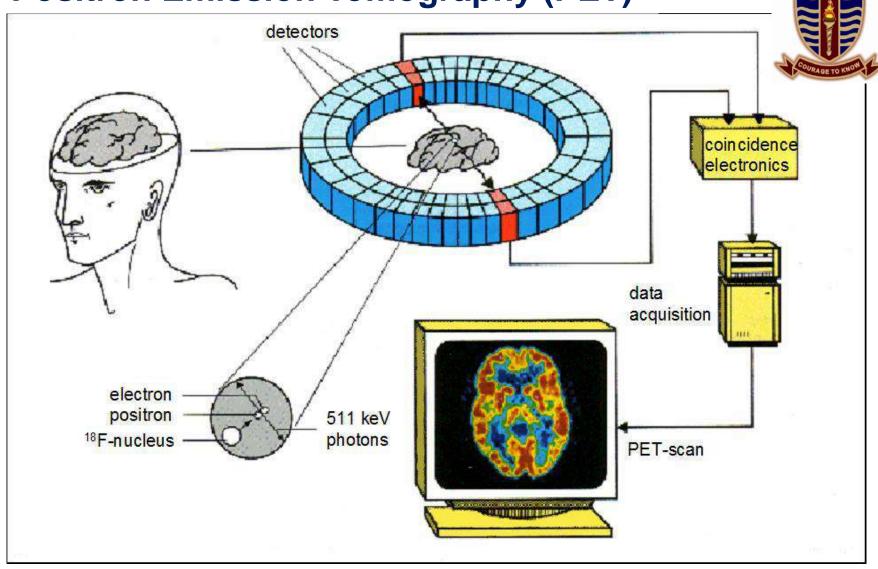
#### **ImmunoPET**

Labelling of antibodies with metallic positron emitters, e.g. <sup>89</sup>Zr, to trace their way to tumours.

Metallic radionuclides are versatile.



# **Positron Emission Tomography (PET)**



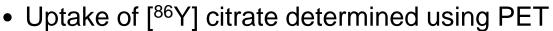
Courtesy: H. Herzog, FZ Jülich



# Application

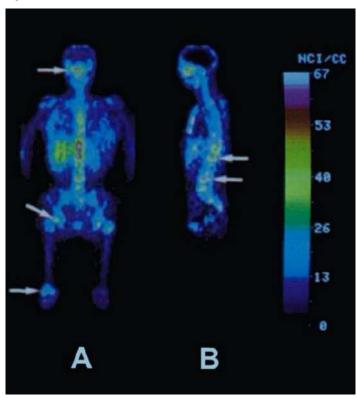
# Beginning of real theranostic approach

 Use of β<sup>+</sup> emitting <sup>86</sup>Y prior to the therapy nuclide <sup>90</sup>Y ("matched pair")

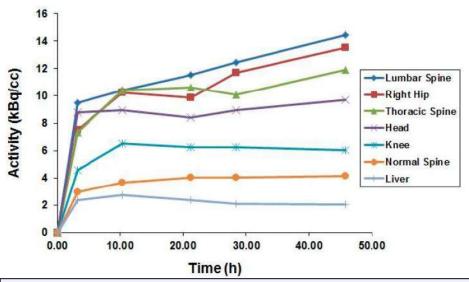




Herzog et al., JNM **34**, 2222 (1993).



(A) Anterior (B) Sagittal



Accurate dose calculation possible in targeted  $\beta^-$  or  $\alpha$ -therapy

Rösch, Herzog, Qaim, Pharmaceuticals **10**, 56 (2017)





# **Targeted Therapy**

- Direct use of metal radionuclide rather seldom
- Special demands on radionuclide and chemistry



(trivalent metals very attractive)

# Scheme - Radiometal (chelator) - Linker - Targeting vector Radiometal

- Radiometal tightly coordinated to chelator (DTPA, DOTA, etc.)
- Linker (amino acid, PEG, etc.) connects chelator to targeting vector
- Targeting vector (peptide, antibody, etc.)
   (reaches biological target through cellular receptor, antigen, etc.)



# Targeted $\alpha$ -Radiation Therapy

**Example:** <sup>213</sup>Bi ( $T_{1/2}$  = 46 min;  $E_{cr}$  = 5900 keV) from <sup>225</sup>Ac generator

Prostate-specific membrane antigen radioligand therapy (PSMA-RLT)



<sup>68</sup>Ga/<sup>177</sup>Lu-PSMA successfully applied ("analogous pair")

New approach: <sup>68</sup>Ga/<sup>213</sup>Bi-PSMA

M. Sathekge et al., EJNMMI 44, 1099 (2017)



<sup>68</sup>Ga-PSMA (PET-CT scan)
Pre-therapy



68Ga-PSMA (PET-CT scan)Post-therapy(11 months after <sup>213</sup>Bi-PSMA)

Targeted  $\alpha$ -radiation therapy appears promising.



# **Concluding Remarks**

- COURAGE TO KNOW
- Good and friendly relations have always existed between Germany and Pakistan.
- Long-term cooperations in many areas of science
- Extensive cooperations in fields of mutual interest

# **Appreciation**

- Special thanks to Germany for facilitating and encouraging cooperation with Pakistan; thanks to Pakistan for appreciating and honouring the cooperative efforts; appreciation to dedicated co-workers.
- Acknowledgement to supporting bodies/programmes: HEC, TOKTEN, NTP, Abdus Salam ICTP, IAEA, PAS, PAEC, COMSTECH

# PRODUCING AFFORDABLE BIOTECH MEDICINES FOR THE ISLAMIC WORLD: OPPORTUNITIES AND REQUIREMENTS

#### AHMED AZAD FIAS

Former Chief Research Scientist, CSIRO Division of Biomolecular Engineering, Australia

#### **ABSTRACT**



Introduction: The provision of lifesaving medicines to even the poorest is very important for achieving Health Equity in the Islamic world. Islamic countries, including economically disadvantaged ones, have been very well served by the availability of relatively inexpensive Generic medicines. A small number of Islamic countries have been producing high quality generic medicines and exporting them worldwide. In recent times the pipeline of small molecule originator drugs, from which Generics are copied, has almost dried up. This provides an opportunity for Islamic countries to step in to develop novel small molecule drugs from indigenous Biota. Lately multinational drug companies have turned their attention almost exclusively to Biologics. These highly specific and efficacious protein-based drugs are extremely expensive and

beyond the reach of all except wealthy countries and rich individuals. There is, therefore, a *unique opportunity for the Islamic world to produce more affordable copies of the originator Biologics, known as Biosimilars.* These two drug development initiatives would be dependent on multidisciplinary collaborations across the Islamic world. IAS and COMSTECH could play important catalytic and enabling roles in these product development and capacity-building initiatives, in which the least developed countries (LDC) should also be enabled to make a positive contribution.

Rational Bioprospecting of Indigenous Biota: Islamic countries, including LDC and technology-lagging ones, are endowed with diverse hotspots of unique flora and fauna, and very rich knowledge of traditional medicines. Marrying of traditional knowledge with modern technologies is likely to open up a treasure trove of drug candidates present in the indigenous biota, and lead to discovery and development of novel pharmaceuticals.

Ethnobiologists, ethnopharmacologists and medicinal chemists from all over the Islamic world have been very prolific in publishing large numbers of scholarly research articles on natural products, but unfortunately very little of this has translated into scientifically-verified, safe and efficacious modern medicines. Inclusion of molecular biosciences would strengthen natural products research and help to identify disease-specific molecular targets and develop highly selective bioassays based on these. "Rational bioprospecting" of natural product and isolated chemical libraries with such disease-specific and selective bioassays would greatly enhance chances of discovering novel and very promising lead molecules. These could then be optimised into candidate medicines using a range of biomolecular technologies. Since these medicines are based on disease-specific molecular targets, they are not likely to affect normal host biology and as such expected to exhibit little or no adverse side effects. All the above steps could generate new IP that can be exploited in partnership with local industry for commercialisation. For this particular project, the International Centre for Chemical and Biological Sciences (ICCBS), could serve as a major resource and training centre for the entire OIC region. Other regional research centres could also provide support to scientists from disadvantaged countries in their neighbourhood.

Development of Affordable Biosimilars through Reverse-Engineering and Recombinant DNA Technology: To meet local healthcare needs, and to keep abreast of current technological developments, the pharmaceutical sector in the Islamic world needs to get involved in the development of recombinant Biosimilars, which are relatively cheaper copies of highly expensive protein-based Biologics. The first step in producing more affordable Biosimilars would be to produce the active chemical ingredients (ACI) locally. A few Islamic countries, including Bangladesh, have already produced a limited number of Biosimilar from "seed clones" kindly provided by the International Centre for Genetic Engineering and Biotechnology (ICGEB). Similar seed clones from commercial sources are exorbitantly expensive. The most efficacious monoclonal antibody (mAb)type Biologics are not only extremely expensive but are also patent protected. Development cost and time to market could be drastically reduced if the seed clones could be produced locally, and if IP restrictions could be circumvented. LDCs in the Islamic world can help out as they are exempt from patent restrictions till 2033, and thus free to copy and develop any ACI for any Biosimilar irrespective of patent status. This provides a huge competitive advantage to LDCs over possible rivals from more advanced countries. Bangladesh, an LDC, has developed the required competencies for upstream processing technologies for producing seed clones for any type of Biosimilars. Thus, Bangladesh can supply seed clones to competent pharmaceutical companies in the Islamic world till at least 2026, and then transfer technology to other LDCs to allow WTO's patent waiver to continue till 2033, provided an integrated microbioreactor system is available for selection of highly expressing clones of the desired recombinant Biosimilar. Bangladesh can also provide Biosimilars produced under cGMP conditions and ready for human clinical trials in other Islamic countries. Besides meeting healthcare needs, affordable Biosimilars will also lead to cost saving and wealth creation as the market value for mAb-type Biosimilars is growing exponentially and projected to surpass \$0.5 trillion by 2026. Capturing even a modest fraction of this market will greatly benefit the Islamic world and its pharmaceutical sector.

IAS and COMSTECH could Play an Enabling and Coordinating Role: The above drug development initiatives would involve researchers from different Islamic countries, including disadvantaged ones, through development and adequate funding of multidisciplinary collaborations between research groups possessing complementary expertise and facilities. Discovery and development of new biotech drugs is only the first step. Commercialisation would require management and funding of IP, development of simplified and uniform guidelines to expedite and reduce cost of clinical trials and regulatory affairs, and forging of productive partnerships with local pharmaceutical companies with required competencies. IAS and COMSTECH could coordinate and provide logistics support to this OIC-wide initiative, and also convince governments of strategically located and richer Islamic countries to host resource centres and technology platforms which would also be accessible to researchers from neighbouring disadvantaged countries. IAS and COMSTECH, with OIC and TWAS, could jointly persuade IsDB to substantially fund the collaborative research networks involved in producing essential biotech medicines for the Islamic world.

## Producing Affordable Biotech Medicines for the Islamic World: Opportunities and Requirements

Ahmed A Azad MSc (Dhaka) PhD (Toronto)

FTWAS, FIAS, EFBAS, MASSAf, FRSSA

#### Formerly:

Chief Research Scientist, Biomolecular Engineering, CSIRO, Australia

Director of Research and Professor of Medical Biotechnology, University of Cape Town

Member, Council of Scientific Advisers, International Centre for Genetic Engineering and Biotechnology

Director, Board of Medical Research Council of South Africa

Honorary Positions (2007-Present)

Secretary General, Islamic-World Academy of Sciences (till Dec 2022)

Honorary Professor, Faculty of Health Sciences, University of Cape Town, South Africa

Incepta Distinguished Professor, Bangladesh University of Health Sciences

TWAS Research Professor, BRAC University, Bangladesh

TWAS Research Professor, CARS, Dhaka University, Bangladesh

Incepta Research Professor, CARS, Dhaka University, Bangladesh

Advisor, Biotech Medicines, INCEPTA Pharmaceuticals, Bangladesh

Visiting Professor, ICCBS, University of Karachi, Pakistan

## Economic Status and S&T Proficiency in Islamic World

- Of 57 OIC-Member Countries
  - None classified as Developed Country
  - 21 classified as Least Developed Countries (LDC) [most in SSA]
  - Majority of countries are classified as Scientifically-Lagging
- Socioeconomic development is critically dependent on Excellence in need-based *Higher Education* and *Postgraduate Research* (PhD and Postdoc) and *Technological Proficiency*
- LDCs and Technology-poor countries must not be left behind in the quest for socioeconomic development of the entire Islamic World

# Research Collaborations within Islamic World in Areas of Common Interest and Highest Priorities

- Difficult for most OIC-member countries, especially LDCs, to be internationally competitive in all areas of research due to lack of trained manpower and adequate scientific resources
- Need to focus on, and adequately fund, R&D in areas of common interest, existing strength, and development priorities (Food Security, Health Equity, Green Energy, Climate Change, Environment etc.)
- Research productivity can be maximised through *multidisciplinary* and *multi-institutional collaborations* between research groups in different Islamic countries that possess *complementary expertise and facilities*
- Discovery and Development of essential Biotech Medicines can involve researchers from Islamic countries at varying levels of economic and scientific development

# Two Areas of Drug Development Research that Provide Best Opportunities for Collaborations and Product Development

- 1. Rational Bioprospecting of BIOTA for Discovery of Novel Drugs
  - Huge opportunity for OIC-wide collaborations and productive involvement of LDCs and scientifically-lagging countries
  - Immense prospects for Intellectual Property (Patents) development at different stages of the drug discovery and development process
- 2. Development of Affordable Biosimilar Medicines through Reverse Engineering of very expensive Patented Biologics
  - Meet healthcare needs of Islamic countries, including economically disadvantaged ones
  - Huge opportunity for capacity development and wealth creation, and strategic involvement of LDCs

# Rational Bioprospecting for Discovery and Development of Novel Drugs

Combines Traditional Knowledge with Modern Sciences to Discover and Develop Modern Medicines from Indigenous Flora and Fauna

## Rational Bioprospecting Indigenous Biota for Novel Drugs

Existing Strengths and Resources:

Indigenous Knowledge / Traditional medicines

Regional Flora and Fauna / Biodiversity Hotspots

- Ethno-pharmacology (impressive scholarly publications)
- Extract Libraries from plants/living organisms (organize and catalogue)
- Chemistry of novel secondary metabolites from medicinal plants/Biota (impressive scholarly publications)
- Secondary Metabolite Libraries from Biota (organize and catalogue)
- Natural product-derived Extract and Secondary Metabolite Libraries are Goldmines of undiscovered wonder drugs!

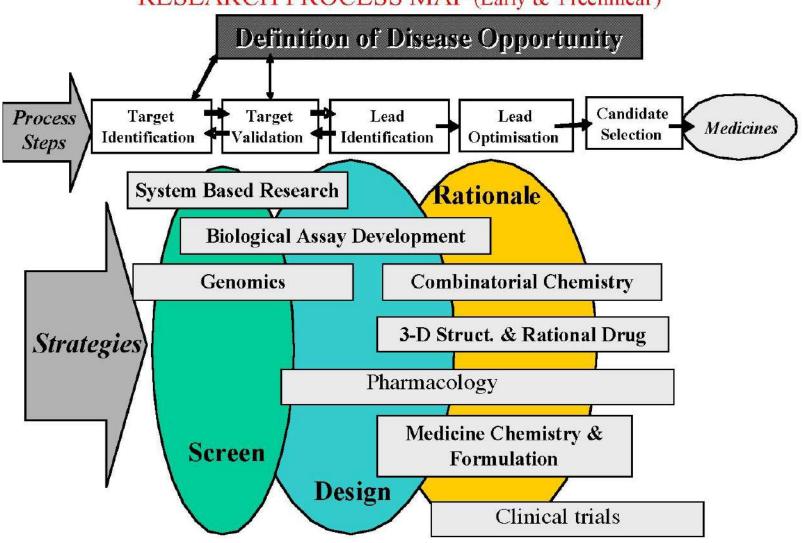
Extensive research publications have not resulted in too many modern medicines!

What is needed to translate research into new medicines?

- ✓ Multidisciplinary collaborations, and involvement of molecular biosciences
- ✓ Generation and utilization of IP (Patents); Funding for patent protection?
- ✓ Interaction and partnership with modern drug companies

#### The Drug Discovery and Development Process:

#### RESEARCH PROCESS MAP (Early & Preclinical)



### Rational Bioprospecting of Biota for Novel Drugs

Combining strengths in **traditional knowledge**, and medicinal chemistry, with **modern molecular biosciences**:

- ➤ Bioprospecting of natural product-derived extract and isolated chemical libraries with **Disease-Specific Molecular Target-based Bioassays** could result in
  - ✓ Much higher levels of lead identification
  - ✓ Candidate drugs with high specificity and insignificant side effects
- > Ample opportunities for IP generation, and Technology Transfer (academia-Industry partnership) for Commercialisation
- ➤ Very high potential for multidisciplinary and multi-institutional collaborations, and involvement of scientists from LDCs and scientifically-lagging countries
- High Market demand (as no new small molecule drugs being developed)

## Discovery and Development Pathway for Novel Drugs from Biota (Expertise and Facilities Required):

#### **Discovery Research**

- ❖Identification and validation of disease-specific molecular targets\* [new IP]
  - (molecular and cell biology, genomics, proteomics, computational biology, animal and tissue models)
- Development of disease-specific molecular target-based bioassays\* [new IP]
   (Molecular Biosciences and immunochemistry)
- ❖ Natural product libraries (extracts and isolated secondary metabolites):
  ❖ (Ethnopharmacology and Medicinal Chemistry)
- ❖ Identification of **new lead compounds** by screening NP libraries with *highly specific* molecular target-based *bioassays* [**new IP**]
- \*Find and involve researchers in disease pathogenesis and assay development

## Discovery and Development Pathway for Novel Drugs from Biota (Expertise and Facilities Required):

#### **Development Research**

- Molecular target-based Bioassay-directed lead molecule purification and characterisation [new IP]
- Optimisation of lead molecules into possible candidate drugs [new IP]
  - (combinatorial and synthetic chemistry, structural biology, computational chemistry/drug design)
- ❖ Selection of best candidate drug
  - ❖(preclinical animal studies, and human clinical trials)

#### Commercialisation

\*Regulatory affair, manufacturing under GMP conditions, marketing

# Disease-Specific Molecular Targets, and Target-Based Bioassays for Identification of *Therapeutic Leads Against COVID-19*

#### Example 1:

Disease-Specific Molecular Target:

Receptor-binding domain (RBD) of SARS-COV-2 Spike Protein: Responsible for virus attachment/entry to human cells by binding specifically to human receptor ACE 2

Target-Based Bioassay (in vitro binding of virus RBD to human ACE2)

Therapeutic *lead compounds* (in NP extracts) could *prevent/disrupt binding of viral Spike Protein to human ACE 2,* without affecting biological activity of ACE 2

#### Example 2:

Disease-Specific Molecular Target

RNA-dependent RNA Polymerase (RDRP) of SARS-COV-2: Responsible for Viral RNA genome replication in infected human cells

Target-based Bioassay (Viral RDRP dependent viral RNA synthesis):

Inhibitors (present in NP extracts) could specifically inhibit viral RNA synthesis without inhibiting any human RNA/DNA polymerases

## Biologicals, Biosimilars and Biobetters

Peptide- and Protein-based Therapeutics produced by Recombinant DNA Technology

# Human Protein/Peptide-Based Medicines Produced by Recombinant DNA Technology

*Biologics*: Patented Bioactive human proteins/peptides produced by recombinant DNA technology

- ➤ 1<sup>st</sup> Generation: Insulin, Interferon, Erythropoietin, Growth Factors etc.
- ➤ Monoclonal Antibodies (Mab): Therapeutic antibodies (originally produced by hybridoma technology, and then by recombinant DNA technology)
- Fc-Fusion Proteins: Recombinant Protein in which a bioactive protein/peptide linked to constant Fc domain of a Mab
  - Mabs and Fusion proteins are mostly patent-protected and extremely expensive (>\$50,000/person/year)

# Human Protein/Peptide-Based Medicines Produced by Recombinant DNA Technology

Generics: Exact copies of small-molecule drugs produced by synthetic chemistry (Clinical Trials not needed)

❖ Biosimilars: Cheaper versions of Biologics produced by recombinant DNA technology with same therapeutic properties, but structurally not identical to the original Biologics (Clinical Trials a requirement for regulatory approval)

### BIOSIMILARS: Low-Hanging Fruit Ready for the Picking

- Pharmaceutical companies in some Islamic countries sell Biosimilars "repackaged" with imported ACI (from China, Korea, India, Brazil etc.)
- A few have produced ACI for Biosimilars (Insulin, Interferon, EPO, growth factors etc.) from seed clones obtained from *ICGEB*
- To produce affordable Biosimilars of new generation patent-protected Biologics (Mab / FC-Fusion Proteins) their ACI (seed clones) need to be locally produced
- Patent restriction can be circumvented (till 2033) by carrying out the upstream R&D in a LDC that has the required competencies
- Besides making very expensive modern drugs available to Islamic countries, this is also an excellent opportunity for wealth creation
- Global market for Biosimilars was \$2.5 billion in 2014 and expected to exceed \$69 Billion in 2025 (and possibly multi-Trillion \$ in 2030)

## Golden Opportunity for Production of Affordable Mab and Fc-Fusion Biosimilars for Islamic and Developing Countries

- Cheaper *Mab and Fc-Fusion Biosimilars* (of expensive and patented Biologics) are desperately needed for Islamic World and poorer developing nations
- LDCs can legally copy any patented drug to produce and market cheaper new generation Biosimilars as they are exempt from patent restrictions till 2033
- This provides a huge competitive advantage over likely competitors in developed and developing countries (Korea, China, India, Brazil, Argentina)
- Excellent opportunity for LDCs, with required competencies and low labour costs, to take advantage of WTO's patent concession to produce affordable Biosimilars for the Islamic and Developing World
- Are there any LDCs in the Islamic World that have the required upstream competencies, trained manpower and resources to develop Biosimilar seed clones, and the downstream technologies to manufacture Biosimilars for clinical use in humans?

## Golden Opportunity for Production of Affordable Mab and Fc-Fusion Biosimilars for Islamic and Developing Countries

- Incepta Biotech (Bangladesh) has already produced and marketed new generation Biosimilars from (imported) seed clones, and also demonstrated competencies for producing own seed clones by reverse engineering
- An independent team of young researchers in Bangladesh (mentored by AAA)
   have developed all upstream competencies for producing any Fc-Fusion seed
   clone of choice
- With suitable operating funds, sponsored trainees (research scholars) and a semi-automated clone selector, this research team (from Bangladesh) can develop any seed clone for production of latest high-value Biosimilars
- Very important to know if any other LDCs also have competencies and trained manpower for the development of seed clones of latest Biologics?
- Bangladesh could help to train and transfer technology to other LDCs in the Islamic World till 2026 (when it loses its LDC label)

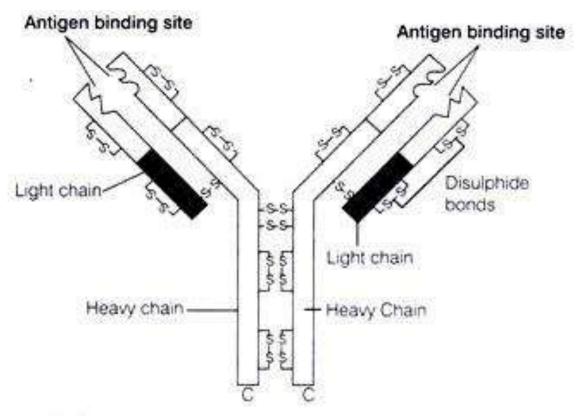
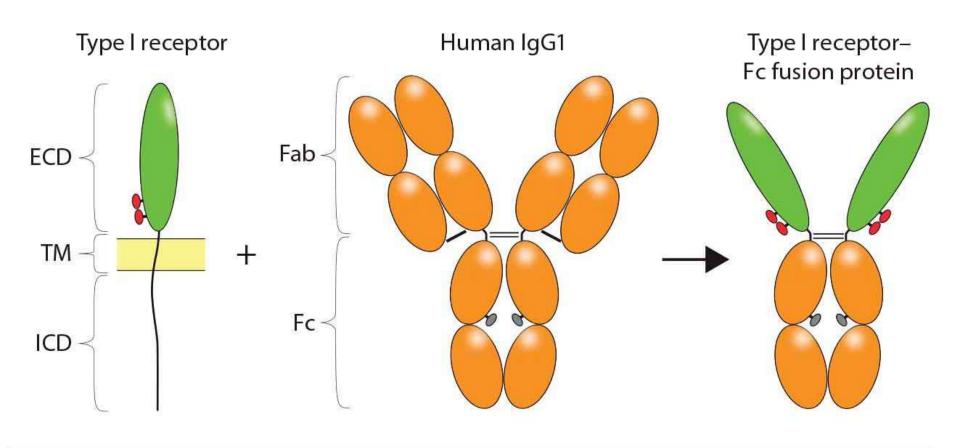
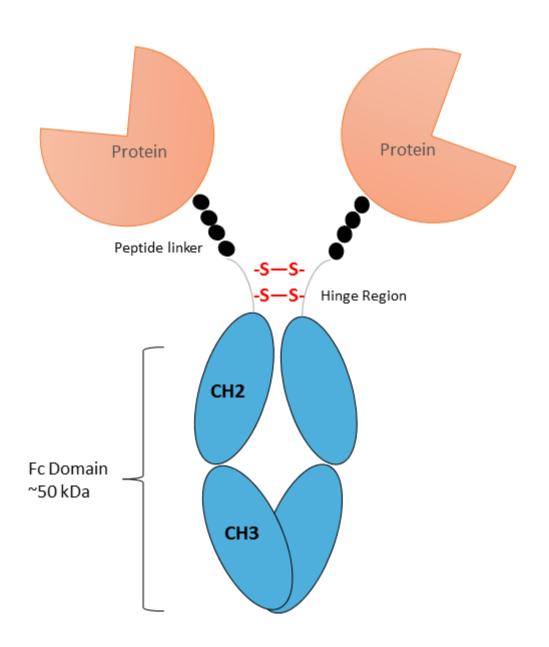


Fig 8.2 Structure of an antibody molecule





#### Development of Seed Clones of New Fc-Fusion Biosimilars

#### Upstream Processing (Reverse Engineering and seed clone development)

- Obtain amino acid sequence of the N-terminal therapeutic protein
  - √ Known protein (patent/literature; Unknown protein (direct sequencing)
  - √ Need access to Tandem MS (MALDI-Tof/Tof-MS or LC-MS/MS)
- Design equivalent gene (for Biosimilar) using human codons
- Chemically synthesize designed gene for Biosimilar
  - ✓ Preferably use own polynucleotide synthesiser (for confidentiality)
- Integrate Biosimilar gene into suitable mammalian expression vector in which gene for constant Fc region of IgG is built-in
  - ✓ C-terminus of therapeutic protein covalently linked to Fc N-terminus
- Small-scale Fermentation in CHO cells for expression of Biosimilar ✓ Ascertain integrity and biological activity\* of expressed Biosimilar
- Selection of clone(s) with highest levels of expression of bioactive Biosimilar ✓ Semi-Automated Clone Selector\* with built-in FACS and cell sorter required

#### Development of New Fc-Fusion Biosimilars from Seed Clones

- ➤ Downstream Processing
  - Production of Biosimilar by batch fermentation to ascertain structure and biological activity of Biosimilar
  - Produce enough Purified Biosimilar for Preclinical Animal Studies (safety, efficacy and bioavailability)
  - Large-scale fermentation and purification of Biosimilar under GMP conditions for human clinical trials
- ➤ Preclinical Animal Studies
  - Contained and SPF facilities for any challenge studies (for anti-infectives)
- Human Clinical Trials (Adequate funding and appropriate expertise required)
- ➤ Regulatory Approval (OIC-wide Simple and uniform guidelines required)
- ➤ Manufacture and Marketing (Easing/removal of trade barriers within Islamic World)

#### Should Islamic World Produce New Generation Biosimilars? Important Points to Consider!

- Very high demand for cheaper Mab-type Biosimilars of highly efficacious but extremely expensive Biologics (>\$50K/person/year)
- 2. Production costs will be greatly reduced if Biosimilars of patented Biologics are made from seed clones developed within Islamic world.
- 3. To circumvent patent protection, clone development and selection of highest-expressing clones could be carried out in a LDC as WTO has granted them exemption from patent restriction till 2033
- 4. This provides huge competitive advantage to LDCs over major competitors (China, Korea, India etc.) who can only produce and market Biosimilars of out-of-patent Biologics

#### Should Islamic World Produce its Own New Generation Biosimilars? Important Points to Consider!

- 5. Decision, to produce molecular seed clones in LDCs, must be made without delay if full advantage is to be taken of the time remaining on patent cover for individual Biologics
- 6. Are there any LDCs in the Islamic world, besides Bangladesh, that have the required competencies?
- 7. How can more scientifically advanced Islamic countries contribute?
  - ✓ Develop Bioassays to affirm biological/clinical activity of intended Biosimilar
  - ✓ Host researchers from disadvantaged countries and provide access to advanced technologies
  - ✓ Facilitate human clinical trials
- 8. Enabling and Coordinating Role for IAS and COMSTECH?

## How can IAS and COMSTECH Play an Enabling and Coordinating Role in Supporting OIC-wide Research Capacity Development?

Provide administrative, policy and logistical support to initiatives that bring together multidisciplinary research teams from different Islamic countries

To promote **OIC-wide Research Capacity Development**, *IAS and COMSTECH* should undertake the following initiatives:

- With science academies in Islamic World, convince Governments to
  - Increase funding for *postgraduate research* and national *R&D* to minimum levels recommended by UNESCO
  - Host visiting researchers (from disadvantaged countries) for training and access to contemporary equipment and facilities
  - Encourage academia-industry partnerships, and industry funding for academic and industry R&D (in return for tax concessions and trade benefits)
- In partnership with **IsDB** and other development partners secure funding to establish a **Trust/Foundation** to adequately fund/support:
  - Collaborative research in areas of common interest and highest priority
  - PhD scholarships, Postdoctoral Fellowships, Training and Visiting Fellowships
  - Purchase of essential equipment
  - Pre-clinical animal studies and human clinical trials
  - IP/Patent generation, maintenance and protection

## How can IAS and COMSTECH Play an Enabling and Coordinating Role in Supporting OIC-wide Research Capacity Development?

- Establish strategically located world-class research centre(s)
  - State-of-art equipment and technologies (that most Islamic countries cannot afford to buy or maintain individually)
  - World-class goal-oriented research addressing development priorities of Islamic countries
  - Internationally recognised expertise in required scientific disciplines
  - Postgraduate research and training hub for young researchers, especially from LDCs and scientifically-lagging countries
  - ➤ A World-Class Molecular Biosciences Research Centre to support Biomedical, Agricultural, Green Energy and Environmental Sciences Research with following shared facilities:
    - Latest gene, protein and cell technologies
    - Bioinformatics, structural biology, combinatorial and synthetic chemistry, computational chemistry (drug design)
    - ➤ World-class "contained" facilities for producing transgenic animals (as disease models), and for preclinical "challenge studies"
    - > 'Controlled environment' glass house for transgenic plants and tissue culture
- **Technology Transfer Office(s):** as one-stop advisory and support hub(s) for IP, Regulatory Affairs and Commercialisation, with uniform and harmonised guidelines for all OIC-member countries (e.g. EUMA covers all EU nations)

# STATUS AND PROGRESS IN RELATION TO SUSTAINABLE DEVELOPMENT GOALS IN THE ISLAMIC WORLD: OPPORTUNITIES FOR CHANGE

## ZULFIQAR A BHUTTA<sup>1,2</sup>, DAINA ALS<sup>1</sup>, JAI K DAS<sup>2</sup>, MAYA KSHATRIYA<sup>2</sup>, BUSAYO AKINDOLE<sup>2</sup>, JULIA INGENFELD<sup>2</sup>

<sup>1</sup>Centre for Global Child Health, Hospital for Sick Children, Toronto, Canada & <sup>2</sup>Institute for Global Health & Development, the Aga Khan University, South-central Asia, East Africa and United Kingdom

#### **ABSTRACT**



As the end of the Millennium Development Goals period (2000-2015) approached, and it became clear that many countries would not meet the eight health targets established by the United Nations (UN), a new more comprehensive list of targets were established and would come to be known as the Sustainable Development Goals (SDGs). The 17 SDGs encompass health, economic and environmental targets for countries to achieve by the year 2030. With the mid-point of the SDGs approaching, we sought to investigate how countries were performing in terms of meeting health and health related Sustainable Development Goals (HHSDGs), which included the majority of the

SDGs. We identified available health and health related indicators available in Demographic Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS). Indicators that were not available in DHS and MICS, were sought from other nationally representative sources such as WHO, World Bank and UNESCO. We then determined the indicators that had two time points available to generate trends in HHSDG achievement. We further narrowed our focus on the performance of countries with predominantly Muslim populations, which will hereafter be referred to as Muslim Majority Countries (MMCs). In focusing on this group of countries and comparing them to others comparable on the basis of development, we sought to identify areas where MMCs are outperforming or falling behind other countries and consider the factors that may cause the observed disparities. This presentation will highlight salient areas of progress and stagnation, suggesting modalities for scaling up implementation and reducing inequities.

## DIGITAL TRANSFORMATION: TECHNOLOGY AND INNOVATION FOR SOCIO-ECONOMIC DEVELOPMENT

#### ADNAN BADRAN FIAS

President, Islamic World Academy of Sciences
Chancellor, University of Petra
Chairman of the Board of Trustees of the University of Jordan, Jordan

#### **ABSTRACT**



Some OIC countries were successful in building culture of innovation for socio-economic development, while others failed to do so. Those who made it took measures to support science, technology and relevant quality education from childhood to higher education, which resulted in wealth creation and quality of life. They concentrated on building rich human resources in a stable political environment which have triggered the human capital potential to new frontier areas in science for a sustainable development, and made a new space among other OIC developing economies. Those who invested more in R&D and quality education harvested an enormous development as seen in major science indicators

as: peer-reviewed publications, patents, higher number of scientists per one million population, and higher world ranked academic institutions and stronger links of academia with industry in developing hi-tech exports worldwide.

To alleviate poverty, and unemployment and climate change and, to meet the UN-SGDs 2030, OIC countries need a comprehensive stable policy toward a green economy in a sustainable ecosystem, capitalizing on technology, innovation and creativity as human-based rich resources.

## Digital Transformation: Technology and Innovation for Socio-Economic Development

#### Adnan Badran,

FIAS, FTWAS, FAAS

Prof. and Chancellor, University of Petra, Amman, Jordan

The 24<sup>th</sup> Conference of the Islamic World Academy of Sciences (IAS)

On

Challenges to Promote Science and Technology for Socio-Economic Development in OIC Countries Mar 7-8, 2023 Karachi-Pakistan

### **Digital Transformation:**

- Today's buzzword after the pandemic is: "distance education and E-learning.
- Although one is dependent on the other.
- E-learning is a style of pedagogical learning includes use of technology and digital resources.



### **Innovation and Digital Transformation (DT):**

- DT requires trust, resilience and innovation.
- Create friendly environment for new ideas.

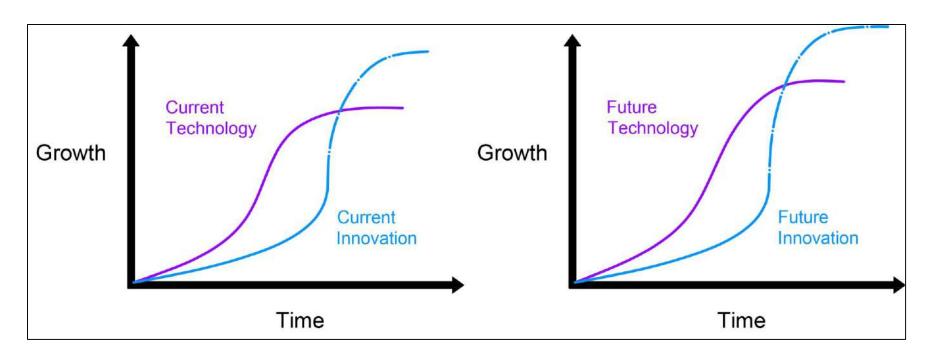


- Bring people from various disciplines and backgrounds.
- Start from customer needs with reverse-engineering scenario.
- Breakdown silos of disciplines for integrated interdisciplinary approach.
- Build resilience into business models to withstand exogenous shocks.

#### How to drive Transformation by Innovation:

- Structural change for new skills, hands-on.
- Retrain workers for alignment with new opportunities created.
- Empowering capacity of human resources to release their potential in creativity and innovations.
- Adapting artificial intelligence (AI) has achieved success in the pandemic environment.
- Space for creative thinking to generate innovative ideas.
- In the digital world, variety and diversity will drive innovations and transformation to new orbits.

### **Diffusion: From Technology to Innovation**



Rise of Technology would Raise Innovation

### **Trends of Technology and Innovation:**

- 1. Cloud as digital foundation will attract biggest investment.
- **2. Data** is the business pivot (IOT).
- Ecosystem to bridge the gap of skills in building the culture of innovation.
- 4. Security and Privacy, cybersecurity to protect new technologies.



#### The Metaverse:



- To live within a digital universe.
- Started with Neal Stephenson: (1992) science fiction novel (snow cash), lifelike avatars, 3D Virtual Reality (VR) environment.
- Online virtual world: Augmented Reality (AR), VR, 3D holographic avatars, video communication.
- Hyper-real alternative world to live and coexist.
- Mark Zuckerberg: CEO Meta Verse (Former Facebook) expects 10 years for metaverse to become mainstream online.

### **Examples of Metaverse:**

Metaverse is an evolution of the internet- an online space where people can socialize and play and construct as avatars. What you need VR headset connected to PC and later to iPhones.

- **Meta Facebook:** expected next platform for immersive embodied internet.
- **Microsoft:** holograms and mixed reality (MR) of Avatars.
- Reimagining Martin Luther King 1963 "I have a dream".
- **Minecraft:** Legos for kids where players create their own digital characters.

#### Why Innovation Matters in Education:

- It's how to use technology to empower students to become lifelong learners and agents of change.
- Aligned to their abilities and culture and identity.
- Looking to solve problems.
- Innovate to improve. This is how Apple maintain dynamic in the marketplace from iMac to iPhone.



# UNESCO Four Pillars of Education in Digital Transformation:

There are four pillars of learning for the twenty-first century, laid out by UNESCO (Jacques Delors Report):

- 1. Learning to be: To solidify my existence as a thinking person in the foundation of knowledge, and my identity as a citizen. "I think, therefore I am".
- **2. Learning to know:** To develop my cognitive skills and critical intellectual skills in research, enquiry, questioning, discovery, invention, searching for the unknown and arriving at the truth.
- **3. Learning to work:** to develop skills working and to excel. Continuous Education
- **4. Learning to live with others:** understanding pluralism and contrast, respecting difference, and appreciating other cultures and civilizations, without discrimination.

# Life-long Learning: the McDonald Model in the Digital World:

- **Fixed programs and curricula** that take a long time to change, may be of no value in a world that wants skills that respond quickly to market needs and societal changes.
- Therefore, life-long learning will spread in the future that provides quick meals of special educational packages, to prepare the individual according to his needs and abilities to the field of work.
- He may return again to take other educational and learning sandwich that lead him to another work, and thus the human resources are evolved internally in a changing world.
- **This will cut unemployment**, thus turning society into a dynamic productive society in an ever changing world, rich in diversity.



#### Role of Scientific Research in developing Technologies:

# The university plays a major role in bringing change in economy and society.

#### **Examples:**

- 1. The 500-year-old university in South Korea, Sun Kye-kwan, has introduced the world to Samsung.
  The success story of Iceland and Ireland in scientific research, medical and educational techniques, energy and modern management.
- 2. The scientific-industrial complexes in Malaysia on the Corridor between Kuala Lumpur and the airport, technological institutes that turned into a dynamic green land, scientific incubators and industrial scientific communities.
- 3. Silicon Valley, which is adjacent to Stanford University in California and the scientific city in Cambridge surrounding MIT in Boston, where emerging companies startups from the research and development outputs of the university, to become giant companies that manage the market and the global economy.

#### Role of Scientific Research in developing Technologies: (continue)

- 4. Finland was based on the outputs of scientific research in communication from R&D outputs of 52 universities, each of which contains incubators and scientific-industrial complexes, invented Nokia and other advanced satellite communication.
- **5.** The scientific-technological triangle in Canada, where Canadian universities participate to adapt their research outputs through their incubators into advanced commodity and knowledge technology, in the techno-park.
- **6. Chungbuk Technopark** is a technology park located in the North Chungcheong province in South Korea for small and medium-sized companies in S.Korea, aiming to foster biotechnology and assist business incubation. The technology park is a regional innovation center for industrial development, enterprise support and job creation through collaboration between local industry, academics, local and national government.

#### Reforms of Education: Innovation from Schooling to E-Learning

- Contemporary education requires a new learning Digital ecosystem that is student-centered, with problem-based learning and real-world learning that spark innovation and entrepreneurship. Students should become the vehicles of change.
- Utilization of smart phones provides new learning tools for students to think "outside the box" and look for new ways of developing skills beyond the classroom.
- We have to train a new generation of teachers who overcome the traditional way of teaching, enabling them to move into technology-based-learning, **blended-learning** utilizing multi-media, and interactive debate on problem-solving.



### **Building a Culture of Innovation:**

The WB has set a strategy for entrepreneurial assessment summarized in the following:

- Identifying current performance and opportunities.
- Designing targeted solution.
- Strengthening policy design and governance.
- Engaging globally with stakeholders.

## How to Enhance a Vibrant Innovation and Entrepreneurship Ecosystem:

- Policy makers, business leaders, academia, and civil society are called on to collaborate with clear plans for job creation.
- The Forum of Young Global Leaders at the World Economic Forum (WEF) at the Dead Sea with Booz and company have put a visionary plan to engage the youth in innovation and entrepreneurship for startups to open new horizon for work for economic development.
- Entrepreneurs will be vital engines to drive the transition.



### **Conclusion:**

- Although R&D outputs of universities in the Islamic World, are on the increase as indicated and cited in international peer-reviewed journals, much of the R&D lacks application to industry and the marketplace.
- Reforming education from early childhood to build creativity, critical thinking, an enquiry-based and student-centered education to spark the mighty minds to become inventors, problem-solvers, and disciplinary and multidisciplinary leaders.
- Policy-makers, academia, and business leaders must identify what motivate people to start up a business.
- The region with the potential of its youth and with investment in the knowledge economy will undoubtedly become a dynamic global center for entrepreneurial ventures and innovations. Big ideas may come in the future from the Islamic world as it used to be in older times.



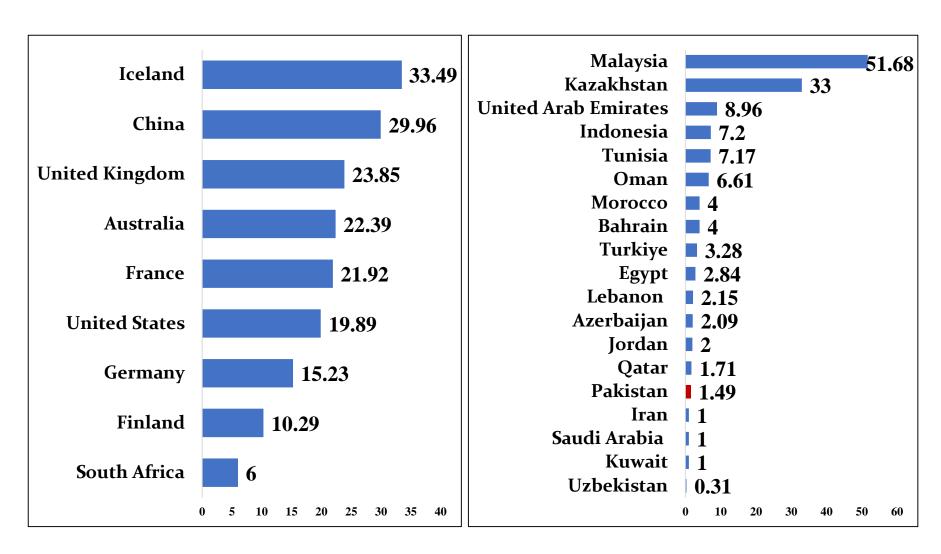


Fig 1. The ratio of high technology in total exports (% of manufactured exports) of Islamic countries as compared to the world, 2019-2021

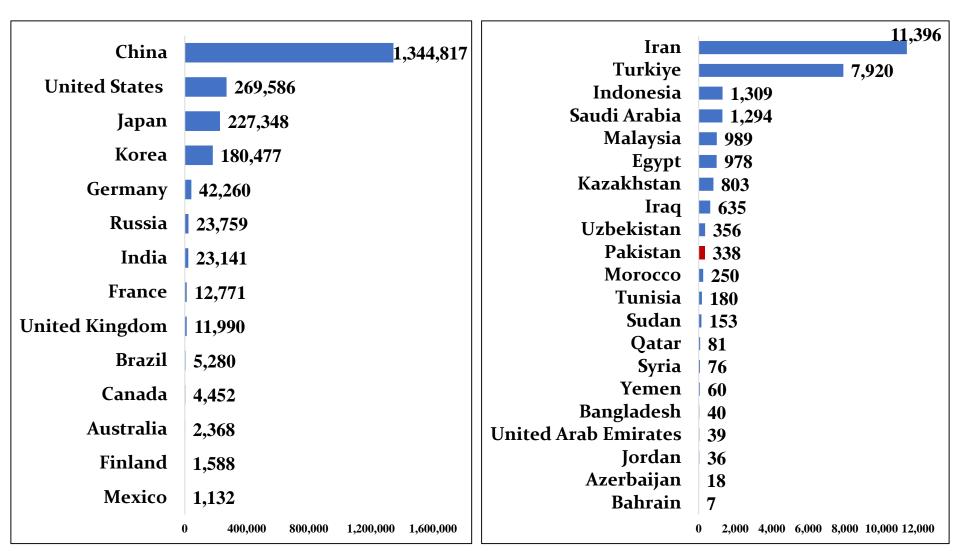


Fig.2 Patents of residents in Islamic countries as compared to the world. World Bank (2018-2020)

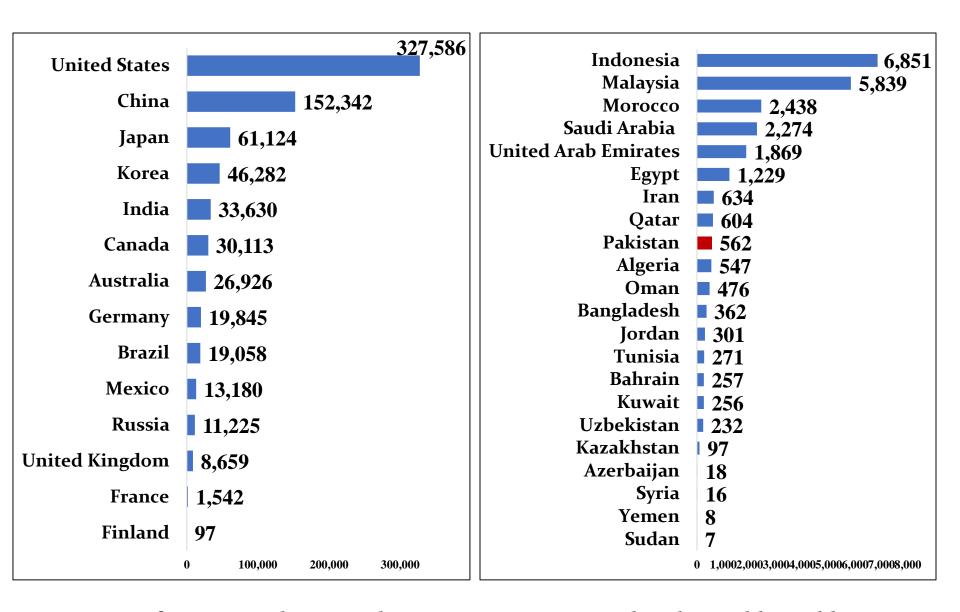


Fig.3 Patents for non-residents in Islamic countries compared to the world. World Bank (2018-2020)

my motto:



## **ICID**

Initiate, Create Innovate, Disseminate



## COMBATING THE DRUG DEVELOPMENT CHALLENGES WITH SUSTAINABLE AND INCLUSIVE DRUG DISCOVERY AND DEVELOPMENT - AN EMERGING PARADIGM

### MUHAMMAD IQBAL CHOUDHARY\* FIAS AND ATTA-UR-RAHMAN FRS

\*Mustafa (PBUH) Prize Laureate, Hilal-i-Imtiaz, Sitara-i-Imtiaz, Tamgha-i-Imtiaz UNESCO Chair on Medicinal and Bio-Organic Natural Product Chemistry \*Coordinator General OIC-COMSTECH / Director, International Center for Chemical and Biological Sciences (ICCBS), Pakistan

#### **ABSTRACT**



Sustainable and inclusive drug discovery and development is based on the principles of the use of renewable resources, and green chemistry methods. Nature-based discovery of drugs against prevailing and emerging diseases can play an important role in achieving SDG-3 (Health and wellness for all). Our work in the past two decades has been focused on the discovery of new drug leads from medicinal plants, as well as synthesis of bioactive analogs by green biocatalytic transformations. We have been working largely at the interface of chemistry and biology for the discovery of chemical constituents from plants used in traditional medicines, as well as for designing of new

biotransformed products with therapeutic potential. This has resulted in the identification of several novel drug leads against various therapeutic targets. Emphasis has been on the discovery of novel drug like molecules against neglected diseases, such as leishmaniasis and chronic disorders, including epilepsy, cancer, diabetes, and Alzheimer's, and Parkinson's diseases. During this presentation, underlying philosophy and approach of our research on cost-effective discovery of naturel-based lead molecules will be highlighted.











# Sustainable and Inclusive Drug Discovery and Development- An Emerging Paradigm

### Muhammad Iqbal Choudhary and Atta-ur-Rahman FRS

Mustafa (PBUH) Prize Laureate

Distinguished National Professor/ Director ICCBS Coordinator General COMSTECH/UNESCO Chair

International Center for Chemical and Biological Sciences

(H.E.J. Research Institute of Chemistry, and Dr. Panjwani Center for Molecular Medicine and Drug Research)
University of Karachi, Karachi-75270, Pakistan









# Current Drug Discovery Paradigm- *Unsustainable* and Non-inclusive

- Over USD 2.0 billion to develop a new drug
- Over 10-15 years for development of a single drug
- Based on the use of fossil fuel ingredients (Earth's non-renewable resource)
- Synthesis involve the use hazardous chemicals, high energy, toxic waste, etc.
- Technologies, such as combinatorial synthesis, high throughput screening, etc turned out to be largely unproductive.
- No investment on "poor man diseases", so called neglected diseases.

There is a need of a paradigm shift to ensure the availability of drugs for future global healthcare, including the poors of Global South

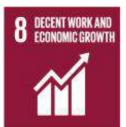
## Sustainable Drug Discovery- A New Paradigm

- Drug for all (SDG 3)
- Drug discovery from renewable resources, zero dependence on fossil fuel (SDG 12)
- Drug discovery without the use
  - of toxic chemicals (SDGs 13, 14, 15)
- Medicines for poor men diseases (SDGs 3, 10)



13 CLIMATE ACTION































## Two Examples of Our Ongoing Research

- Drugs from Nature for Neglected Tropical Diseases
- Cost Effective Drug Discovery through Repurposing

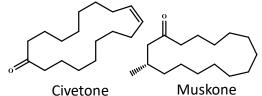


# Sustainable Drug Discovery from Nature



"Natural products possess enormous structural and chemical diversity that cannot be matched by any synthetic libraries of small molecules, and continue to inspire novel discoveries in chemistry, biology, and medicine. They are evolutionarily optimized as drug-like molecules and remain the best sources of drugs and drug leads."

(Newman and Cragg, Journal of Natural Products, 2012).



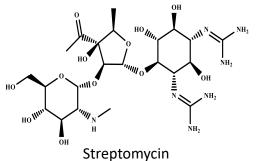
Morphine



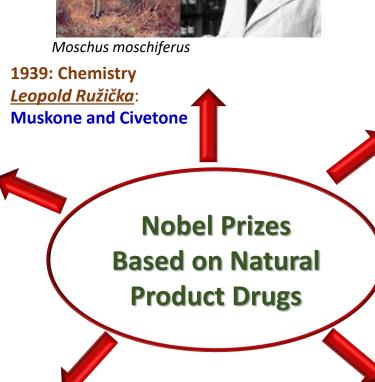
Strychnos nux-vomica Strychnine

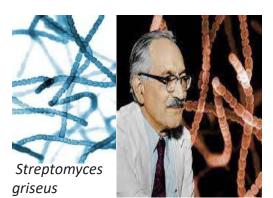
1947: Chemistry Robert Robinson:

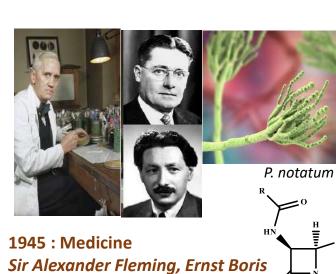
Morphine, Strychnine, Cocaine, Atropine



1952: Physiology or Medicine Selman Abraham Waksman ": Streptomycin

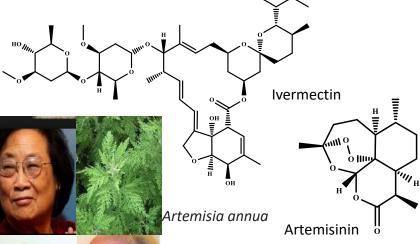


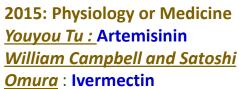




**Chain and Sir Howard Walter** 

Florey": Penicillin





Penicillin

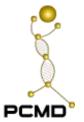


5,000 Plant Extracts

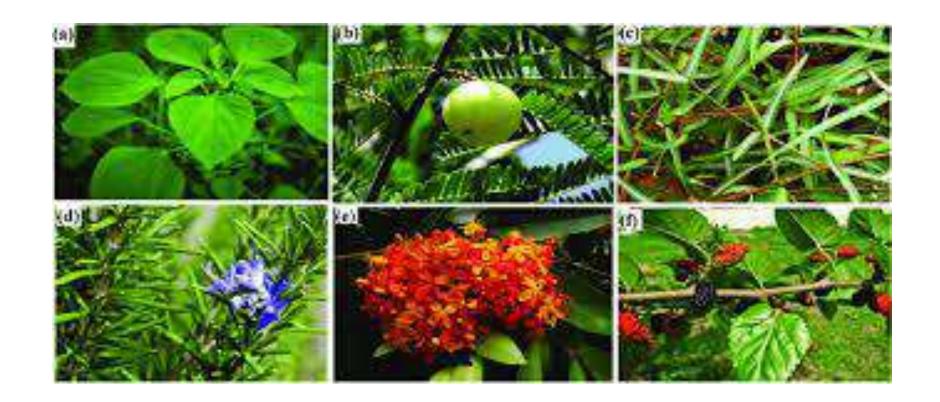


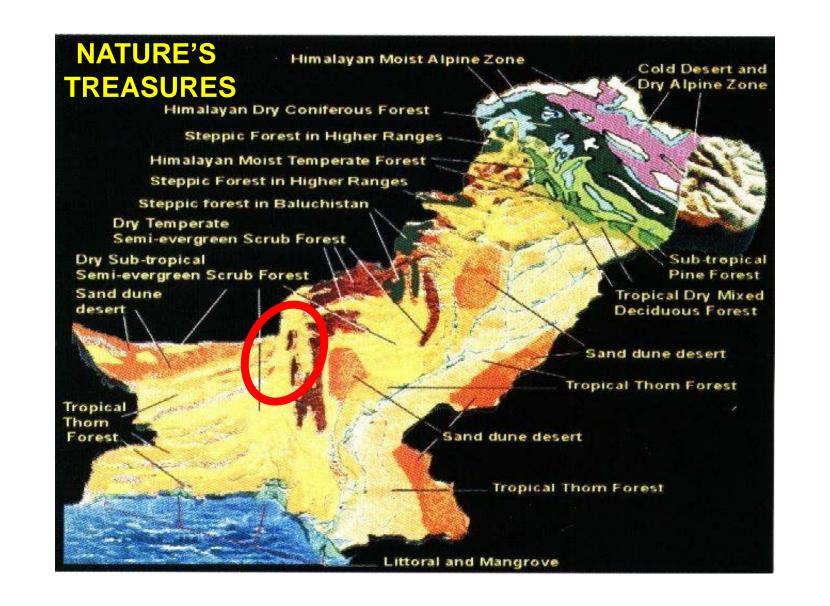
MOLECULAR BANK (More than 22,500 Natural Products)

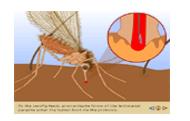




## ANTI-LEISHMANIAL DRUG LEADS DISCOVERY FROM NATURAL SOURCES



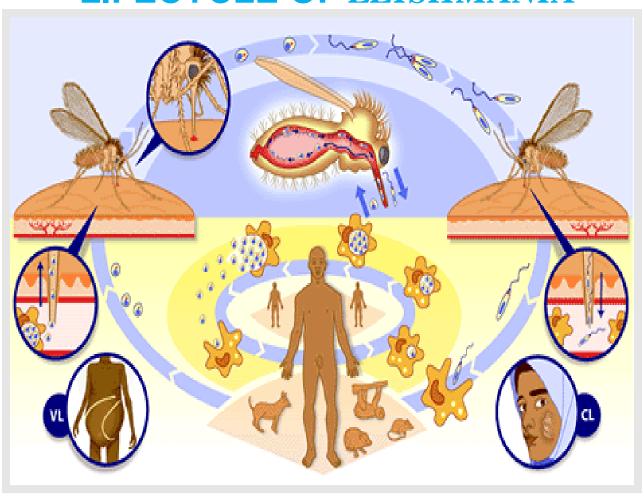




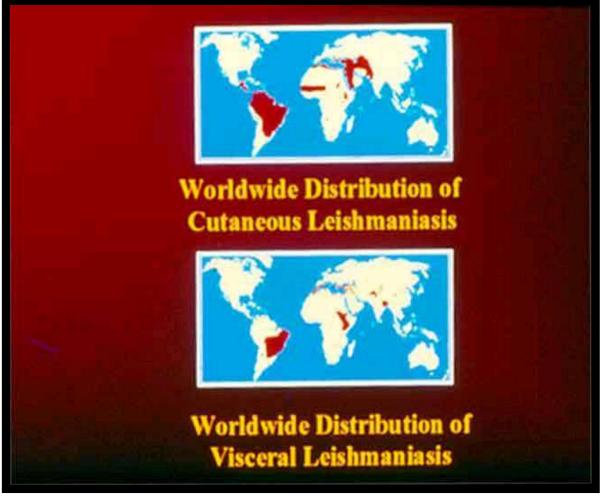
### **LEISHMANIASIS**

- \* Among the greatest public health problems in some developing countries (WHO).
- \* Broad spectrum of diseases caused by different species of protozoan parasites of the genus *Leishmania*.
- \* Prevalent in many parts of the world, particularly Africa, Asia and Latin America.

### LIFECYCLE OF LEISHMANIA









### Leishmaniasis in Pakistan



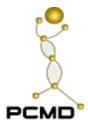
- CL is endemic in Pakistan and has been reported from almost all parts.
- Diagnosis and treatment is difficult due to poor access to health care services
- *L. major* is the most common (3/4<sup>th</sup> cases) species, followed by *L. tropica*.
- Cases of mixed- and con-infections are reported as well.
- A wide spectrum of clinical variants pose a major diagnostic challenge in rural Pakistan.



Map showing distribution of cutaneous leishmaniasis in Pakistan and surrounding countries of South Asia.



## **Recent Outbreaks of Cutaneous** Leishmaniasis in Pakistan



HOME (https://www.samaaenglish.tv) > Health (https://www.samaaenglish.tv/health)

### Leishmaniasis outbreak in Dadu causes alarm

At least 1,633 people have been affected

SAMAA | Hamid ur Rehman (https://www.samaaenglish.tv/author/hamidrehman/)

Posted: Feb 4, 2022 | Last Updated: 2 months ago



### Several thousand affected by vector-borne skin disease across Kachho belt











DADU: A severe skin infection, attributed by health officials to sandflies' sting, has turned into an outbreak as it has alreads spread across 13 UCs of Kachho belt in the west of Dadu district Leishmaniasis spreads in Dadu, suburbs like a wildfire

y: News Desk

Published: 06:24 PM, 7 Feb. 2022



### Establishment of centres for skin disease put on backburner

By Our Correspondent

fast spreading in Kachho area but Tando Rahim, Sawaro, Haji Khan, ished the hospital would need more to health department has not yet set up Gozo, Chinnni and other areas. treat the patients whose number was any centre at basic healthcare facilities Wazir Ali, Khadim Khoso, Hussain fast increasing near patients' villages, and failed to Faqir and Ramzan Jamali, who led the DG health Dr Mohammad Juman make available ample supply of glucan- protest, complained that sores and boils. Bahuto, said, that, bealth, teams, were time injection, the only antidote for the were spreading on patients' faces, conducting soray in affected areas to

The patients complained to Dawn cials were not ready to treat them at skin disease treatment would also be the other day that the health depart healthcare facilities near their villages, set up wherever needed. ment had put on the backburner plans neither were they spraying insecticides Dr Niaz Jamaii, additional DHO, said for the establishment of centres in to kill the disease carrying sand files. that his office was receiving 100 to 150 Kachho while shortage of the injection 
Johi taluka hospital's medical super injections daily from the DG health

and required drugs in Kachho area, than the hospital could cope with. He injection, said sources.

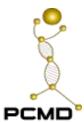
especially in Johi taluka hospital, said bad informed senior officers of shortthat the health department had failed age of the injection, he said. to provide injections to basic health He said that the available injections DADU: Cutaneous leishmaniasis is units in Drigh Bala, Wahi Pandhi, were being used but once they were fin-

skin disease, at the area's hospitals. arms, feet and hands but health offi-kill the sand flies and centres for the

had multiplied patients' misery. Intendent Dr. Zublin Ahmad Panhwar office, which were being distributed The patients, who staged a demon-said that the number of follow-up and among hospitals. The government hosstration along with their families in fresh cases was reported at 6,000 only pitals in Dadu, Khairpur Nathan Shah Johi town against shortage of injections in the taluka hospital, which was more and Mehar also faced shortage of the



## **Our Strategy**



Nationwide wide ethnobotanic survey, focusing on leishmaniasis and other infectious skin diseases







Evaluation of selected medicinal and dietary plants, and other natural products against *Leishmania* parasites *in vitro* 

**Pre-clinical studies and clinical trials** 







## **Selected Plants against Leishmaniasis**



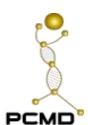


Physalis minima L.



Allium sativum





# Phytochemistry and Clinical Trials For Cutaneous Leishmaniasis

80% Ethanolic Extract of Aerial Parts of

Physalis minima L.

Std: Amphotericin B :  $0.12 \pm 0.105 \mu g/mL$ 

**Leprosy Center** 

Shaheed Benazir Bhutto University of Health Sciences, LARKANA



## BIOLOGICAL AND PHARMACOLOGICAL IMPORTANCE OF PHYSALIS MINIMA



- •Physalis minima (Linn. var. indica) is a herb which is bitter in taste and widely used in folk medicines.
- •The plant is used in various ailments (gallbladder disorders, burning sensation, bronchitis, chronic inflammation, enlargement of spleen, urinary and abdominal troubles and headache).
- •The roots are used as a vermifuge and febrifuge.
- •The 50% alcoholic extracts of the plant is also used as antimalarial agent.

SCHEME OF WORK

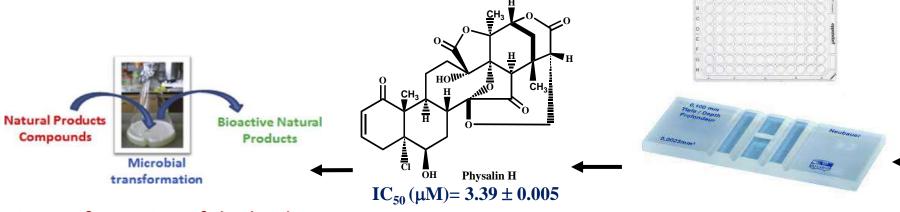


Extraction of aerial parts of Physalis minima





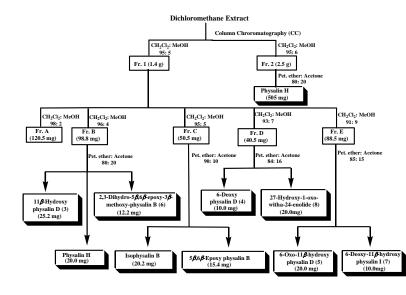
Clinical trails of 80% Ethanolic Extract of Aerial Parts of *Physalis minima* 



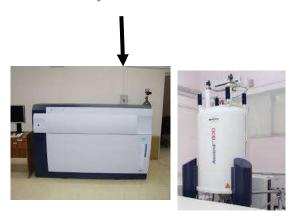
Biotransformation of the lead molecule Physallin H

Identification of antileishmanials *i.e.,* Physallins

Anti-leishmanial activity of pure compounds



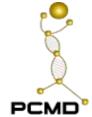
Isolation and Purification of Physallins

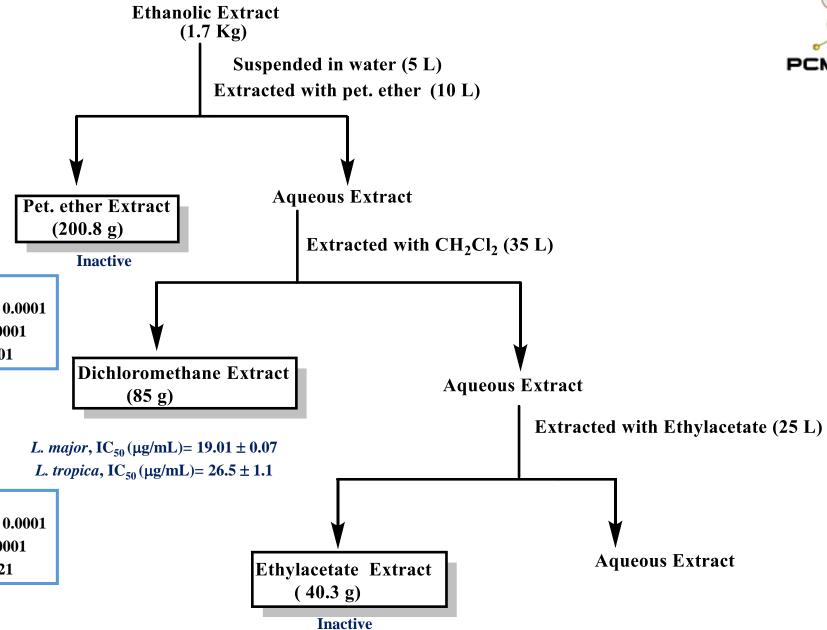


Characterization of pure compounds using IR, UV, Mass spectrometry, and NMR



### **EXTRACTION OF PHYSALIS MINIMA**





### L. major

Amphotericin B=  $3.14\pm0.04 \mu g/mL$ , p-value < 0.0001

Pentamidine =  $9.25\pm0.05 \mu g/mL$ , p-value < 0.0001

Miltefosine= 10.4 $\pm$  0.42 µg/mL, p-value < 0.0001

### L. tropica

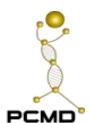
Amphotericin B=  $3.16\pm0.04$  µg/mL, p-value < 0.0001

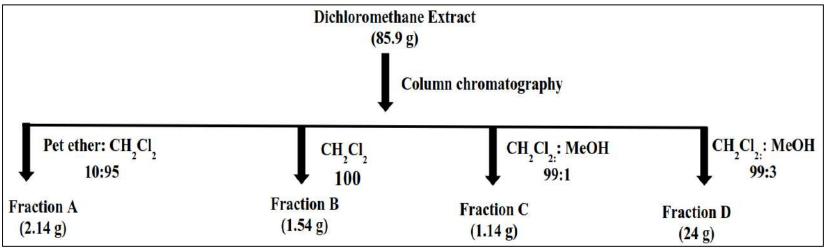
Pentamidine =  $9.25\pm0.05~\mu g/mL$ , p-value < 0.0001

Miltefosine= 17.4 $\pm$  0.42 µg/mL, p-value < 0.0021



### Fractionation of Dichloromethane Extract of *Physalis minima*





L. major,  $IC_{50}\,(\mu\text{g/mL})\text{=}6.67\pm0.1$ 

*L. major*,  $IC_{50}$  (µg/mL)= 9.95 ± 1.9

*L. major*,  $IC_{50}$  (µg/mL)= 6.3 ± 0.02

*L. major*,  $IC_{50}$  (µg/mL)= 6.37 ± 0.02

*L. tropica*,  $IC_{50}$  (µg/mL)= 26.5 ± 1.1

*L. tropica*,  $IC_{50}$  (µg/mL)= 6.41 ± 0.7

 $\textit{L. tropica}, \text{IC}_{50}\,(\mu\text{g/mL})\text{=}6.34\pm0.05$ 

*L. tropica*,  $IC_{50}$  (µg/mL)= 6.37 ± 0.02

### L. major

Amphotericin B=  $3.14\pm0.04~\mu g/mL$ , p < 0.0001Pentamidine =  $9.25\pm0.05~\mu g/mL$ , p < 0.0001Miltefosine=  $10.4\pm0.42~\mu g/mL$ , p < 0.0001

### L. tropica

Amphotericin B=  $3.16\pm0.04~\mu g/mL$ , p < 0.0001Pentamidine =  $9.25\pm0.05~\mu g/mL$ , p < 0.0001Miltefosine=  $17.4\pm0.42~\mu g/mL$ , p < 0.0021

### L. major

Amphotericin B=  $3.14\pm0.04~\mu g/mL$ , p < 0.0001Pentamidine =  $9.25\pm0.05~\mu g/mL$ , p < 0.8898Miltefosine=  $10.4\pm0.42~\mu g/mL$ , p < 0.5084

### L. tropica

Amphotericin B=  $3.16\pm0.04~\mu g/mL$ , p < 0.0001Pentamidine =  $9.25\pm0.05~\mu g/mL$ , p < 0.0001Miltefosine=  $17.4\pm0.42~\mu g/mL$ , p < 0.0021

### Fraction C and D

### L. major

Amphotericin B=  $3.14\pm0.04~\mu g/mL$ , p < 0.0001Pentamidine =  $9.25\pm0.05~\mu g/mL$ , p < 0.0001Miltefosine=  $10.4\pm0.42~\mu g/mL$ , p < 0.0001

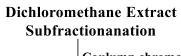
### L. tropica

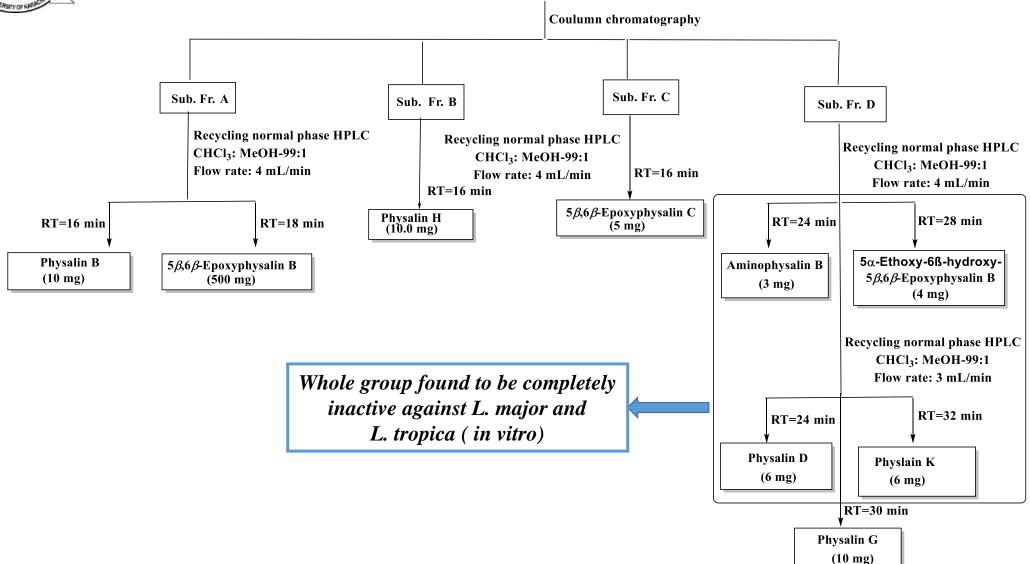
Amphotericin B=  $3.16\pm0.04~\mu g/mL$ , p < 0.0001Pentamidine =  $9.25\pm0.05~\mu g/mL$ , p < 0.0001Miltefosine=  $17.4\pm0.42~\mu g/mL$ , p < 0.0021



### **PURIFICATION OF PHYSALINS FROM DICHLOROMETHANE EXTRACT**







## Clinical Trials



### **Before treatment**

### **After treatment**

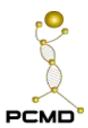






80% Methanolic Extract of Aerial Parts of *Physalis* minima





### **Before treatment**



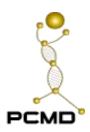
### **After treatment**





#### **Before treatment**

#### **After treatment**











#### **Before treatment**



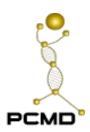
#### **After treatment**





#### **Before treatment**

#### **After treatment**







- Total Subjects: 100
- Follow up for 2 weeks
- 65.71% showed excellent recovery



# Topical Formulation for the Treatment of Cutaneous Leishmaniais

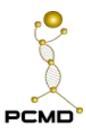








## Survey at Dadu, Juhi and other Villages



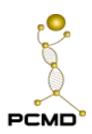








# Topical Formulation for the Treatment of Cutaneous Leishmaniais









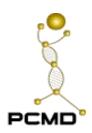








### **Local Treatment of Cutaneous Leishmaniais**









US008287921B

#### (12) United States Patent

Rahman et al.

#### (54) FORMULATIONS AGAINST CUTANEOUS LEISHMANIASIS

(76) Inventors: Attaur Rahman, Karachi (PK);
Mohammad Iqbal Choudhary, Karachi (PK); Sammer Yousuf, Karachi (PK); Samreen Khan, Karachi (PK); Farooq Rahman Soomro, Karachi (PK);

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35

Shahida Perveen, Karachi (PK)

U.S.C. 154(b) by 0 days.

(21) Appl. No.: 13/189,509

(22) Filed: Jul. 24, 2011

(51) Int. Cl. A01N 65/00 (2009.01)

#### (10) Patent No.: US 8,287,921 B1

(45) Date of Patent: Oct. 16, 2012

(52) U.S. Cl	(52) U	U.S. Cl		424/72
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#### (56) References Cited

#### U.S. PATENT DOCUMENTS

2003/0175366 A1 \* 9/2003 Pauly et al. ...... 424/725 \* cited by examiner

Primary Examiner — Michael Meller (74) Attorney, Agent, or Firm — Sarfaraz K. Niazi

#### 57) ABSTRACT

Treatment of leishmaniasis in animals and humans using the methanolic extract of *Physalis minima* in petrolatum is described.

1 Claim, No Drawings



## NO.DDG/VBD/DD/ 401/404 /2023 DIRECTORATE GENERAL HEALTH SERVICES SINDH HYDERABAD

(E-mail: vbdhealth@sindhhealth.gov.pk)
DATED: 01st FEBRUARY 2023

To

The Professor Dr. M. Iqbal Chaudry International Centre for Chemical and Biological Sciences (HEJ & PCMD) 'Karachi.

SUBJECT: SUPPORT REQUIRED REGARDING PROVISION OF OINTMENTS [COMPRISES OF 25% W/W ALLIUM SATIVAUM L, EXTRACT IN SOFT PARAFFIN] FOR THE TREATMENT OF CUTANEOUS LEISHMANIASIS CASES.

With reference to your kind support were provided in 2022 to Vector Borne Diseases, Directorate General Health Services Sindh Hyderabad regarding treatment of Cutaneous Leishmaniasis through ointments, which is highly appreciable. Currently we are expecting unusual rise of Cutaneous Leishmaniasis cases due to post floods situation.

In this context, you are requested to provide support 10000 jars (100g each) of topical ointments comprises of 25% w/w Allium sativaum L, extract in soft paraffin for the treatment of cutaneous leishmaniasis.

Your support in this regard will be highly appreciated.

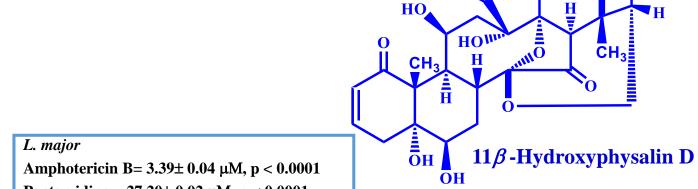
DEPUTY DIRECTOR GENERAL HEALTH SERVICES SINDH (VBD) HYDERABAD

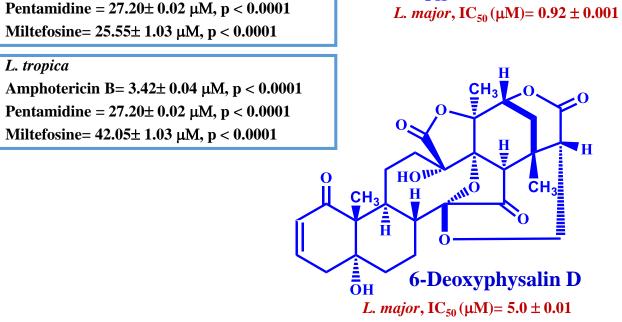
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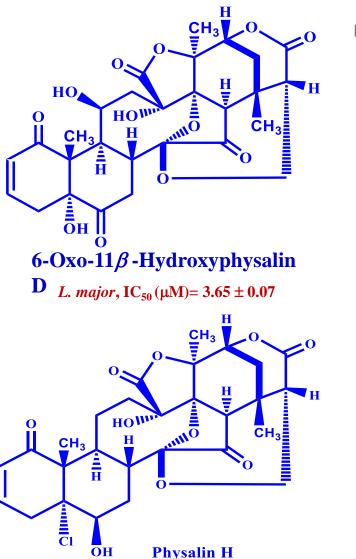
- 1- The Secretary Health Department, Government of Sindh, Karachi.
- 2- The Director General Health Services Sindh Hyderabad.3- The P.S to Minister Health, Government of Sindh Karachi.
- 4- Master File











*L. major*,  $IC_{50}$  ( $\mu M$ )= 3.34± 0.64

*L. tropica*,  $IC_{50}(\mu M) = 9.59 \pm 0.27$ 



#### L. major

Amphotericin B=  $3.39\pm0.04~\mu M$ , p < 0.0001Pentamidine =  $27.20\pm0.02~\mu M$ , p < 0.0001Miltefosine=  $25.55\pm1.03~\mu M$ , p < 0.0001

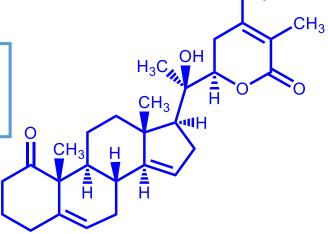
0001 1001 Holling CH<sub>3</sub>
Holl

## 2,3-Dihydro-5 $\beta$ ,6b-epoxy-3 $\beta$ -methoxy-physalin B

*L. major*,  $IC_{50} (\mu M) = 19.5 \pm 0.18$ 

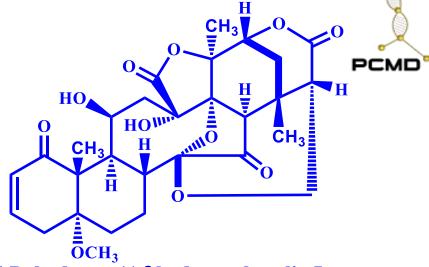
#### L. tropica

Amphotericin B=  $3.42\pm0.04~\mu M$ , p < 0.0001Pentamidine =  $27.20\pm0.02~\mu M$ , p < 0.0001Miltefosine=  $42.05\pm1.03~\mu M$ , p < 0.0001



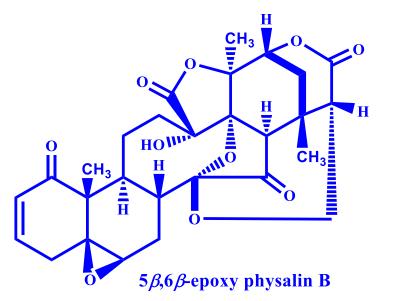
27-Hydroxy-1-oxo-witha-5,14,24-trienolide

*L. major*,  $IC_{50}(\mu M) = 38.5 \pm 1.05$ 



#### 6-Dehydroxy-11β-hydroxyphysalin I

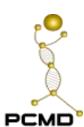
*L. major*,  $IC_{50}$  ( $\mu M$ )=  $4.86 \pm 0.08$ 



*L. major*,  $IC_{50}(\mu M) = 3.76 \pm 0.85$ 

*L. tropica*,  $IC_{50}(\mu M) = 18.53 \pm 0.28$ 



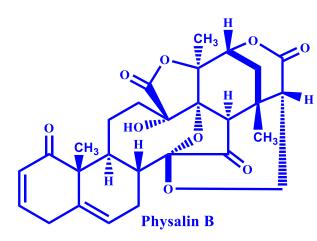




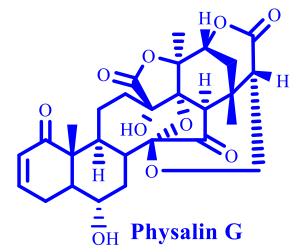
Amphotericin B=  $3.39\pm0.04~\mu M$ , p < 0.0001Pentamidine =  $27.20\pm0.02~\mu M$ , p < 0.0001Miltefosine=  $25.55\pm1.03~\mu M$ , p < 0.0001

#### L. tropica

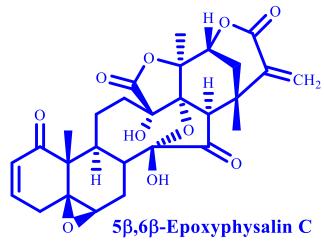
Amphotericin B=  $3.42\pm0.04~\mu M$ , p < 0.0001Pentamidine =  $27.20\pm0.02~\mu M$ , p < 0.0001Miltefosine=  $42.05\pm1.03~\mu M$ , p < 0.0001



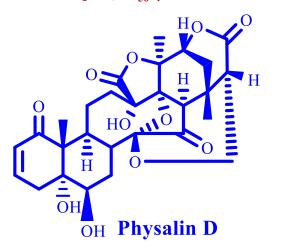
*L. major*, IC<sub>50</sub> ( $\mu$ M)= 3.04  $\pm$  1.12 *L. tropica*, IC<sub>50</sub> ( $\mu$ M)= 13.33  $\pm$  0.09



*L. major*,  $IC_{50}$  ( $\mu M$ )=  $52.28 \pm 1.18$ *L. tropica*,  $IC_{50}$  ( $\mu M$ )=  $19.09 \pm 0.02$ 



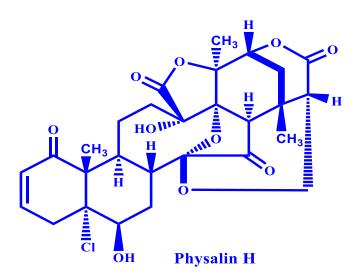
*L. major*,  $IC_{50}$  ( $\mu M$ )= 84.79 ± 1.96 *L. tropica*,  $IC_{50}$  ( $\mu M$ )= 23.76 ± 1.90



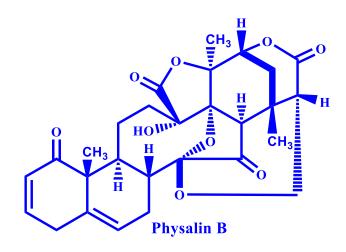
*L. major*, IC<sub>50</sub> ( $\mu$ M)= Inactive *L. tropica*, IC<sub>50</sub> ( $\mu$ M)= 55.24 ± 0.01



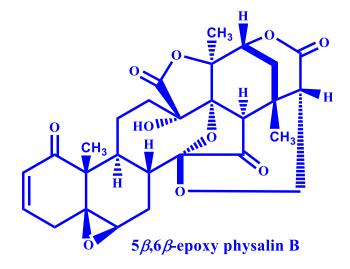
## Macrophage assay to evaluate intracellular anti-leishmanial activity against amastigotes



*L. major*,  $IC_{50}$  ( $\mu M$ )= 3.34± 0.64 *L. tropica*,  $IC_{50}$  ( $\mu M$ )= 9.59 ± 0.27

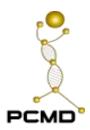


*L. tropica*,  $IC_{50}$  ( $\mu M$ )= 13.33  $\pm$  0.09 *L. major*,  $IC_{50}$  ( $\mu M$ )= 3.04  $\pm$  1.12



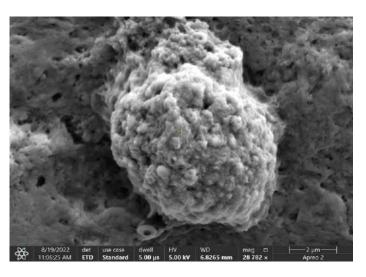
*L. major*,  $IC_{50}$  ( $\mu M$ )= 3.76  $\pm$  0.85 *L. tropica*,  $IC_{50}$  ( $\mu M$ )= 18.53  $\pm$  0.28





## Antileishmanial Activity of Physalins Against Amastigotes Stage of Parasite *via* Infected Macrophage Cell line Assay





# HEJ and PCMD

#### PROTOCOL SUMMARY



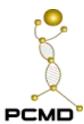
Grown J774.2 cells (normal Human macrophage cells) and incubated in CO<sub>2</sub> incubator



Cells grown by placing round cover slip



Incubated in CO<sub>2</sub> for 24 hours







Washing of cells and treatment of infected macrophages with test samples



**Incubated in CO<sub>2</sub> for 24 hours** 



Adherent macrophages infected with stationary phase parasites (clinical isolates)



Microscopy



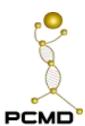
**Incubated in CO<sub>2</sub> for 24 hours** 

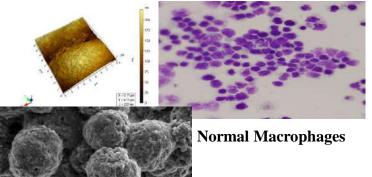


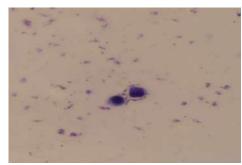
Staining with GIEMSA dye



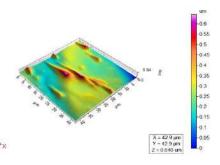
## Images of Various Stages of Macrophage Assay (5% GIMSA Dye, AFM, and SEM)





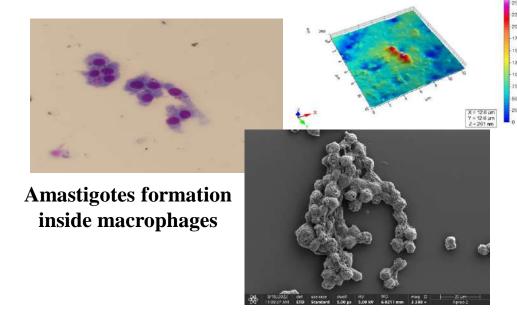


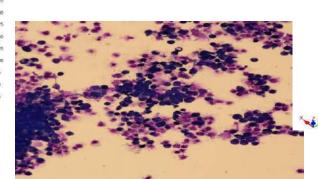
大龙——



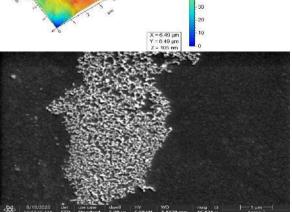
Attachment and engulfment of leishmania parasite inside macrophages

Engulfment of *Leishmania major* parasite inside macrophages by pseudo hype formation



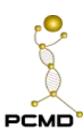


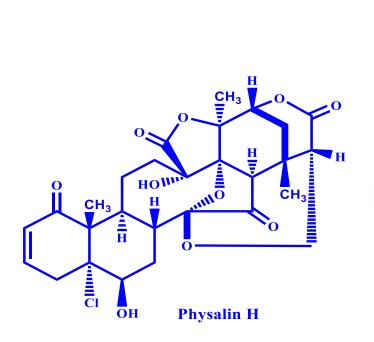
Effect of test compounds on macrophages. Light purple shows dead cells along with dark colored live cells of macrophages

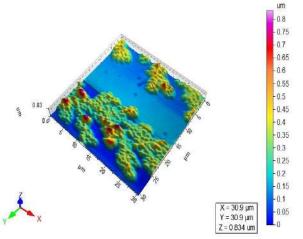


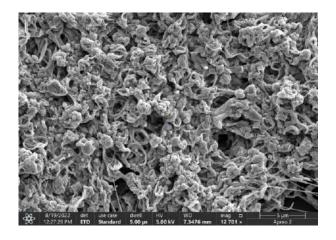


## ANTILEISHMANIAL ACTIVITY AGAINST AMASTIGOTES BY INFECTING MACROPHAGES CELL LINE

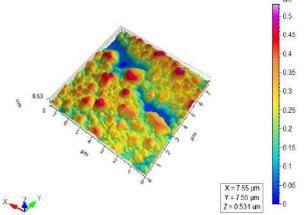


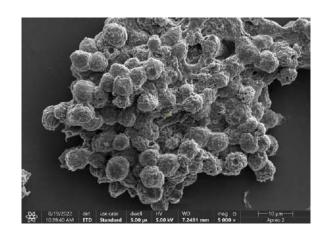






Infected macrophages with L. major (untreated)



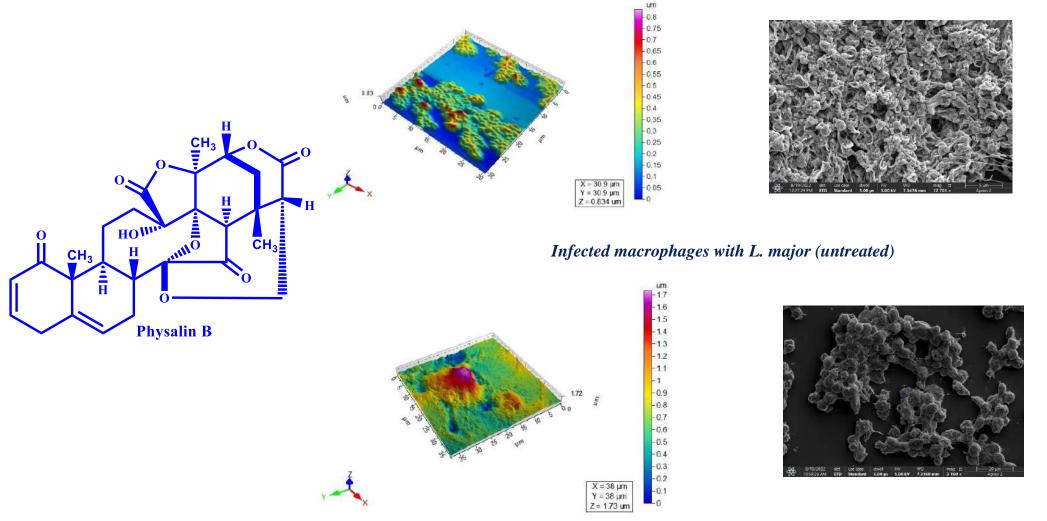


Infected macrophages with L. major (Treated)



## ANTILEISHMANIAL ACTIVITY AGAINST AMASTIGOTES BY INFECTING MACROPHAGES

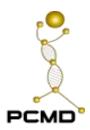


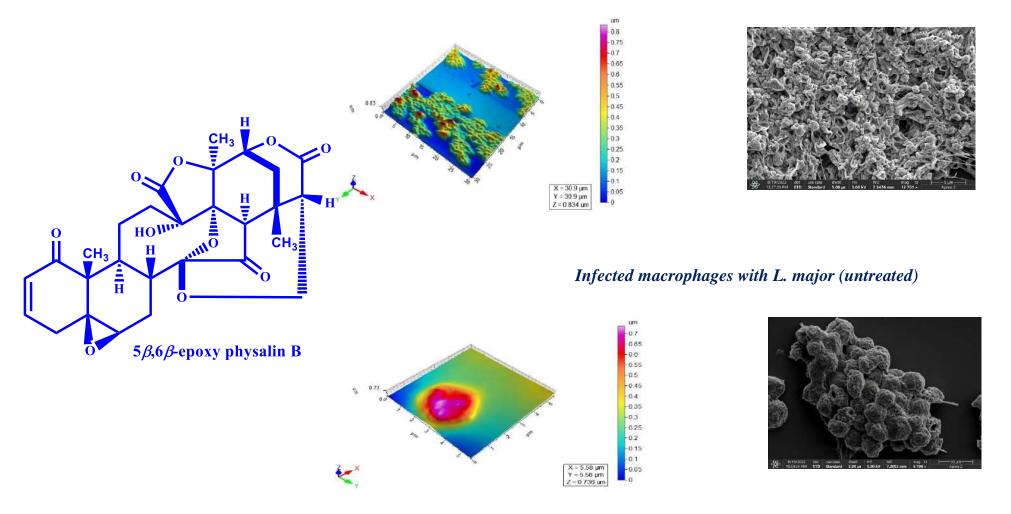


Infected macrophages with L. major (Treated)



## ANTILEISHMANIAL ACTIVITY AGAINST AMASTIGOTES BY INFECTING MACROPHAGES





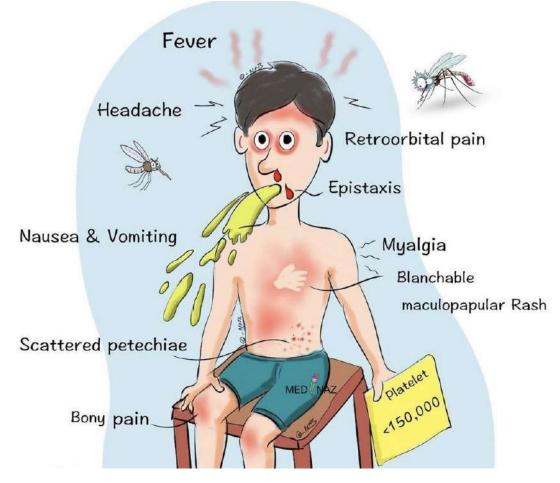
Infected macrophages with L. major (Treated)

## **Drug Repurposing**

An approach to identify the new therapeutic indications of already approved drugs, for the treatment of both common and rare diseases. It potentially lowers the cost, and time required for drug discovery and development.

## Identification of New Inhibitors of Non Structural Protein-5 (NS5) from Dengue Virus





HOME LATEST PS. 2023 PARISTAN OPINION BUSINESS WORLD CULTURE PRISM SPORT MAGAZINES TECH VIDEOS POPULAR ARCHIVE FLOOD DONATIONS

#### Karachi reports over 6,000 confirmed dengue cases in September alone

Faiza liyas | Published October 1, 2022





A health worker carries out anti-dengue spray in Kharadar.—Online

KARACHI: As dengue fever claimed another life on Friday, the total number of cases from the mosquito-borne infection crossed over 6,000 mark in the metropolis in September.



Trending: Kashmir Coronavirus

**EDITORIALS & OPINIONS** ARTS, CULTURE & BOOKS LATEST PAKISTAN BUSINESS SPORTS

#### PAKISTAN TOP STORIES

#### Dengue cases sharply increasing across **Pakistan**

Web Desk

SEPTEMBER 12, 2022











ePaper

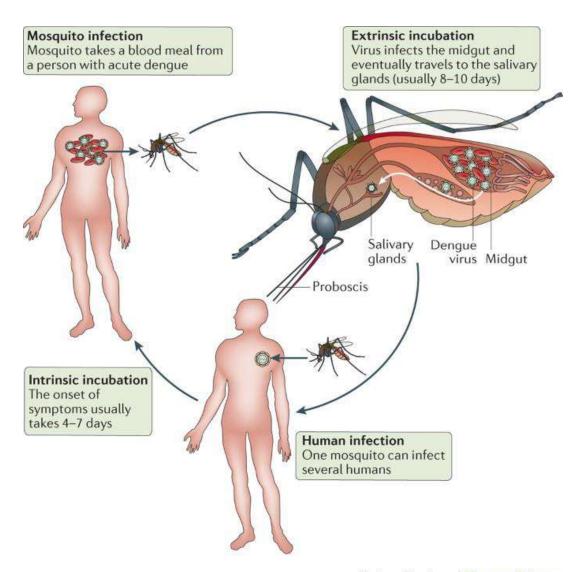
d



Pakistan's major cities experienced a sharp increase in dengue cases. In the past 24 hours, 62 patients in Lahore received a dengue diagnosis, while 55 new cases were reported in Islamabad and 113 cases were confirmed by the Karachi Health Department.

### Dengue Virus Infections

- Rapid spread of dengue virus has now become a major health problem worldwide, especially in tropical and sub-tropical regions.
- Nearly half of the human population is at the risk of getting infection.
- No vaccine developed so far. No treatment.
- Despite the recent advances, there is still an immense need for effective approaches towards drug discovery against dengue virus.
- According to a recent report (2022), a total of **78,554 cases of dengue**, including **194 deaths** have been reported in **Pakistan**. (WHO-2023)

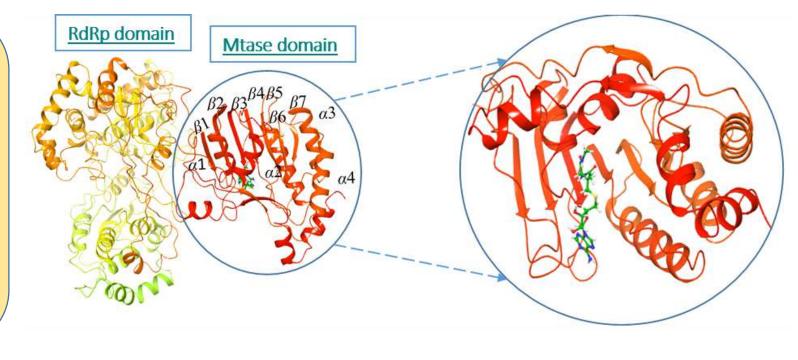


### Nonstructural protein NS5- A validated drug target for Dengue Virus

Among the proteome of dengue virus, nonstructural protein NS5 is conserved across the *Flaviviridae* family.

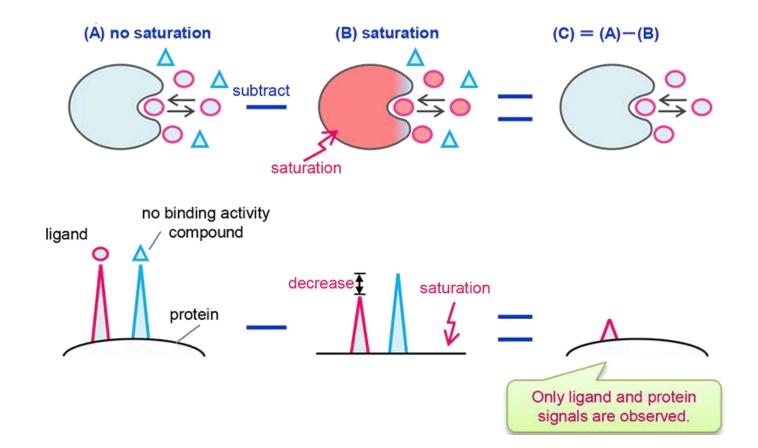
Among all the nonstructural proteins, NS5 is the most important one which helps the virus to replicate, and protect against the host immune reaction. Due to highest homology among all the serotypes, NS5 is identified as a promising target for anti-DENV therapy.

- NS5 is a monomeric 104.387 kDa protein, having methyl transferase (MTase) domain at Nterminal, while C-terminal harbors RNA-dependent RNA polymerase (RdRP) region.
- The catalytic domain of MTase containing seven β-sheets surrounded by four-helices.



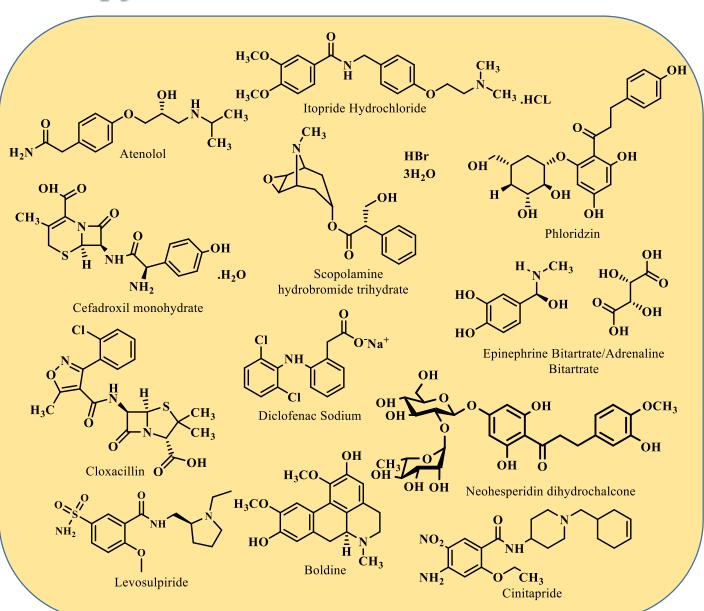
#### Evaluation of drugs by biophysical method i.e. STD-NMR Spectroscopy

Saturation transfer difference (STD-NMR) is a robust technique for the analysis of protein-ligand interactions, as well as for the identification of binding epitope of a ligand when bound to its receptor protein.

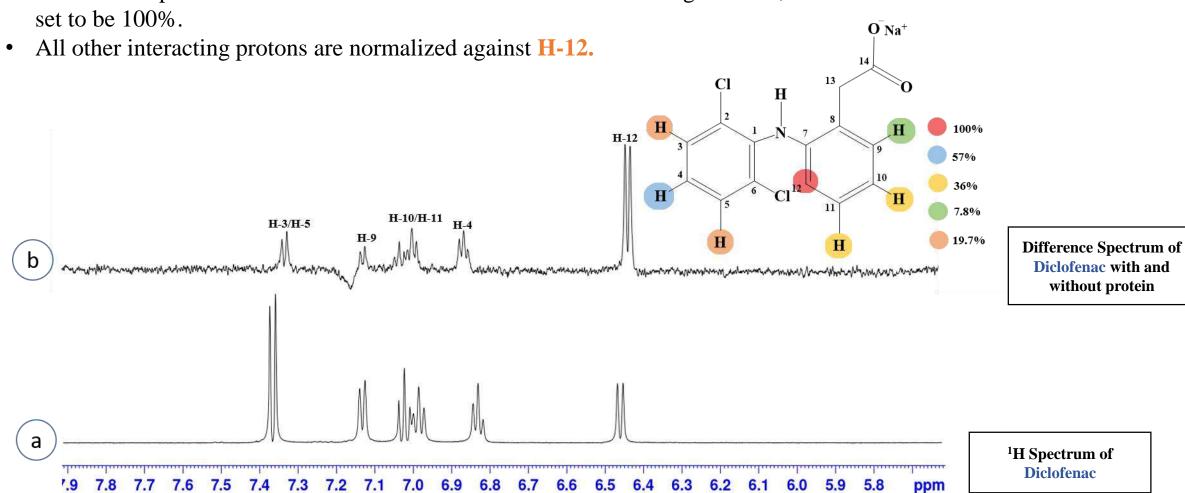


## Outcomes of STD-NMR Spectroscopy

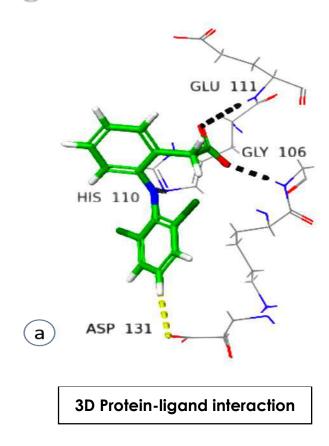
- 75 FDA approved drugs (grouped into 15 mixtures) were checked for their ability to interact with NS5 protein.
- Identified ligands were further validated by molecular docking and simulation studies.
- 10 drugs were identified which could be the lead candidates to be further studied as potential antiviral agents.



H-12 of compound 5 received the maximum saturation of STD integral value, set to be 100%.



Molecular docking and simulation studies on Diclofenac sodium

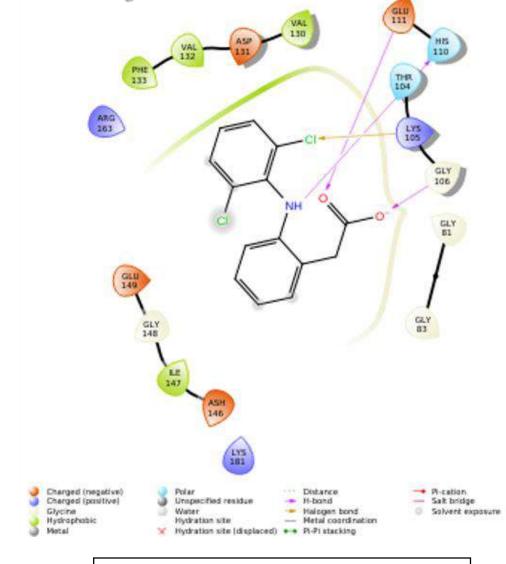


**Docking score -4.7** 

Diclofenac sodium showed hydrogen bond interactions with Glu111 and Gly106, and aromatic hydrogen bond intercation with Asp131 of NS5 polymerase enzyme of dengue virus.

Hydrogen bond

Aromatic hydrogen bond

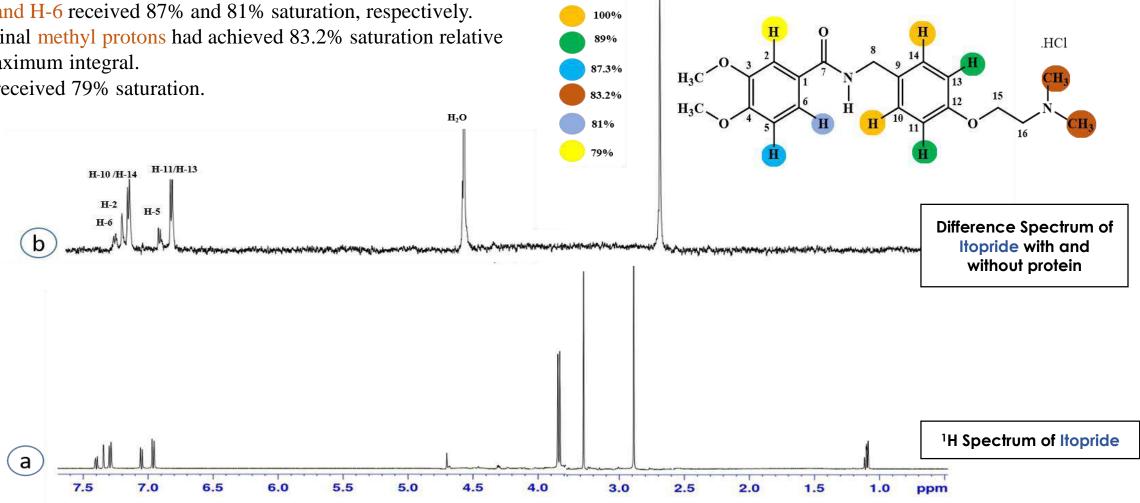


2D Protein-ligand interaction

#### STD-NMR of Itopride

- H-10/H-14 with the integral value 100% had achieved maximum interactions.
- H-11/H-13 have displayed 89% saturation.
- H-5 and H-6 received 87% and 81% saturation, respectively. Terminal methyl protons had achieved 83.2% saturation relative to maximum integral.
- H-2 received 79% saturation.

Itopride is an acetylcholine esterase inhibitor and dopamine D2 receptor antagonist used to treat symptoms of functional dyspepsia such as nausea and vomiting



2NCH<sub>3</sub>

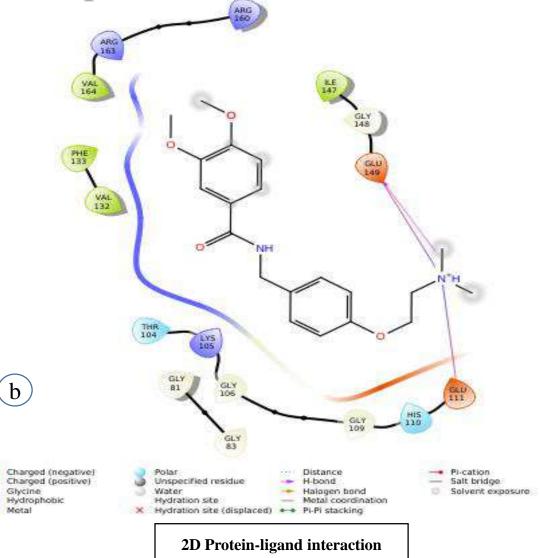
Molecular docking and simulation studies on Itopride

**GLU 149**  aromatic hydrogen bond a

**Docking score -3.8** 

showed hydrogen bonding and aromatic **Itopride** hydrogen bonding interaction with Glu149 of NS5 polymerase enzyme of dengue virus.

Hydrogen bond

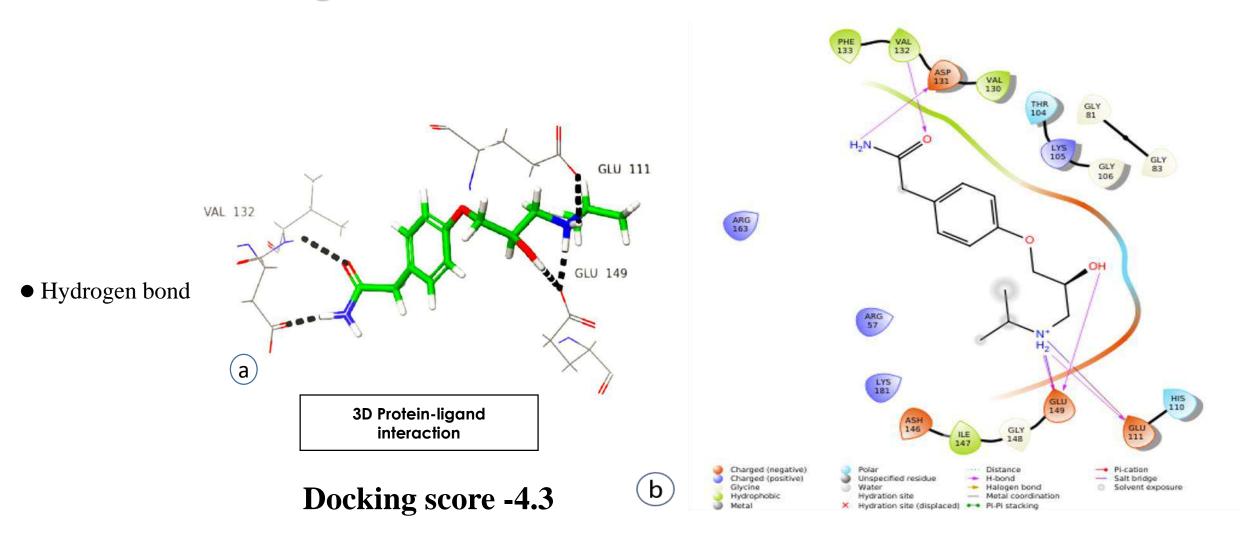


### STD-NMR of Atenolol

- and heart-associated chest pain.
- maximum (100%) saturation from protein.

HO Atenolol is a beta blocker medication 100% primarily used to treat high blood pressure  $H_2N$ 99.5% 98.8% Aliphatic protons of CH<sub>2</sub> at C-9 have shown 91.5% 80.9% Rest of proton was normalize against C-9. 80.6% 79.1% CH2-9 b 2CH<sub>3</sub>-13, 14 75.2% H-2/H-6 **Difference Spectrum of Atenolol** with and without protein a <sup>1</sup>H Spectrum of Atenolol **1.5** 57 7.0 6.5 6.0 5.5 5.0 4.0 3.5 3.0 2.5 2.0 ppm

#### Molecular docking and simulation studies on Atenolol



Atenolol showed hydrogen bond interactions with Glu149, Glu111, and Val132 of NS5 polymerase enzyme of dengue virus.

2D Protein-ligand interaction

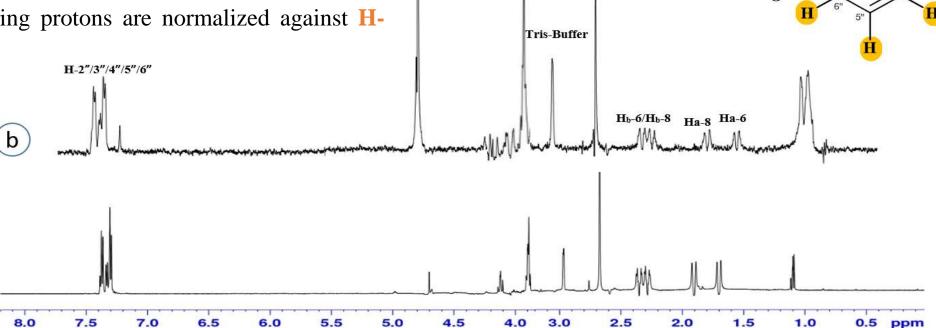
#### STD-NMR of Scopolamine

Scopolamine works by blocking the effects of acetylcholine on the central nervous system. It is used to prevent nausea and vomiting caused by motion sickness or medications used during surgery.

Aliphatic protons H-2'/H-3' had received a maximum H<sub>2</sub>O saturation of relative STD integral value, set to be 100%.

All other interacting protons are normalized against H-2'/H-3'.

**Difference Spectrum of Scopolamine** with and without protein



Ha-2'/H-3'

CH<sub>3</sub>-10

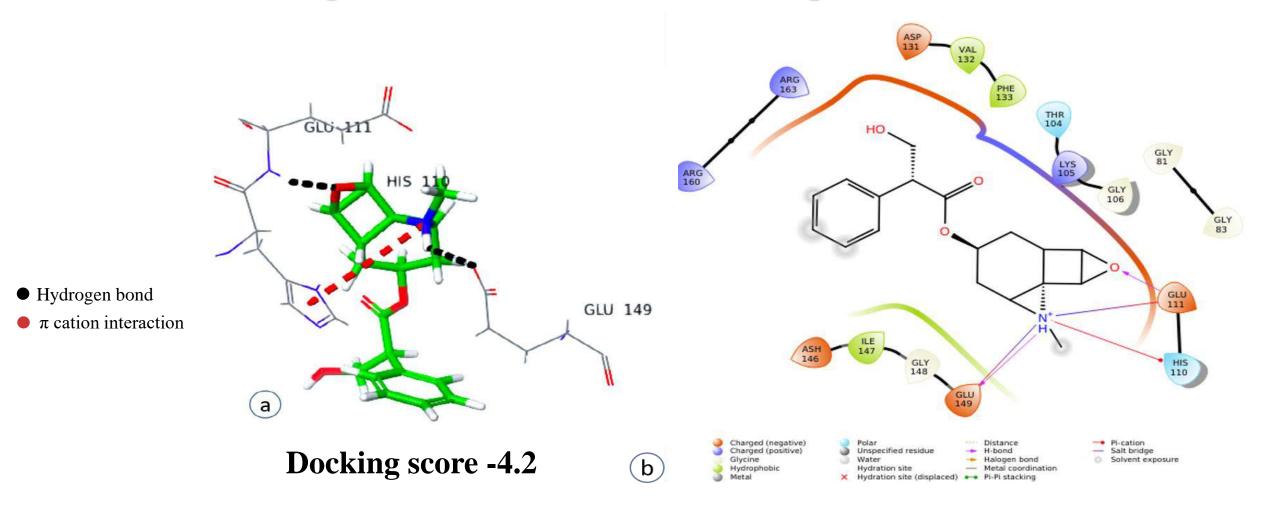
HBr

3H<sub>2</sub>O

<sup>1</sup>H Spectrum of **Scopolamine** 

a

#### Molecular docking and simulation studies on Scopolamine

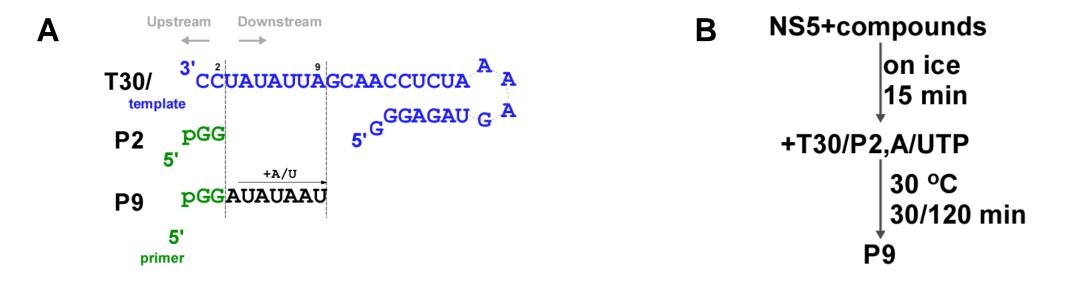


Scopolamine showed hydrogen bond interactions with Glu111 and Glu149, and  $\pi$  cation interaction with His 110 of NS5 polymerase enzyme of dengue virus.

2D Protein-ligand interaction

# Diclofenac sodium effectively inhibits the activity of dengue virus NS5 polymerase

## Protocol for polymerase inhibitory activity

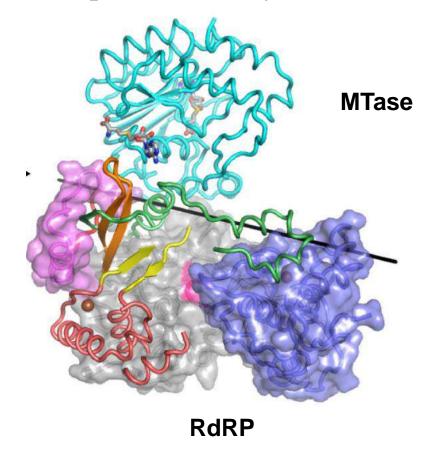


**A:** A diagram of construct T30/P2 used in NTP-driven polymerase reactions to generate 9-mer products. T30: RNA template; P2: dinucleotide primer.

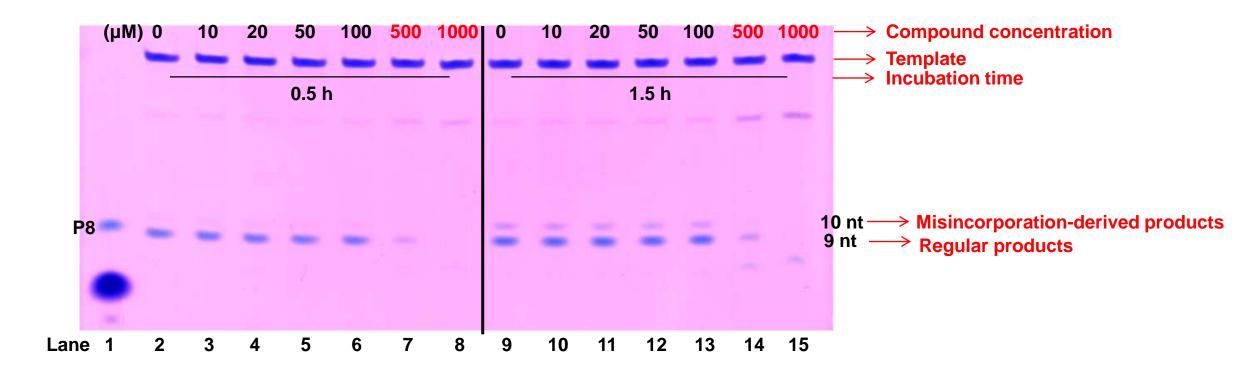
**B:** 6  $\mu$ M protein was incubated with different concentrations of drugs in assay buffer (50 mM Tris-HCl pH 7.5, 5 mM MgCl<sub>2</sub>, 5 mM dithiothreitol) on ice for 15 min. The reaction was started by the addition of 4  $\mu$ M RNA template, 300  $\mu$ M ATP, and 300  $\mu$ M UTP in a final reaction volume of 20  $\mu$ L. After incubation at 30 °C for various durations, the reaction was stopped by adding 2× STOP solution.

## RNA Polymerase inhibitory activity

The full-length protein of NS5 was used in the above activity tests. Flavivirus NS5 is a fusion of an S-adenosyl-l-methionine (SAM)-dependent methyltransferase (MTase).



### Inhibition of the polymerase activity by diclofenac sodium



This compound has an inhibitory effect when provided at 500  $\mu M$  or beyond.

# What we have been able to achieve recently?

- Identify nature based- drug leads and herbal formulations for medicinal plants (Anti-Lesihmanial, Anti-epileptic, Anti-leishmanial, Anti-Parkinson's, etc). These drug leads are in different phases of development.
- Produce bioactive chemical space through bio-catalytic methods with enhanced pharmacokinetic properties.
- We focused on many neglected diseases, such as Dengue hemorrhagic fever, by drug repurposing.

### **ACKNOWLEDGMENTS**

#### Prof. Dr. Atta-ur-Rahman FRS Our Teacher

#### Development of Anti-Leishmanial Agents

- Prof. Dr. Sammer Yousuf
- Dr. Azam Jah Samdani
- Dr. Farooq Soomro
- Mr. Samreen
- Ms. Sobia Ghani









### **Financial Support**





### Drug Repurposing against Dengue Virus

Prof. Dr. Atia-tul-Wahab

**Prof. Dr. Peng Gong** 

(Construct provided)

Mr. Asmat Ullah

Mr. Abdul Mateen

#### **Financial Support:**

- The Searle Company Pakistan
- Higher Education Commission, Pakistan
- Pakistan Academy of Sciences
- Searle Pharmaceutical Company Pakistan
- GCRF-NTD UK









A Global Network for Neglected Tropical Diseases Chagas disease | Leishmaniasis

https://ntd-network.org

# COMSTECH

(OIC's Ministerial Standing Committee on Scientific and Technological Cooperation)



### **Genesis and Governance**

# Established in 1981

# Chaired by The President and Co-Chaired by The Prime Minister

# **Organizational Structure**

**COMSTECH** works with all member states and plays its due role under:

**General Assembly** 

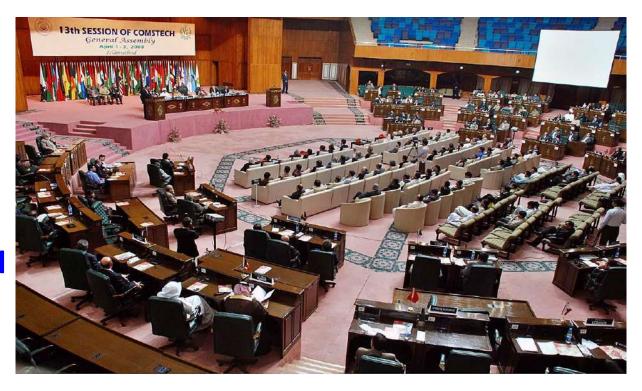
**Executive Committee** 

**Coordinator General** 

**COMSTECH Secretariat** 

### **COMSTECH's GENERAL ASSEMBLY**

■ Ministers in Charge S&T
 ■ Secretary General OIC
 ■ President IsDB
 ■ Observer States
 ■ OIC-15 Dialogue Platform
 ■ Relevant OIC Organizations
 ■ Muslim Communities endorsed by OIC
 ■ Collaborating International Organizations
 ■ Relevant UN and its Organizations



## **Strong Network-Real Strength of**

# **COMSTECH**

DAUGHTER ORGANISATIONS

**OIC-GS** R P G **COMCEC ICESCO** N **IOFS** N **SESRIC** R **OIC-CERT** S 0 IAS N

0

**INWRDAM** INTROM INIT **ISNET** INOC CINVU INSTP

**COMSTECH Inter-Islamic Networks** 

# **MAJOR PROGRAMS**

- Largest Research Training Fellowship Programs (IsDB, ICGEB, IOFS)
- COMSTECH Health and S&T Programs (IsDB, OIC-GS, LRBT)
- COMSTECH Research Projects Support Programs (IFS, TWAS, UNESCO, ICGEB)
- COMSTECH Consortium of Excellence Program
- COMSTECH IOFS Food Security Initiatives
- COMSTECH's Country Specific Programs (Palestine, Yemen, Nigeria, Sudan, and Somalia)
- COMSTECH Forum on Environment and Ecosystem Restoration (CFEER)

# **COMSTECH Research Fellowships**

- >500 Scholarships and Fellowships for Palestine (CCoE, PICA)
- Virology and Vaccine Training Fellowships (BioFarma, Indonesia)
- Fellowships for Muslim Minorities (IsDB)
- **►** Technician Training Program (IsDB)
- > Fellowships for LDC-Africa (IsDB)
- Fellowships for Women Researchers (IsDB)
- ➤ "Science in Exile Fellowships" for Refugee scientists (UNESCO, TWAS)
- **➤ Biotechnology Research Training Initiatives for Africa (ICBEB)**

### CAPACITY BUILDING PROGRAMMES

- Reverse Linkages Program for institutional strengthening
- COMSTECH-CCoE Yemen Program for Capacity Building in Public Health, Health Research, and Biomedical Technology
- Country specific programs with Nigeria, Sudan, and Somalia
- ➤ IOFS-COMSTECH Fellowships for Research/Training in Food Security for Afghanistan and others.
- **➤ COMSTECH COMCEC project on Agriculture 2023**
- Training on Clinical Trials Uganda, and Egypt
- Pakistan- Türkiye- Kazakhstan Youth Forums on Biotechnology

# COMSTECH's Top Priority Africa Health and S&T Programs

### HEALTH FOR AFRICA PROGRAM

- Two-year training of Ophthalmologists from Africa (Pakistan Medical Commission)
- Cataract Surgery Campaigns (Surgeries, Trainings, Equipment Repair) in LDC-OIC Africa

Niger Nov 2021, Feb 2022

**Chad January 2023** 

Uganda March 2023

- Repair & maintenance of biomedical/ophthalmology equipment
- Over 400 Cataract Surgeries & Post Op examination in each campaign
- Training Workshops for doctors and paramedics

### HEALTH FOR AFRICA PROGRAM

 Training Workshops in Cancer Care: Burkina Faso, Niger, and Sudan.

 Training Workshops in Neurology/Neuro-critical Care: Senegal, Guinea-Bissau, and Uganda

# S&T Education and Research Institutions Building in Africa

- Establishment of MS computer science program and labs at the University of Gambia
- PNAC Accredited Halal Products Testing Laboratory at the IUIU, Uganda
- Citrus Value Added Product Technology Transfer for Nigeria
- Faculties of Engineering and Science at N DJamena University, Chad

# Partners of the COMSTECH Forum on Environment and Ecosystem Restoration (CFEER)













































# COMSTECH Action Plan for "Preventing Food Crisis in the Sahel" (July 2022)

- Concept approved by partners
- The aim is to develop a COMSTECH Framework to assist the Sahel countries in addressing challenges of food insecurity.
- COMSTECH program partners CILSS, ICESCO, and IOFS.













# Cooperation Agreement between COMSTECH & Permanent Inter-State Committee for Drought Control in the Sahel (CILSS)



- MoU signed in August, 2022.
- CILSS is an international organization based in Ouagadougou, Burkina Faso, and covers 17 countries in West Africa.
- 12 OIC members: countries are members of CILSS

Benin

Gambia

Mauritania

Sierra Leone

Burkina Faso

Guinea

Niger

Togo

Chad

Guinea Bissau

Nigeria

Côte d'Ivoire

Mali

Senegal

# **COMSTECH-OIC Technology and Innovation Portal**

The COMSTECH-OIC Technology and Innovation Portal is a digital information platform to showcase the prowess of scientists, innovators, and product developers from the OIC world. The portal provides a platform to help exchange information about the emerging and existent technologies, originating from the OIC Member Countries. This will result in intra-OIC interactions, and business engagements.

The portal also provides a platform for companies/organizations/ R&D institutions to showcase their products/services to reach out to potential end users, investors, etc. This portal has the potential to bring meaningful change to the lives of millions of people across the OIC Member Countries, by giving researchers, technologists, innovators, and entrepreneurs the opportunity to exchange information about emerging technologies, and their applications.



# COMSTECH Program for Celebrating Muslims in Science

(In collaboration of International Turkic Academy, and Host Countries)

- Global Al-Farabi Forum, Islamabad 2020
- Iqbal Forum, Almaty 2022
- The Global Forum Babur-Balasagyn, Bishkek 2023
- Al-Biruni Forum, Tashkent 2023





# **COMSTECH Key Programs for 2023**

- **➢OIC-15** Dialogue Platform Ministerial Meeting (Kazakhstan, OIC-GS, COMSTECH)
- **➤ COMSTECH General Assembly (Islamabad, Pakistan)**
- **▶**Third Youth Forum for Biotechnology (Kazakhstan)
- **≻**Kazan IPR and S&T Policy Trainings for OIC
- **➤ Launching of COMSTECH-IsDB-Pakistan Fellowship Program**
- **➤ COMSTECH-Pakistan Technology Expos (Cybersecurity, Agritech, E-health, Climate Change)**
- Communication Centers (Government of Pakistan, Perdis Technology Park. Bilkent Tech Park)
- ➤ Skill Development Programs in E-gaming, E-Commerce, IoT, Blockchain, Data Science, etc (Government of Pakistan)

# **Exhibition of COVID Related Technologies**













# Al and IoT Products Exhibition







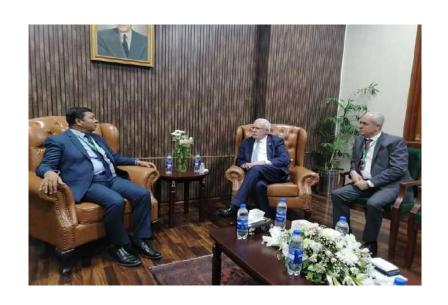






### SOME GLIMPSES OF RECENT MEETINGS







# Thank you very much

### HALAL PRODUCTS BIOMOLECULAR SCIENCE AND HEALTHY LIFE

#### ALI A. MOOSAVI-MOVAHEDI FIAS

Institute of Biochemistry and Biophysics, University of Tehran, Iran

#### **ABSTRACT**



Today, Halal products are placed in the framework of science, and scientific parameters can be measured for them. The insights of science in halal products can be studied by different disciplines such as biochemistry, biophysics, and bioinformatics. From a biological point of view, the common relationship between halal products and human health is supposed. One of the angles is the biophysical look on protein functions in halal and non-Halal foods. Protein is molecular machine for our life and the rule proposed as protein structure and function relationship.

Myoglobin is an oxygen-carrying protein in muscle that is found in meat. In this work, the Halal and non-Halal myoglobins were purified from slaughtered sheep's and the thermal profiles were measured by differential scanning

calorimetry (DSC) for both proteins. Thermal profile of protein by DSC is the identification of protein structure. In this research, the structures of both myoglobins are completely different via DSC, therefore their functions should be different. Functional parameters for aggregation, digestibility, unbalanced free radicals of two types of myoglobins were measured and shown non-Halal case for aforementioned parameters were increased several times that of Halal case.

It is important to note that diabetes, especially type 2, is not only a disease of sugar, but also a disease of stress. The molecular definition of stress means the induction of unbalanced free radicals. Therefore, the use of stressful foods increases the possibility of diabetes or any type of industrial diseases, which should be careful. Therefore, lifestyle based on science and reason is one of the most important general knowledge for humanity and society, which should be searched from lifestyles of different nations.

**Keywords:** Halal and non-Halal foods, Scientific measurement, DSC, Biochemistry, Biophysics, Free radicals, Diabetes.



# Halal Products Biomolecular Sciences and Healthy Life

### Ali A. Moosavi-Movahedi, FTWAS, FIAS

Institute of Biochemistry and Biophysics (IBB), UNESCO Chair on Interdisciplinary Research in Diabetes (UCIRD), University of Tehran, Tehran, Iran



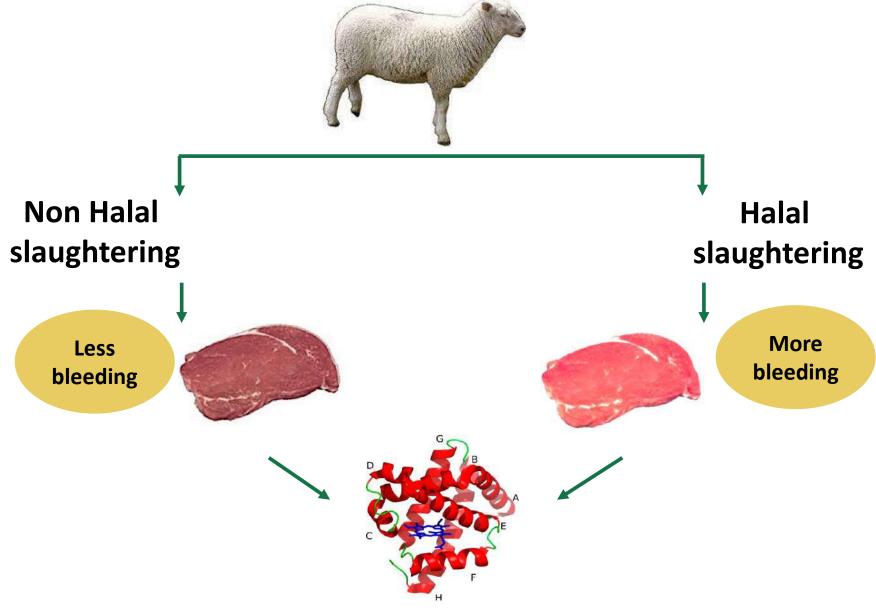




# Halal Science and Correleation to Proteins as Molecular Machines

• Today, Halal products are placed in the framework of science, and scientific parameters can be measured for them. The insights of science in Halal products can be studied by different disciplines such as biochemistry, biophysics, and bioinformatics. From a biological point of view, the common relationship between Halal products and human health is supposed. One of the angles is the biophysical outlook on protein functions in Halal and non-Halal foods. Protein is molecular machine for our life and the main rule proposed as protein structure function relationship.





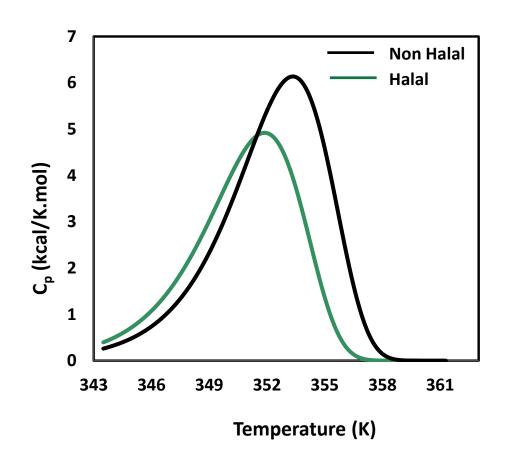
**Extraction of Myoglobin as an indicator of meat proteins** 



# Difference in Halal and Non-Halal Myoglobins

Myoglobin is an oxygen-carrying protein in muscle that is found in meat. In this work, the Halal and non-Halal myoglobins were purified from slaughtered sheep's and the thermal profiles were measured by differential scanning calorimetry (DSC) for both proteins. Thermal profile of protein by DSC is the identification of protein structure.

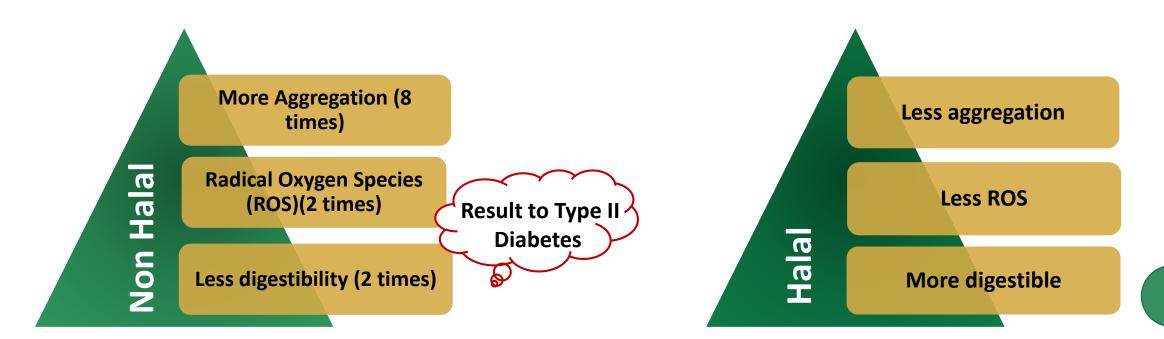
**Cp and anesthesia degree** 





# **Protein Sturcture Function Relationship**

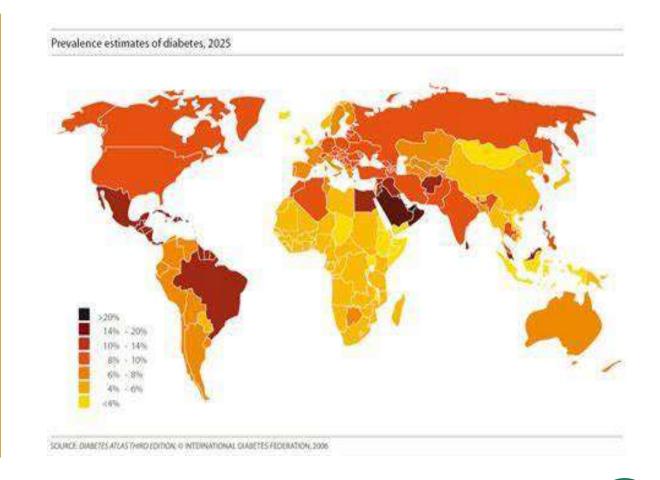
In this research, the structures of both myoglobins are completely different via DSC, therefore their functions should be different. Functional parameters for aggregation, digestibility, unbalanced free radicals (stress) of two types of myoglobins were measured and shown non-Halal case for aforementioned parameters were increased relative to Halal case.





# Radical Oxygen Species and Diabetes World Map

It is important to note that diabetes, especially type 2, is not only a disease of sugar, but also a disease of stress. The molecular definition of stress means the induction of unbalanced free radicals. Therefore, the use of stressful foods and stressful habit increases the possibility of diabetes or any type of industrial diseases, which should be careful.





# Lifestyle based on Science and Wisdom

Lifestyle based on science and reason is one of the most important general knowledge for humanity and society.

### Lifestyle such as:

- Halal Meat-Myoglobin oxygenation in muscles
- Good Sleep-Melatonin (Night)
- Happiness- Serotonin (Day)
   Have a happy day, sleep well at night
- Satisfaction-Oxytocin
   Forgiveness, exercise induced oxytocin

# **Molecular Lifestyle**

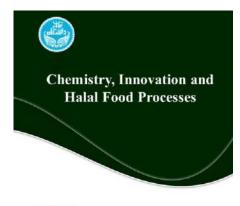
Molecules play important and vital roles in our life, we get them from our lifestyle and good deeds. They are made in our body and called reward molecules. We can coin in this conference the terminology named "Molecular Lifestyle". Hope I can write a book in this term in near future.



### Man Metabolism as Chemical Reactor

Man metabolism is resemble to chemical reactor, molecules are the vital vibrate of our life, let's know and respect them as a reward vital molecules.

# The End



Authors:

Ali A. Moosavi-Movahedi Maryam Moslehishad Dina Alhooei Maryam Salami Halal products have a different molecular mechanism from non-Halal products. The biomolecular structure of Halal products (less stressful) play the important roles in human health and well-being.

## DRUG RESEARCH THROUGH NATURE - FROM LAB TO PATENT

#### ILKAY ERDOGAN ORHAN FIAS

Dean, Faculty of Pharmacy, Gazi University, Ankara Principal Member, Turkish Academy of Sciences (TÜBA), Türkiye

#### **ABSTRACT**



Great biodiversity of nature with enormous number of plants, animals, marine organisms, and microorganisms has so far offered a prodigious role in discovery of new drug molecules and also served for therapeutic purposes to mankind since ancient cultures. As well-known, a lot of modern medications took their roots from aged traditional medicinal systems such as Chinese traditional medicine, Ayurvedic medicine, Unani medicine, Kampo medicine, etc. Due to progresses in chemistry over centuries, it gives the impression that natural medicines were misplaced, but it is now very obvious that they are again attractive targets for drug discovery and research. Because many clinically available drugs, e.g.

quinine, aspirin, tubocurarine, taxol, artemisinin, exenatide, statins, ivermectin, metformin, acyclovir, etc. have been discovered in organisms such as microorganisms, macrofungi, insects, animal venoms, plants as well as marine organisms. In our far-reaching search and screening *via* primarily Turkish flora, which consists of roughly 12.000 plant taxa being the richest flora in whole Europe continent, we have been able to report quite promising natural molecules with substantial enzyme inhibitory activity by *in vitro* and *in silico* tools against cholinesterase, tyrosinase, elastase, collagenase, xanthine oxidase, lipoxygenase, etc as well as cell culture and *in vivo* experiments.

In this talk, eminence of biodiversity in drug R&D will be emphasized also pointing out in part to the findings from our research group.



# Drug Research Through Nature - From Lab to Patent

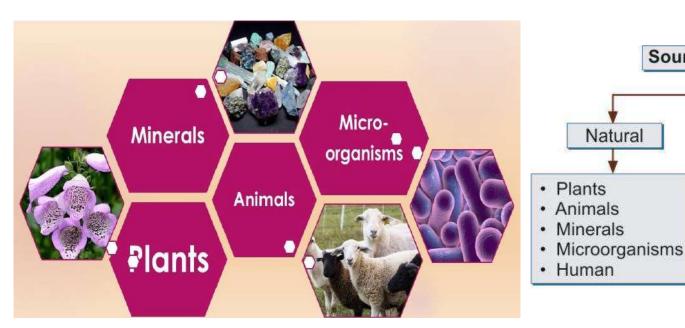


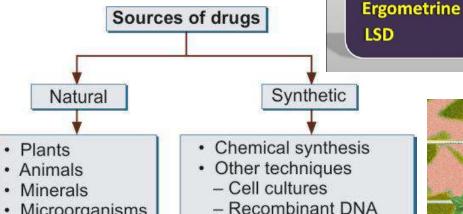
## Prof. Dr. Ilkay ERDOGAN ORHAN

Dean-Faculty of Pharmacy, Gazi University, Ankara, Türkiye Principal Member of Turkish Academy of Sciences (TÜBA) Fellow of Islamic World Academy of Sciences (IAS)



## **Drug Research Through Nature**





technology

- Hybridoma technique



Natural Drugs (3)

Semi-synthetic

**Bromocriptine** 

Carbergoline

Methysergide

Natural vs Synthetic/semi-synthetic

**ERGOT** 

Natural

**Ergotamine** 

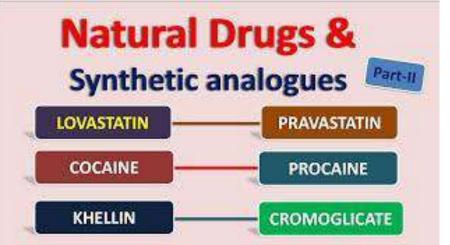












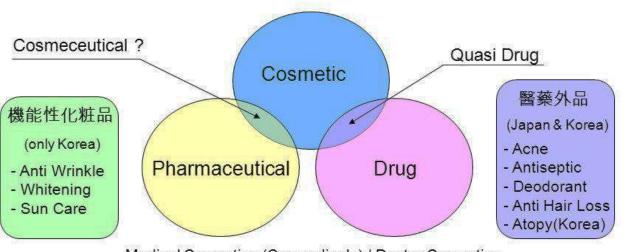
#### Cosmetics/Cosmeceuticals/Cosmedicals

#### Cosmeceuticals

**ILKAY ERDOGAN ORHAN** 

Cosmeceuticals represent the marriage of cosmetics and pharmaceuticals

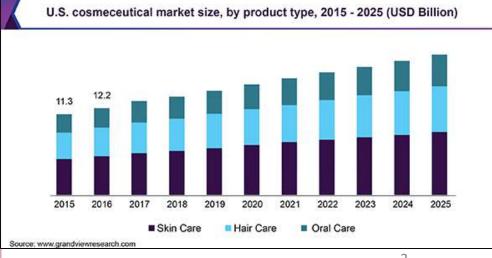
Cosmeceuticals are cosmetic products with biologically active ingredients purporting to have medical or drug-like benefits.



Medical Cosmetics (Cosmedicals) / Doctor Cosmetics

However, according to the United States Food and Drug Administration (FDA), the Food, Drug, and Cosmetic Act "does not recognize any such category as "cosmeceuticals." A product can be a drug, a cosmetic, or a combination of both, but the term "cosmeceutical" has no meaning under the law" (\* wikipedia)





## **Consumer and cosmetic industry**







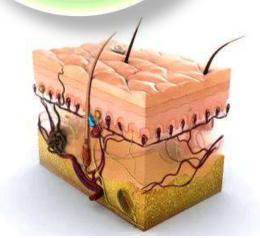


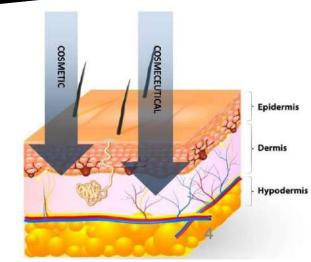
**Natural &** 

Products at the borderline between cosmetics and pharmaceuticals

Cosmeceuticals



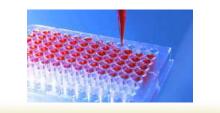








#### **Work Flow in Our Laboratory**





Traditional medicine data / random screening



Plant Collection

**Extraction** 



Screening by enzyme inhibition assays (in vitro methods)

**Active fraction(s)** 

Screening by enzyme inhibition assays (in vitro methods)

Activity-Guided Fractionation



Active extract(s)



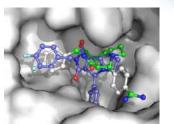
Active Compound(s)

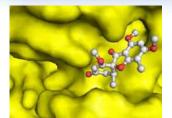
Screening by enzyme inhibition / cell culture assays

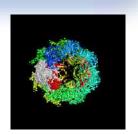
Molecular docking assays (in silico methods)

Phytochemical analysis









## **Enzyme Inhibition Assays for Skin Aging/Bleaching**



**Tyrosinase** 

Collagenase

**Elastase** 

Lipoxygenase





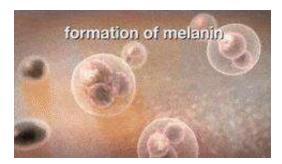
**Activity-guided fractionation** 







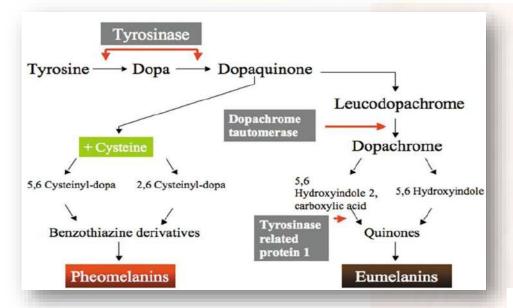


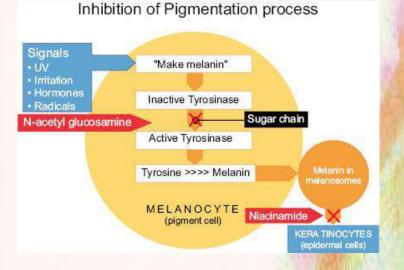




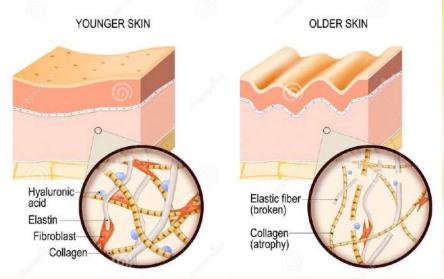
## DEPIGMENTING AGENTS











-Hydroquinone

-Arbutin

-Ascorbic acid

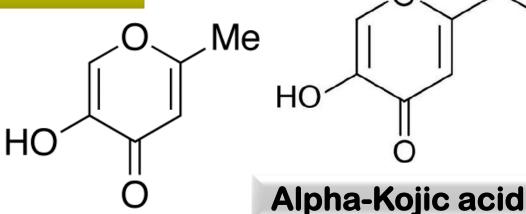
-Alfa-Kojic acid

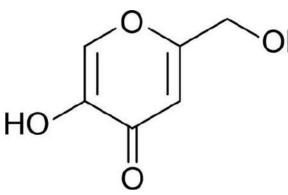
-Tretionin

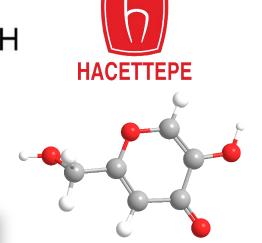
ILKAY ERDOGAN ORHAN

## **Tyrosinase Inhibition**











**Fungal metabolite** derived from Acetobacter Aspergillus, and **Penicillium** 

.OH





Kojylmethyl Dichlorobenzyl Piperazine





(12) United States Patent Aytemir et al.

(10) Patent No.: (45) Date of Patent:

US 9,975,884 B2 May 22, 2018

(54) KOJIC ACID-DERIVED MANNICH BASES WITH BIOLOGICAL EFFECT

(71) Applicants:Mutlu Aytemir, Ankara (TR); Berrin Ozcelik, Ankara (TR); Ilkay Erdogan Orhan, Ankara (TR); Gulsah Karakaya, Ankara (TR); Fatma Sezer Senol, Ankara (TR)

(72) Inventors: Mutlu Aytemir, Ankara (TR); Berrin Ozcelik, Ankara (TR); Ilkay Erdogan Orhan, Ankara (TR); Gulsah Karakaya, Ankara (TR); Fatma Sezer Senol, Ankara (TR)

\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days, days. Database Registry [Online] Chemical Abstracts Service; Columbus, Ohio; US; Aug. 28, 2011 (Aug. 28, 2011); XP002760857; Database Burdeal; Grant State Chemical Abstracts Service; Columbus, accession No. 1324084-63-0 RN 1324084-63-0.

Burdock, G. A., et al., "Evaluation of Health Aspects of Kojic Acid in Food", Regulatory Toxicology and Pharmacology, 2001, vol. 33, pp. 80-101.

Kim, D. H., et al., "Development of 5-[(3-as a Novel Whitening Agent", Chem. Pharm. Bull, 2003, vol. 51, pp.

Brtko, J., et al., "Kojic Acid and its Derivatives: History and Present State of Art", Cent. Eur. J. Publ. Health, 2004, 12 suppl. , pp.

Sentley, R., "From miso, saké and shoyu to cosmetics: a century of science for kojic acid", Nat. Prod. Rep., 2006, vol. 23, pp. 1046-

Uchino, K., et al., "Kojic Acid as an Anti-speck Agent", Agric Biol. Chem., 1988, vol. 52, No. 10, pp. 2609-2610. Noh, Jin-Mi, et al. "Kojic Acid, Tripperide Amid, and Michael Michael Chem.

Noh, Jin-Mi, et al. "Kojic Acid—Tripeptide Amide as a New Tyrosinase Inhibitor", PeptideScience, 2007, vol. 88, No. 2, pp.



Eldgenössisches Institut für Geistiges Eigentum Institut Fédéral de la Propriété Intellectuelle Istituto Federale della Proprietà Intellettuale Swiss Federal Institute of Intellectual Property

Stauffacherstrasse 65/59 g | CH-3003 Bern T+41 31 377 77 77 F+41 31 377 77 78 info@ipi.ch | www.ige.ch



#### Swissreg extract - EP patents

Extract and status : 25.10.2019

Grant date

Application number : 16732363 Filing date : 17.05.2016



Nur per Fax: 089 2195 2221

HERNANDEZ IP · Pullacher Str. 23 · 82049 Pullach · Deutschland (Germany)

Deutsches Patent- und Markenamt 80297 München

Vertretungsübernahme – DE 60 2016 017 022.1 Deutscher Teil des europäischen Patents EP3310778 MANNICHBASEN AUS KOJISÄURE MIT BIOLOGISCHER

WIRKUNG Aytemir, Mutlu, Ankara, TR; Erdogan Orhan, Ilkay, Ankara, TR; Karakaya, Gulsah, Ankara, TR; Ozcelik, Berrin, Ankara, TR; Senol, Fatma Sezer, Ankara, TR

Ihr Zeichen: DE 60 2016 017 022.1 Unser Zeichen: EP3310778 HERNANDEZ IP

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E yhernandez@hernandez-ip.com

4. Oktober 2019

#### MANNICHBASEN AUS KOJISÄURE MIT BIOLOGISCHI

#### Owner

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Erdogan Orhan, Ilkay Gazi Universitesi Eczacilik Fakultesi Farmasotic Kognosi Anabilim Dali

Etiler Ankara



#### **INCELEMELI PATENT**

No: TR 2015 07653 B

Buluş Başlığı

Biyolojik etkili kojik asit türevi mannich bazları,

Başvuru sahibi

MUTLU AYTEMİR BERRİN ÖZÇELİK İlkay Erdoğan orhan Gülşah Karakaya Sezer Şenol

Bu patent, 6769 sayılı Sınai Mülkiyet Kanununun Geçici 1 nci maddesi uyarınca Mülga 551 sayılı Patent Haklarının Korunması Hakkında Kanun Hükmünde Kararname kapsamında 22/06/2015 tarihinden itibaren 20 yıl süre ile korunmak üzere 21/11/2017 tarihinde incelemeli olarak verilmiştir.

> Prof. Dr. Habip ASAN Baskan



#### Silver Medal "International Scientific Invention Fair" 2017 (ISIF-2017) - Istanbul











Kojylmethyl dichlorobenzyl piperazine

## JUNIVERS S Gran

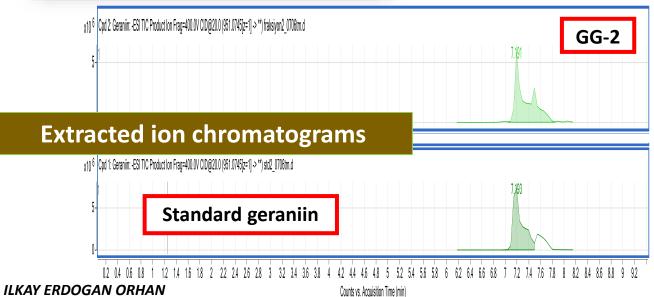
#### Tyrosinase Inhibition by Geranium glaberrimum L.

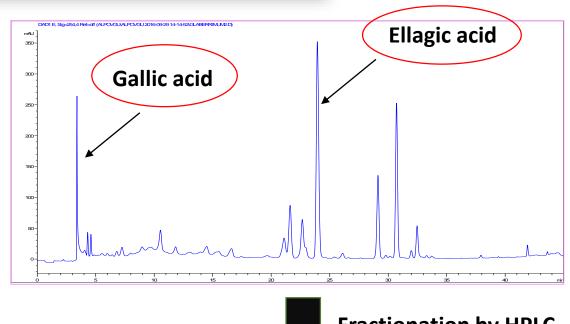


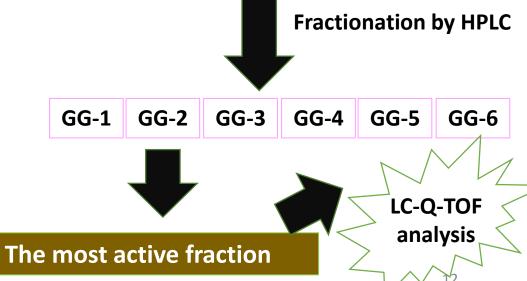




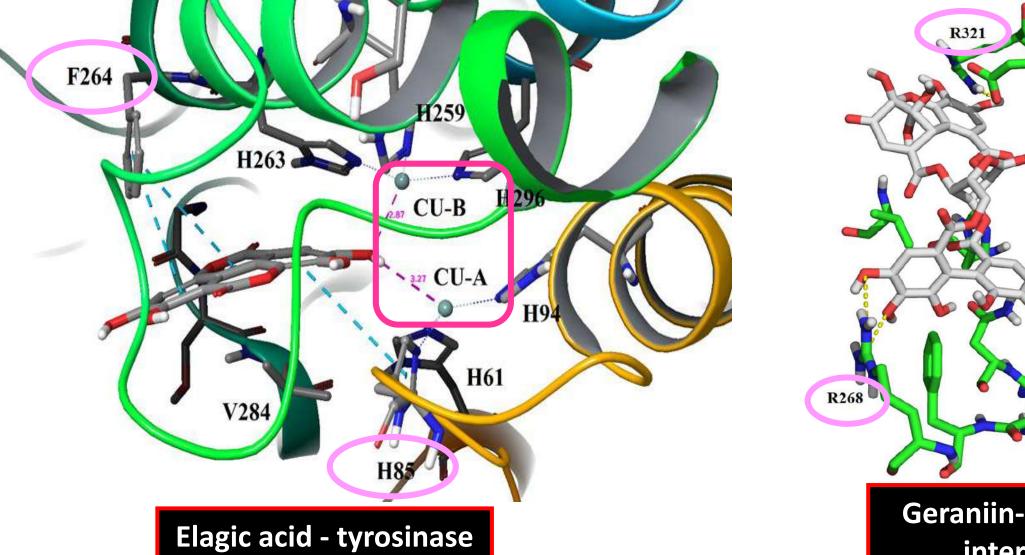
GG - 31.41 ± 1.11%







		но о—
Fractions	Tyrosinase inhibition	HO—OH OOH OOH
FIACTIONS	(Inhibition% ± S.D.)	
GG-1	22,36 ± 2,14	LC-Q-TOF OH HO OH HO OH HO
GG-2	51,79 ± 3,84	analysis 0
GG-3	29,57 ± 2,45	Elagic Geraniin Corilagin Gallic Quinic acid
GG-4	16,32 ± 0,37	acid acid acid
GG-5	22,87 ± 3,87	HO
GG-6	19,01 ± 1,89	HO OH
α-Kojic acid <sup>b</sup>	90,10 ± 0,98	HO HO HO
	OH Quercetin	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
HO		он Corilagin OH
OH O	OH (74.77 ± 0.26%)	Geraniin 13



**Geraniin- tyrosinase** interaction H bondings with Asn81, His85, Val248, Asn260, Arg268, Arg321 and

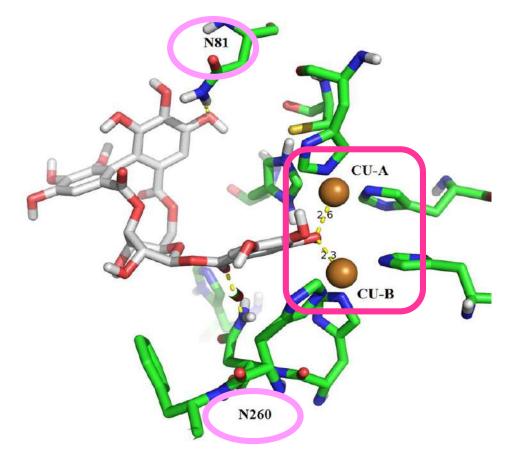
CU-A

Aromatic  $\pi$ - $\pi$  interactions with Phe264 and His85

interactions

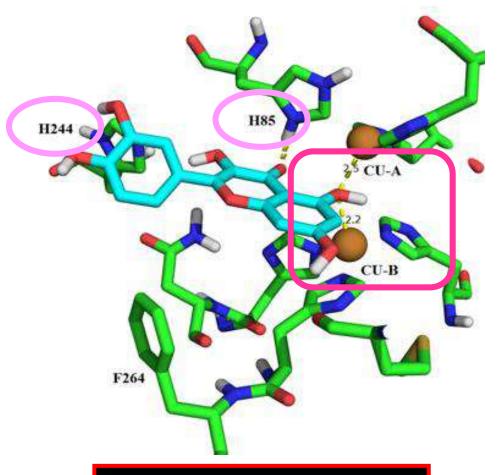
OH group – H bonding with CuA & CuB

- **Glu322**
- OH group H bonding with CuA & CuB 4-5 Å
- Hydrophobic interactions with Val248, Phe264 and Glu322



# Corilagine- tyrosinase interaction

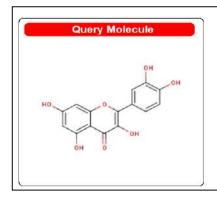
- H bondings with ASN81, Cys83, His85, Asn260 and Met280
- Ligation with CuA & CuB less than 3 Å

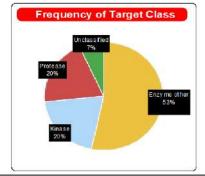


# Quercetin- tyrosinase interaction

- H bondings with His85, His244, Asn260, Met280 and Ser282
- Ligation with CuA & CuB less than 3 Å

#### **Swiss Prediction Program**



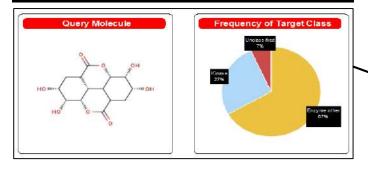


#### **PASS Program**

P <sub>a</sub> <sup>a</sup>	P <sub>i</sub> <sup>b</sup>	Biological activity
0,588	0,003	Skin whitener
0,538	0,003	Antioxidant
0,729	0,002	Astrengant
0,525	0,003	15-Lipoxigenase inhibitor
0,262	0,003	12-Lipoxigenase inhibitor
0,258	0,005	5-Lipoxigenase inhibitor
0,527	0,042	Oxygen scavenger
0,811	0,003	Free radical scavenger

Target	Uniprot ID	Gene code	Chembl ID	Probability	# sim. cmpds (3D / 2D)	Target Class
Carbonic anhydrase 12	O43570	CA12	CHEMBL3242		3/5	Enzyme
Epidermal growth factor receptor	P00533	EGFR	CHEMBL203		6/28	Tyr Kinase
Carbonic anhydrase 1	P00915	CA1	CHEMBL261		10/7	Enzyme
Carbonic anhydrase 2	P00918	CA2	CHEMBL205		10/7	Enzyme
Phospholipase A2	P04054	PLA2G1B	CHEMBL4426		1/1	Enzyme
Receptor tyrosine-protein kinase erbB-2 (by homology)	P04626	ERBB2	CHEMBL1824		6 / 28	Tyr Kinase
Myeloperoxidase	P05164	MPO	CHEMBL2439		1/1	Enzyme
Cytochrome P450 1A2 (by homology)	P05177	CYP1A2	CHEMBL3356		8 / 13	Enzyme
Cyclin-dependent kinase 1	P06493	CDK1	CHEMBL308		3 / 27	Ser_Thr Kinase
Carbonic anhydrase 3	P07451	CA3	CHEMBL2885		10/7	Enzyme
Alpha-trypsin chain 1	P07477	PRSS1	CHEMBL209		1/2	Serine Protease
PEX	P08253	MMP2	CHEMBL333		5/2	Metallo Protease
Stromelysin-1	P08254	MMP3	CHEMBL283		3/2	Metallo Protease
Arachidonate 5-lipoxygenase	P09917	ALOX5	CHEMBL215		10 / 52	Enzyme
Microtubule-associated protein tau	P10636	MAPT	CHEMBL1293224		25 / 77	Unclassified

#### **Swiss Prediction Program**



#### **PASS Program**

P <sub>a</sub> <sup>a</sup>	P <sub>i</sub> <sup>b</sup>	Biological activity		
0,265	0,014	Skin whitener		
0,699	0,004	Antioxidant		
0,680	0,009	Oxygene scavenger		
0,596	0,006	Free radical scavenger		
0,556	0,009	Pankreatic elastase inhibitor		
0,332	0,009	Melanin inhibitor		
0,507	0,012	Non-steroidal anti-inflammatuary		

Target	Uniprot ID	Gene code	ChEMBL ID	Probability	# sim. cmpds (3D / 2D)	Target Class
Cytidine deaminase	P32320	CDA	CHEMBL4502		17/0	Enzyme
Thymidine kinase, cytosolic	P04183	TK1	CHEMBL2883		14/0	Enzyme
Adenosylhomocysteinase	P23526	AHCY	CHEMBL2664		50 / 0	Enzyme
Putative adenosylhomocysteinase 2 (by homology)	O43865	AHCYL1			48/0	Enzyme
Putative adenosylhomocysteinase 3 (by homology)	Q96HN2	AHCYL2			48/0	Enzyme
Adenosine deaminase	P00813	ADA	CHEMBL1910		11 / 0	Enzyme
Thymidine phosphorylase	P19971	TYMP	CHEMBL3106		1/0	Enzyme
Adenosine kinase	P55263	ADK	CHEMBL3589		41 / 0	Enzyme
Casein kinase II subunit alpha	P68400	CSNK2A1	CHEMBL3629		1/0	Ser_Thr Kinase
Dual specificity tyrosine- phosphorylation-regulated kinase 1A (by homology)	Q13627	DYRK1A	CHEMBL2292		1/0	Ser_Thr_Tyr Kinase
Casein kinase II subunit alpha' (by homology)	P19784	CSNK2A2	CHEMBL4070		1/0	Ser_Thr Kinase
Casein kinase II subunit alpha 3 (by homology)	Q8NEV1	CSNK2A3			1/0	Ser_Thr Kinase
Deoxycytidine kinase	P27707	DCK	CHEMBL2447		6/0	Enzyme
Deoxyguanosine kinase, mitochondrial (by homology)	Q16854	DGUOK	CHEMBL5997		6/0	Enzyme
Microtubule-associated protein tau	P10636	MAPT	CHEMBL1293224		13/0	Unclassified

Faz	Bileşen	% (w/w)
Α	Aqua	62,25
A	Carbomer	0,40
A	Microcarea	1,00
A	Glycerin	5,00
A	Dimethicone	2,00
В	Butyrospermum parkii butter	4,00
В	Glyceril stearate	3,75
В	Stearyl alcohol	4,00
В	Tocopheryl acetate	0,50
В	Suncat <sup>b</sup>	3,00
В	Polysorbate20	4,00
В	Simmondsia chinensis seed oil	2,00
С	Orgasol nylon <sup>c</sup>	4,00
С	Geranium glaberrimum EtOH extract	2,00
С	Olea europaea fruit oil	1,00
С	Valvance Look 100 <sup>d</sup>	0,50
С	Perfume	0,30
	Total	100,00



#### PATENT BAŞVURU FORMU



P201

#### 1. BAŞVURU BİLGİSİ

	1. BA	SVURU BILGISI
Başvuru Şekli/Ana Başvuru Numarası	Yeni Başvuru	
Erken Yayın Talebi	Var	
Buluş Başlığı	LEKE AÇICI	BÍTKÍSEL KOZMETÍK FORMÜLASYONU
Türkçe Çeviri Süre Talebi	Yok	
Referans No		
Patent Sınıfı	A61K,	
Tarifname Dili	TUR	
Tarifname	5 Sayfa	
İstem	9 Adet	Skin-bleaching cream
Özet	1 Sayfa	famoulation
Resim	1 Sayfa	formulation
Genetik Kaynak	HAYIR	
Kamu Desteği	HAYIR	
	2. B	AŞVURU SAHİBİ
Adı-Soyadı/Unvanı	GAZİ ÜNİVE	RSÎTESÎ
Adres	Gazi Üniversite	esi Rektörlüğü Teknikokullar Ankara TÜRKİYE
Uyruğu	TÜRKİYE	Sahip Türü Tüzel
TC Kimlik/Vergi Numarası	3890038275	Sahip Profili Universite
TPE Sahip Numarası	5186535	
	3.	BULUŞ SAHİBİ
Adı-Soyadı	İLKAY ERDO	ĞAN ORHAN
Adres	Gazi Üniversite	esi Eczacılık Fakültesi Farmasõtik Kognozi Abd 06330 Etiler TÜRKİYE 1 Q



## **Active Extracts for Skin Aging**

Plant	Part	Tyrosinase	Elastase	Collagenase
Cotinus coggyria	Pedicel	61.97 ± 1.80	3.01 ± 1.18	55.30 ± 4.68
Cotinus coggynu	Leaf	64.43 ± 2.80	51.76 ± 2.33	
Pistacia vera	Pericarpium	6.75 ± 1.92	64.33 ± 1.83	50.33 ± 4.68
Garcinia mangostana	Pericarpium	52.55 ± 0.40	36.50 ± 3.43	52.99 ± 2.63
Vitis vinifera	Seed	27.70 ± 2.55	70.74 ± 1.19	59.79 ± 2.88



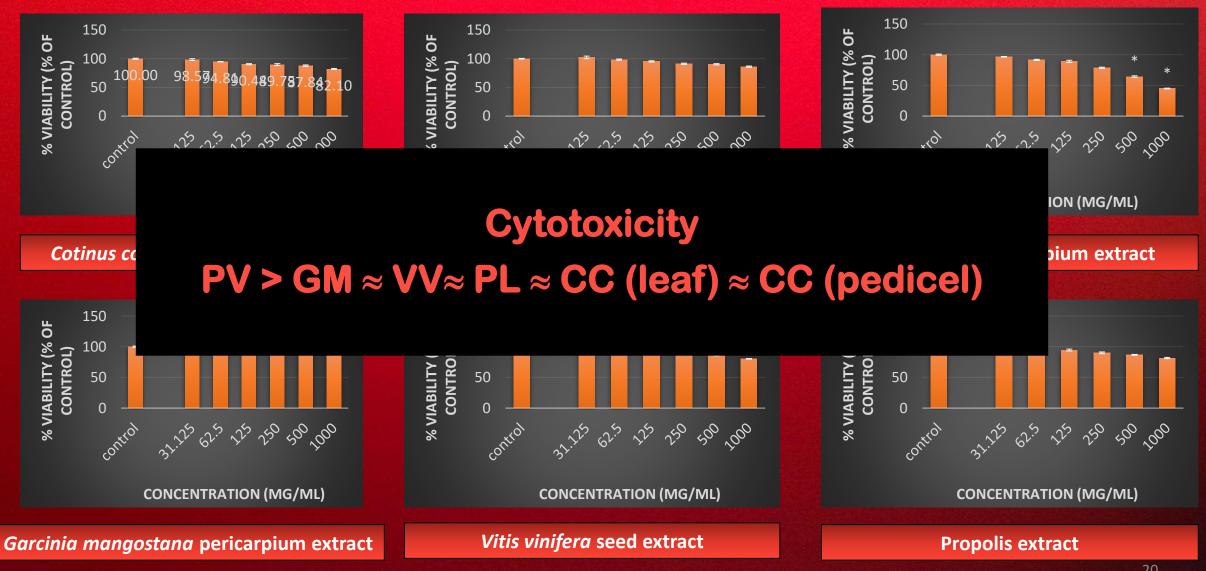






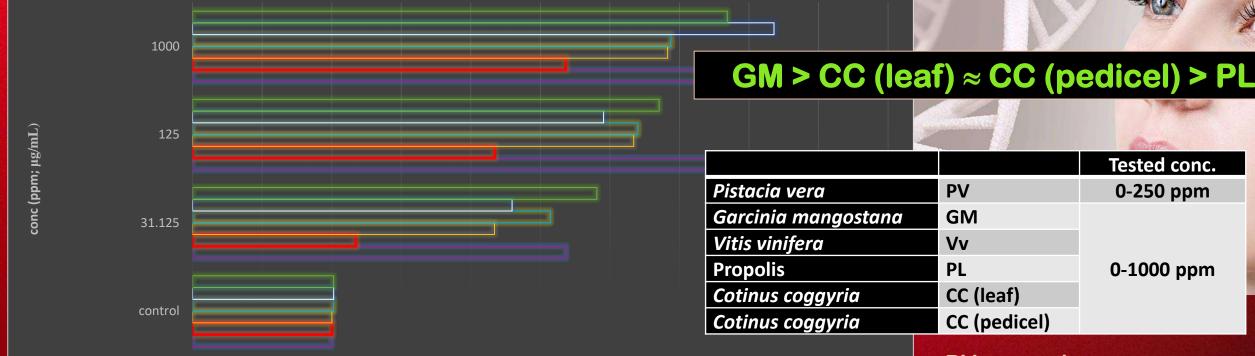


#### Viability of fibroblast using MTT assay



### Collagen content using fibroblast & colorimetric method





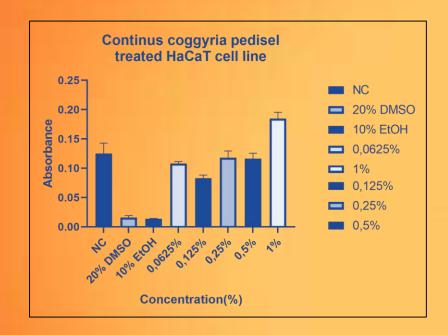
	90	95	100	105	110	11	5	120	125	130	135	140
		contro	ol		31.125			125			1000	
□ CC(Folium)		100.1431	.008	11	9.0694934			123.5403	817	1	28.4435477	
□ CC(pedi)		100.1431	.008	11	2.9688799			119.5509	874	1	31.8021707	
□PL		100.1431	.008	11	5.7220332			122.0089	789	1	24.3875833	
□Vv		100.018	243	11	1.7034746			121.7105	225	1	24.1455956	
PV (31.125, 125, 250 ppm)	)	100.018	243	10	1.7349909			111.7209	662	1	16.8130791	
□GM		100.018	243	11	6.8587855			127.7277	226	1	36.7555962	

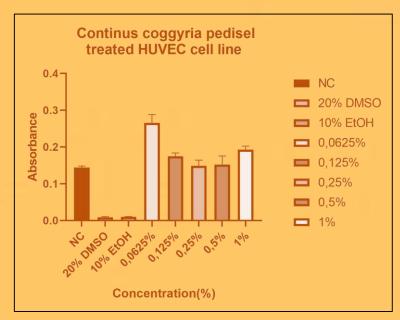
Collagen content (% of control)

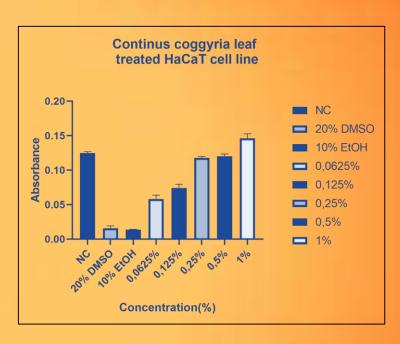
PV can enhance collagen synthesis in fibroblasts, however, the concentrations used was limited due to its cytotoxicity at high concentrations (greater than 500 ppm).



#### Cell culture studies



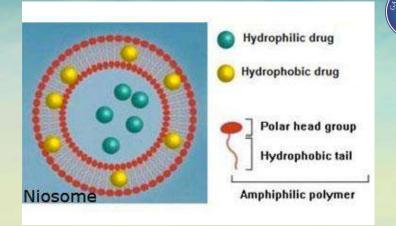






## **Niosome formulations**

Extract	Dry extract	Niosomes
Garcinia mangostana (pericarp) EtOH extract	5,8940 g	Yes
Pistacia vera (pericarp) EtOH extract	3,0245 g	Yes
Vitis vinifera (semen) EtOh extract	1,5304 g	Yes
Propolis	5,1838 g	Yes
Cotinus coggyria (pedicel) EtOH extract	5,0370 g	Yes
Cotinu coggyria (folium) EtOH extract	5,1697 g	Yes
Niosome control formulation		Yes



#### NIOSOME FORMULATIONS



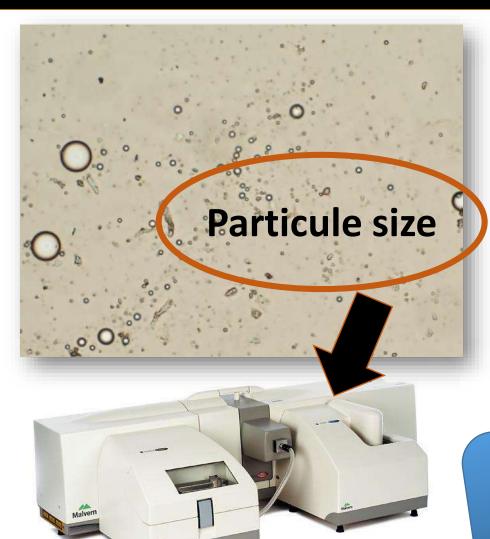




using Span 80 and cholesterol

### **Niosome formulations**





**Inhibition against** collagenase, elastase, and tyrosinase was lower than the main extracts.

**Anti-aging emulgel** formulation with Cotinus coggygria





25.12.2019



PATENT BASVURU FORMU

P201

#### 1. BAŞVURU BİLGİSİ

Başvuru Şekli/Ana Başvuru Numarası

Erken Yayın Talebi

Buluş Başlığı

DUMAN AGACI EKSTRESİ İÇEREN KOZMETİK FORMÜLASYON

Türkçe Çeviri Süre Talebi

Yok

A61K.

Referans No

Patent Sınıfı

Malvern particle size analyzer

**ILKAY ERDOGAN ORHAN** 

## Nanofibers

Nanofibers have gained significant attention recently due to its wide applications in pharmaceutical area.





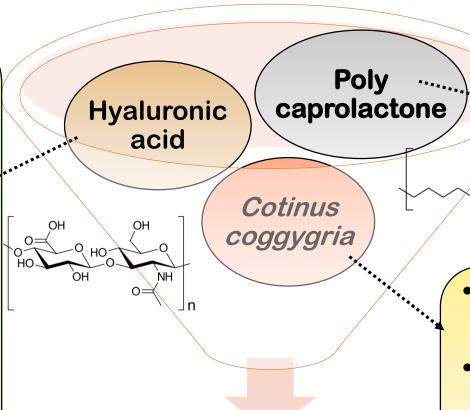






## Nanofiber-Based Wound Dressing Formulation

- Fast wound healing
- Regulates inflammation levels
- Provides more vessels in the damaged area
- Reduces pain



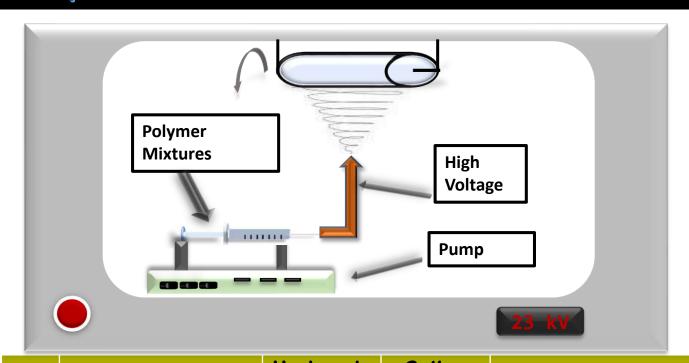
- Excellent mechanical strength
- Limits inflammation
- Biocompatible
- Prevents oxidative damage
- Promote the healing process
- Anti-inflammatory activity



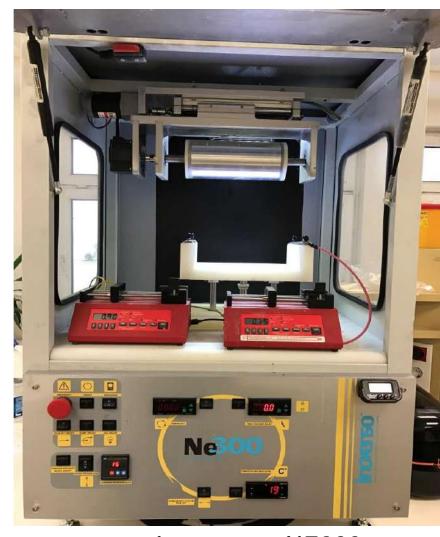
Ideal wound dressing

## Preparation of nanofiber formulations



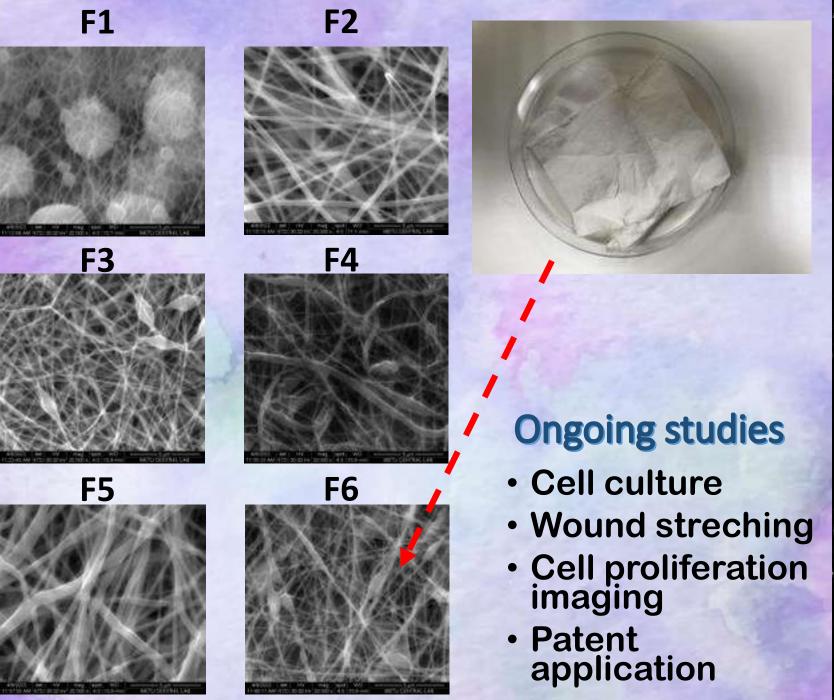


	Polycaprolactone (%)	Hyaluronic acid (%)	Cotinus coggygria (%)	Electrospinning parameters
F1	10	•	-	10 cm, 23 kV, 1 mL/h
F2	10	0,5	-	10 cm, 23 kV, 1 mL/h
F3	10	-	1	12 cm, 23 kV, 0,8 mL/h
F4	10	-	3	12 cm, 23 kV, 0,8 mL/h
F5	10	0,5	1	12 cm, 23 kV, 0,8 mL/h
F6	10	0,5	3	12 cm, 23 kV, 0,8 mL/h



Inovenso – NE300

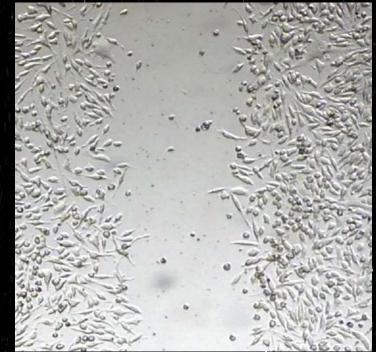
Solvent system: Chloroform/DMF (5:5) or Chloroform/DMF/water (5:4:1)





#### **Pre-Formulation**

- Beadless nanofiber surface
- High Cotinus coggygria content
- Porous structure





# Herbal Antimicrobial Mouth Spray Developed under University-Industry Collaboration

- Patients suffering from oral and dental diseases, consumers who want to protect their oral health against microbial attacks are the target group.
- It is a combined formulation
- Registered as medical device by Ministry of Health
- Ownership Gazi University



Active ingredients including the essential oils of

- Salvia fruticosa Mill.
   (Anatolian sage)
- Eucalyptus camaldulensis
   Dehn. (eucalyptus)
- Origanum majorana L. (marjoram)
- Matricaria chamomilla L.
   (German chamomile), and
- Citrus lemon (L.) Osbeck (lemon)
- as well as propolis extract and
- sweet almond oil (*Prunus*)
   amygdali var. dulci Oleum)
   as carrier.

A61K

Referans No

Rulue Rachăr

Ad Soyad/Unvan

#### PATENT BAŞVURUSU

	TAILITE	AÇVOROOO	
Tahakkuk No	634089	Başvuru Numarası	2020/22177
Evrak Numarası	2020-GE-716744	Evrak Tarihi	2020-12-29 12:24:19
Erken Yayın Talebi	Hayır, başvurum 18 aylık süre dolduktan sonra yayımlarısın.	Başvuru ile Birlikte Araştırma/ İnceleme Talebi	Araştırma
Tarifname Dili	Türkçe	Genetik Kaynak	Hayır
Tarifname Sayfa Sayısı	4	Kaynağın / Bilginin Coğrafi Kökeni	<b>#</b> 3
İstem Sayısı	15	Kamu Desteği	Hayır
Resim Sayfa Sayısı	(*)	Destek Sağlayan Kamu Kurumu	*
Patent Yarışmasına Katılmak İstiyorum	Науіг		

#### BULUŞ BAŞLIĞI / ÖZETİ

LICUCII VAĞ VE DDODOLİŞ İCEDEN EODMÜLASYON

GAZİ ÜNİVERSİTESİ REKTÖRLÜĞÜ

Proje Numarası

Duluş Daşliği	UÇUCU TAG VE PROPULIS IÇEREN PORMULASTON		
Buluş Özeti	Mevcut buluş, oral sprey solüsyon formunda, Salvia fruticosa Mill. (Anadolu adaçayı) Uçucu Yağı, Eucalyptus camaldulensis		
ASSOCIATION OF TAXABLE DATE	Dehn. (Ökaliptus) Uçucu Yağı, Origanum majorana L. (Mercanköşk) Uçucu Yağı, Matricaria chamomilla L. (Alman papatyası)		
	Uçucu Yağı, Citrus limon (L.) Osbeck (Limon) Uçucu Yağı, Propolis Ekstresi ve taşıyıcı olarak Pruni Amygdali var. Dulci Oleum		
	(Tatli Badem Yağı) içeren kompozisyonlar bu kompozisyonların hazırlanması ve kullanımı ile ilgilidir.		

#### BAŞVURU SAHİPLERİ

A			
TC Kimlik/Vergi No	8150346288	Sahip Türü	Tüzel
Uyruk	TÜRKİYE	Başvuru Hak Oranı	
Telefon	3122022023	E-Posta	ozgeeken@gazi.edu.tr
Adres	EMNİYET MAH.BANDIRMA CAD. REKTÖRLÜK BİNASI6 /1 YENİMAHALLE ANKARA TÜRKİYE		

#### **BULUŞ SAHİPLERİ**

Ad Soyad/Unvan	İLKAY ERDOĞAN ORHAN		
TC Kimlik/Vergi No	27794131116	Gizlilik Beyanı	Hayır
Uyruk	TÜRKİYE	Başvuru Hakkı Beyanı	Hizmet İlişkisi
IҢҚ∰Y ERDOGAN ORHAŊ <sub>26458543</sub>		E-Posta	iorhan@gazi.edu.tr

#### Theraphyto:



# AĞIZHİJYENİ AĞIZKOKUSU DİŞ ETİ AFT PROBLEMLERİ AFT BOĞAZ ENFEKSİYONLARI

PROF. DR. İLKAY ERDOĞAN ORHAN TARAFINDAN FORMÜLE EDİLMİŞTİR.







### Patents obtained by our team

- 1. Invention titled "Kojic Acid-Derived Mannich Bases with Biological Effect" **Turkish Patent** (TR2015 07653 (Registration date: 21.11.2017)
- 2. Invention titled "Kojic Acid-Derived Mannich Bases with Biological Effect" US Patent (US 9,975,884 B2) (Registration date: 22.05.2017)
- 3. Invention titled "Kojic Acid-Derived Mannich Bases with Biological Effect" European Patent (EP 16 732 363.3) (Registration date: 14.03.2019)

## JUNIVERS 2 1926

### Patent applications by our team

- 1. Invention titled "Skin-Bleaching Herbal Cosmetic Formulation" **Turkish Patent** (Application date: 19.12.2019)
- 2. Invention titled "Cosmetic Formulation with Smoke Tree Extract" **Turkish Patent** (Application date: 25.12.2019)
- 3. Invention titled "Red Californian Worm Extract and Its Use" Turkish Patent (Application date: 26.12.2019)
- 4. Invention titled "Propagation and Ossification Medium for Dental Pulp Mesenchymal Stem Cells" **Turkish Patent** (Application date: 26.12.2019)
- 5. Invention titled "Mouth Care Spray Formulation Consisting of Essential Oils and Propolis" **Turkish Patent** (Application date: 26.11.2020) & International Patent (Application date: 2022)
- 6. Invention titled "A Formulation Comprising an Essential Oil and Propolis" PCT application (Application date: 26.11.2021, PCT application no: PCT/TR2021/051300)

#### Our lab team



## Acknowledgement



- Prof. Dr. Günther Bonn
- Dr. Thomas Jakschitz





 Assist. Prof. Khaetthareeya Sutthanut Faculty of Pharmaceutical Sciences Khon Kaen University, Thailand



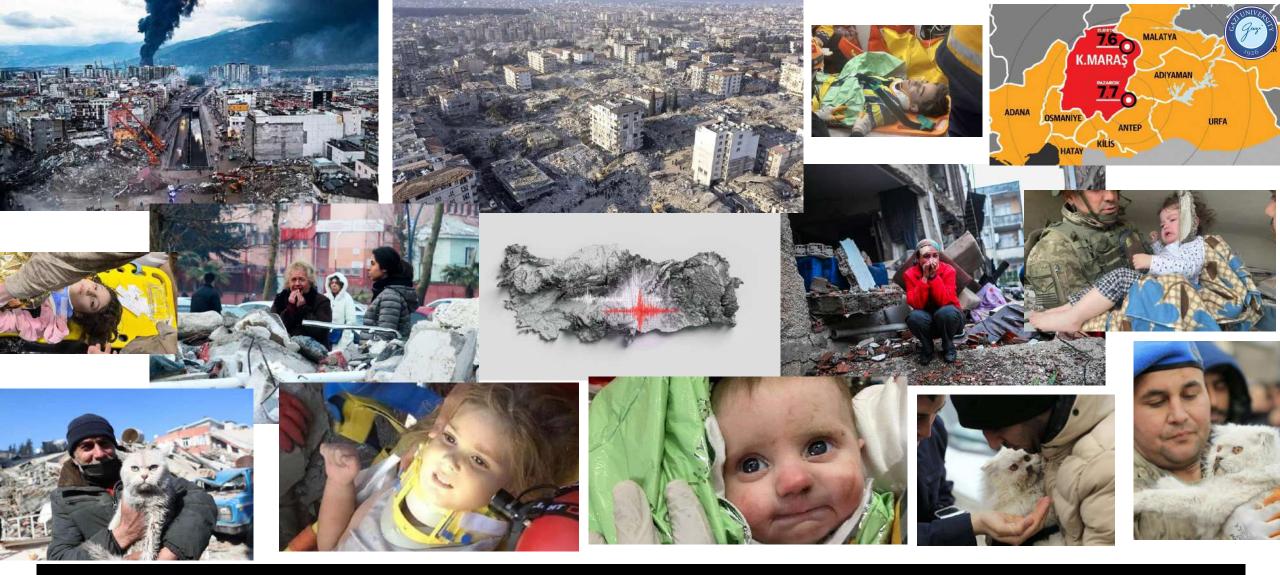


Dr. Çağla Bozkurt Güzel
Dept of Pharmaceutical
Microbiology
Faculty of Pharmacy, Istanbul
University



 Dept of Pharmaceutical Technology, Faculty of Pharmacy, Gazi University, Ankara, Türkiye





Dedicated to my deceased pharmacist colleagues and all Turkish citizens who lost their lifes in two massive earthquakes on February 6th, 2023.



### THE MONTREAL PROTOCOL AND THE OZONE DEPLETING SUBSTANCES PHASE-OUT: IMPACT ON HUMAN, PLANTS AND ENVIRONMENT

#### MOHAMMED BESRI<sup>1</sup> AND ABDELHAFID LAHLAIDI<sup>2</sup> FIAS

<sup>1</sup> Emeritus Professor, Hassan II Institute of Agronomy and Veterinary medicine, UNEP-MBTOC member, Morocco

<sup>2</sup> Vice President, IAS and Emeritus Professor, Faculty of Medicine, Morocco

#### **ABSTRACT**



The ozone layer resides in the stratosphere, surrounds the entire Earth and absorbs sun radiations. As a result, the amount of UV-B reaching Earth's surface is greatly reduced. Prolonged exposure to UV-B can have serious effects on human health, on plants, on Phytoplankton and on environment including climate change. On September 16, 1987, governments around the world agreed on the Montreal Protocol (MP) on Ozone Depleting Substances (ODSs) that deplete the ozone layer (CFCs, HCFCs, HBFCs, halons, carbon tetrachloride, and methyl chloroform). Methyl bromide (MB) was later classified as an ODS under the Copenhagen Amendment of the MP in 1992. The MP has been ratified by 197 parties (196 states and the European Union), making it the first universally ratified treaty in United

Nations' history. A global phase-out schedule of the ODSs was established by the MP. To phase-out the ODSs, the MP has developed a strategy including the establishment of 5 Technical Option Committees (TOC): Foams TOC, Halons TOC, Medical and Chemical TOC, Refrigeration TOC, and Methyl Bromide TOC. TOCs identify existing and potential alternatives to the ODSs, provide recommendations and advices to the Parties on the technical and economic feasibility of the alternatives. Some TOCs e.g. MBTOC have also the task of evaluating the Critical Use Nominations submitted. Without the Protocol, the destruction of the ozone layer would have continued, thus increasing the impact of UV-B radiation on humans, the environment, and climate change. The ozone hole is slowly recovering, and it is expected that the ozone layer will return to 1980 levels between 2050 and 2070. This will be the first time in history that humankind has reversed an environmental problem of such magnitude. The MP is considered as one of the most successful and effective environmental treaties ever negotiated and implemented. About 70 synthetic highly toxic pesticides to humans and to environment have already been banned in developed countries but, unfortunately, continue to be used in many developing countries, including the Islamic ones. Therefore, an Islamic agreement and an action plan are needed to reduce and then completely phase out these toxic synthetic pesticides in the Islamic world. Many lessons can be learned from the MP.





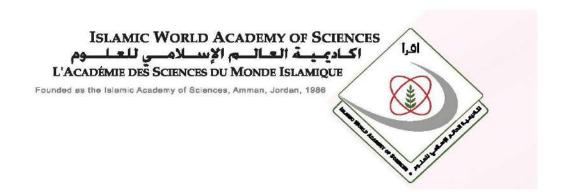






# 24th INTERNATIONAL SCIENTIFIC CONFERENCE ON "CHALLENGES TO PROMOTE SCIENCE & TECHNOLOGY FOR SOCIO-ECONOMIC DEVELOPMENT IN OIC COUNTRIES"

MARCH 7 - 8, 2023, KARACHI, PAKISTAN.



## The Montreal Protocol and the Ozone Depleting Substances Phase-out: Impact on Human, Plants and Environment

Mohammed Besri, Emeritus Professor, Member of the UNEP-MBTOC committee

Abdelhafid lahlaidi; Emeritus Professor, Vice President of IAS

### Introduction 1/2

- The ozone layer acts like a shell or a solar cream protecting man and his environment from the harmful effects of sun UV-B rays.
- Prolonged exposure to UV-B can have serious effects on human health, on plants, on Phytoplankton and on environment including climate change
- A wide range of man-made gases is responsible for ozone depletion. On September 16, 1987, governments around the world agreed on the Montreal Protocol (MP) to phase out Ozone Depleting Substances (ODSs): CFCs, HCFCs, HBFCs, halons, carbon tetrachloride, methyl chloroform and Methyl bromide.

### Introduction 2/2

#### This conference will address the following points:

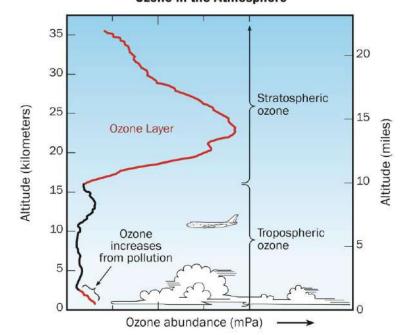
- Ozone and ozone layer
- Human contribution to ozone depletion
- 3. Consequences of ozone depletion on:
  - a. Human health
  - b. Plants
  - c. Environment: marine ecosystems, climate change
- 4. The Montreal Protocol and the ODSs phase out
- 5. Example: Methyl bromide phase out
- The Montreal Protocol successes

### THE OZONE, THE OZONE LAYER AND THE OZONE DEPLETION

### The ozone and ozone layer

- Ozone: a molecule with 3 oxygen atoms;
- Most ozone resides in the stratospheric ozone layer (more than 15 kilometers above Earth's surface) and surrounds the entire Earth
- The concentration of ozone varies with altitude.

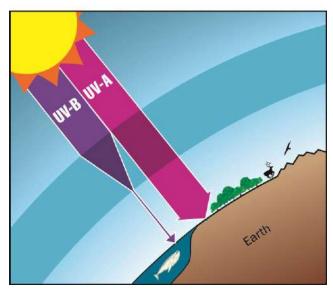
## Ozone and Oxygen Oxygen atom (O) Oxygen molecule (O2) Ozone molecule (O3) Ozone in the Atmosphere

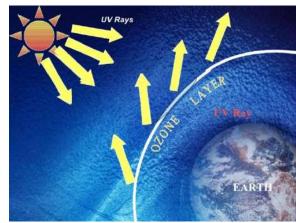


### UV-B protection by the ozone layer

- UV-A (315- to 400 nanometer (nm) wavelength), visible light, are not strongly absorbed by the ozone layer and are the least dangerous;
- UV-B radiation (280- to 315 (nm) wavelength), the most dangerous radiation, is strongly absorbed in this layer. As a result, the amount of UV-B reaching Earth's surface is greatly reduced.
- UV-B have serious effects on human health, on plants, on Phytoplankton and on environment including climate change

#### **UV Protection by the Ozone Layer**





### Nobel Prize in Chemistry in 1995

- In 1974, three scientists, Mario Molina, F. Sherwood Rowland and Paul Josef Crutzen formulated, for the first time, the theory of the ozone layer depletion by Chloro Fluoro Carbons (CFCs). In 1995 they won the Nobel Prize in Chemistry;
- Many other gazes are depleting the ozone layer.

#### The Nobel Prize in Chemistry 1995



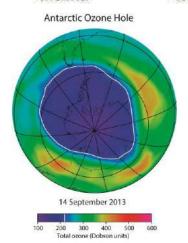
Paul J. Crutzen



Mario J. Molina



F. Sherwood Rowland



### CFC, HCFC, HFC, HC, PFC, and Halon

Prefix	Meaning	<b>Atoms in the Molecule</b>
CFC	chlorofluorocarbon	Cl, F, C
HCFC	hydrochlorofluorocarbon	H, Cl, F, C
HBFC	hydrobromofluorocarbon	H, Br, F, C
HFC	hydrofluorocarbon	H, F, C
НС	hydrocarbon	H, C
PFC	perfluorocarbon	F, C
Halon	N/A	Br, Cl (in some but not all), F, H (in some but not all), C

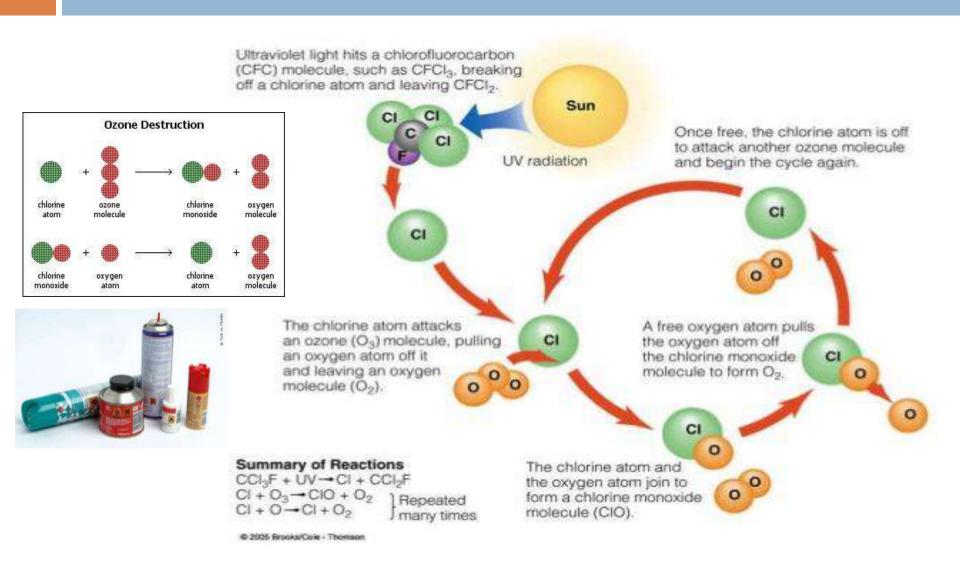
CFC-11 (CCl<sub>3</sub>F) Trichlorofluoromethane CFC-12 (CCl<sub>2</sub>F<sub>2</sub>) Dichlorodifluoromethane CFC-113 (C<sub>2</sub>F3Cl<sub>3</sub>) 1,1,2-Trichlorotrifluoroethane

### Human contributions to ozone destruction

- These man -made gases are responsible for ozone depletion. For example, CFCs were used in fridges, air-conditioning units, plastic foams and aerosol sprays.
- These gases are transported high into the stratosphere where they are broken down by UV radiation. The reaction releases free chlorine, which acts as a catalyst in the ozone destruction
- Other gazes such as HCFCs, Methyl Bromide, halons also deplete the ozone layer.



### How Ozone is depleted?: Example of CFCs



### CONSEQUENCES OF OZONE DEPLETION LAYER

### Consequences of ozone depletion

Effect on human Increased UV health Crop production is Effects on non affected human animals

UV-B radiation exposure has a great impact on human health, on animals on plants and on the environment including climate change

### Effect of ozone layer depletion on human health

- Prolonged exposure to
   UV-B can have serious
   effects on human health
- It can lead to sun burns, cataracts, skin cancer, reduced effectiveness of immune system, respiratory illness, heart problems, premature aging of the skin etc..













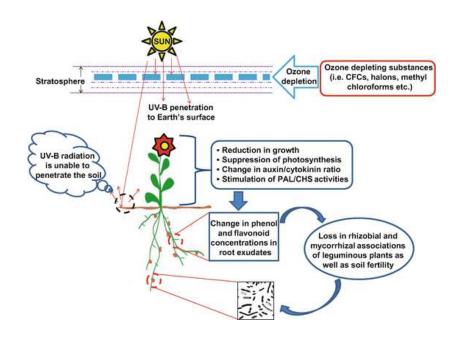


### Effects of enhanced UV-B radiation on Plants

- Reduced photosynthesis;
- Reduced water use efficiency;
- Enhanced drought stress sensitivity;
- □ Reduced leaf area;
- Inhibited flowering;
- Reduced dry matter production;
- Reduced yields;
- Increased plant susceptibility to pathogens.

### Effect of UV-B Radiation on Plants: Example of Leguminous Plants

- Significant reductions in total biomass up to 93 %, photosynthesis up to 90 %, and yield up to 62 % have been reported;.
- Studies reported reduction of about 62 % in nodulation, 78 % in nitrogenase activity, 31 % in nitrate reductase activity, 67 % in nitrite reductase activity and 76 % in leghaemoglobin
- Significant negative impacts of UV-B were also reported on microbial biomass of rhizosphere.

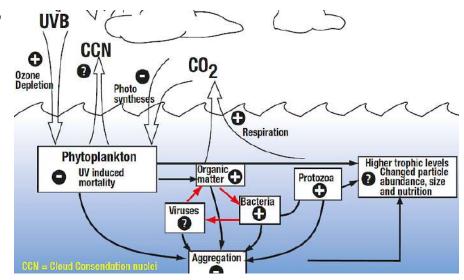


### Effect of ozone depletion on marine ecosystem

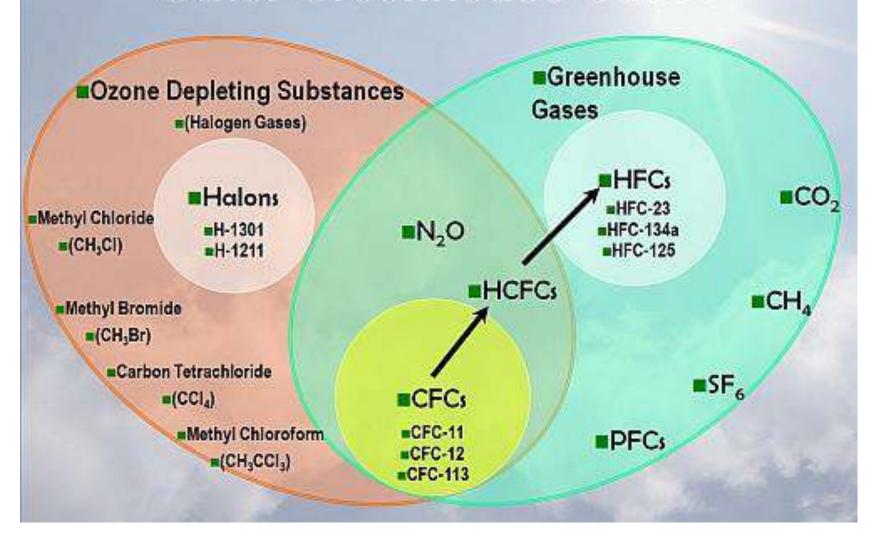
- UV-B can penetrate clear water to a depth of 20 m
- Phytoplankton productivity is limited to the euphotic zone, the layer closer to the surface that receives enough light for photosynthesis to occur and in which there is sufficient sunlight to support net productivity.
- UV-B is damaging to single celled marine plants (phytoplankton) and other micro organisms, protozoa, bacteria and viruses.
- UV-B radiation affects the Phytoplankton survival, causes damage to reproductive capacity and early developmental stages of fish, shrimp, crab, amphibians and other animals.
- Increases in UV-B exposure result in significant reduction in the size of the population of animals that eat these smaller creatures.

### Effect of ozone depletion on marine ecosystem

- Due to the interactions between trophic levels of the microbial community, any UVB-induced impact at one level can alter the entire community.
- Continued depletion of ozone will lead to increased penetration of UV into the upper layers of the ocean, resulting in damage to various forms of marine life such as phytoplankton, Zooplankton, fish, shrimp, crab, amphibians, and other marine animals.
- Phytoplankton is also important in determining global climate. It moderates the global greenhouse effect by absorbing CO<sub>2</sub> from the atmosphere



#### Relationship Between ODS and Other Greenhouse Gases

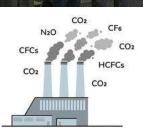


### ODSs, green house gases and public awareness









Greenhouse Gas Emissions



Public awareness has arisen with the negative impacts of ODSs and green house gases on human health, on plants and on the environment



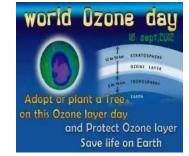


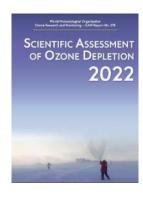
### THE MONTREAL PROTOCOL AND THE ODSs PHASE OUT

#### The Montreal Protocol

- On September 16, 1987, governments around the world agreed on the Montreal Protocol on Substances That Deplete the Ozone Layer (CFCs, HCFCs, HBFCs, halons, carbon tetrachloride, and methyl chloroform)
- Every year, September 16 is observed as the International Day for the Preservation of the Ozone Layer across the world. The celebrations are also known as World Ozone Day.
- A global phase-out schedule of the ODSs was established by the MP.







### Global phase-out schedule of the ODSs established by the MP

#### **Ozone Depleting Substances**

Chlorofluorocarbons (CFCs)

Halons

Carbon tetrachloride

Methyl chloroform

Hydrochlorofluorocarbons (HCFCs)

Hydrobromofluorocarbons (HBFCs)

Methyl bromide

#### **Developed Countries**

Phased out end of 1995 a

Phased out end of 1993

Phased out end of 1995 a

Phased out end of 1995 a

Freeze from beginning of 1996 b

35% reduction by 2004

65% reduction by 2010

90% reduction by 2015

Total phase out by 2020

Phased out end of 1995

Freeze in 1995 at 1991

base level

25% reduction by 1999

50% reduction by 2001

70% reduction by 2000

Total phase out by 2005

#### **Developing Countries**

Total phase out by 2010

Total phase out by 2010

Total phase out by 2010

Total phase out by 2015

Freeze in 2016

at 2015 base level

Total phase out by 2040

Phased out end of 1995

Freeze in 2002 at average

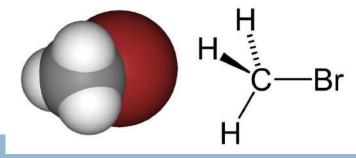
1995-1998 base level

20% reduction by 2005

Total phase out by 2015

EXAMPLE: METHYL BROMIDE PHASE OUT

### Methyl bromide uses



- Methyl bromide, was used extensively in the past (total phase out in 2005 and 2015 respectively in developed and developing countries) as a fumigant for controlling a wide range of pests, weeds and pathogens present in soils (fungi, bacteria, nematodes, viruses) as well as in postharvest commodities, in buildings or structures to control insects, mites, rodents ...
- MB continue to be used for quarantine and preshipment





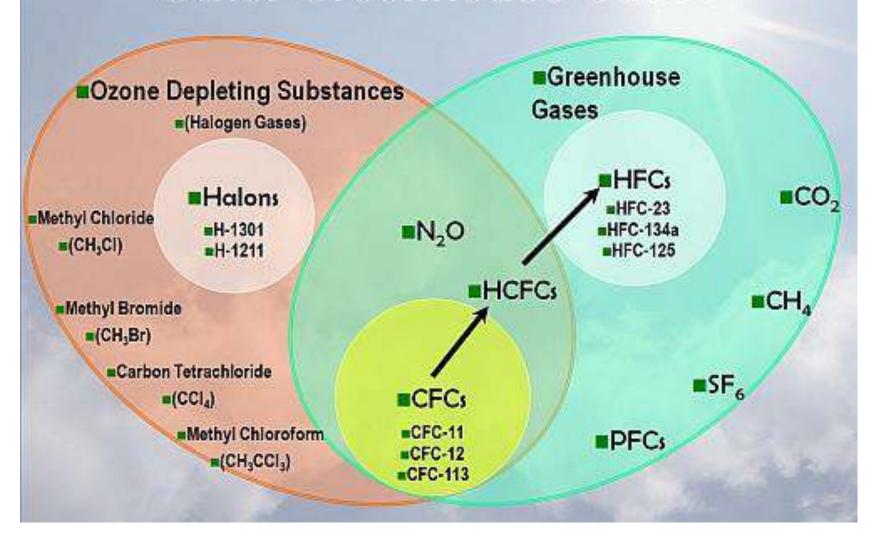








#### Relationship Between ODS and Other Greenhouse Gases



### MB Phase-out Schedules Agreed by the Montreal Protocol

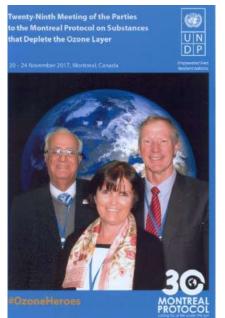
5 Countries Article 5 Countries
oduction baseline
Consumption/production baseline
Freeze
Review of reductions
rovision for 20% reduction
Phaseout with provision for CUEs
Phase P. Montreal Protocol Ha

### **UNEP Technical Option committees**

- To eliminate the ODSs, the MP has developed a strategy comprising several points including the establishment of five technical option committees (TOC) to identify existing and potential alternatives to ODSs: Foams, Halons, Medical and Chemical, Refrigeration, and Methyl Bromide TOCs.
- TOCs provide recommendations and advices to the Parties on the technical and economic feasibility of alternatives. Some TOC e.g. MBTOC have also the task of evaluating Critical Use Nominations submitted by Article 5 and non-Article 5 Parties to the MP







#### **MBTOC** Co chairs

Marta Pizano: Columbia

Ian Porter: Australia

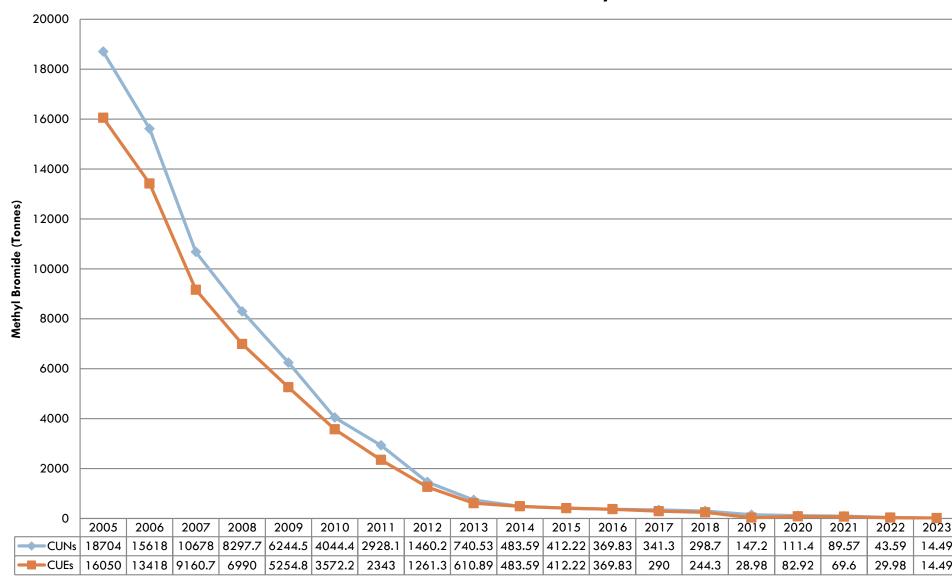
Mohammed Besri: Morocco

#### **CUNs and CUEs**

- In 1997, the Parties to the MP recognized a justifiable need for transitional access to MB and adopted a formal decision to allow limited CUEs. Since 2005, exemptions have been allowed for "Critical Uses" in non-A5 Parties and since 2015 in A5 Parties.
- Exemptions were to be granted only when the following criteria defined by the Decision IX/6 were met:
  - Failure to provide access to MB would result in a significant market disruption.
  - There were no technically and economically feasible alternative available to an applicant that is acceptable from environmental and human health standpoints.
  - The applicant had taken all feasible steps to minimize their use of MB and the associated emissions.
  - Appropriate efforts were being made to evaluate, commercialize, and register alternatives to MB for use by the applicant.
- □ MBTOC evaluates the CUNs and makes recommendations to the Meeting of the Parties (MOP): recommends the full amount requested; a reduced amount; did not recommend the nomination

### THE MONTREAL PROTOCOL SUCCESSES

#### Trends of CUNs and CUEs of Methyl Bromide



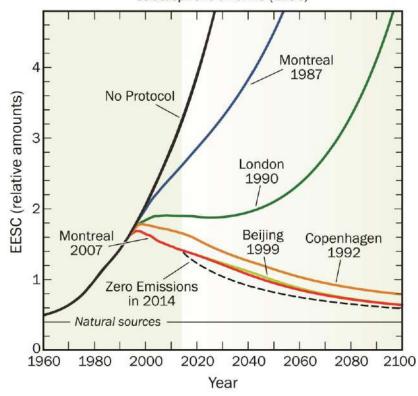
The amount of MB requested for CUNs has fallen from 18,700 t submitted for 2005 (135 nominations) to 14 t submitted for 2023 (2 nominations).

### Recovering of the ozone layer

- Without the Protocol and its amendment, Equivalent Effective Stratospheric Chlorine (EESC) values are projected to have increased significantly in the 21st century.
- The implication of this would have been hazardous and have been estimated to include: 20 million more cases of cancer and 130 million more cases of eye cataracts if there have been no MP.
- The ozone hole is slowly recovering, and it is expected that the ozone layer will return to 1980 levels between 2050 and 2070
- Some ODSs are also potent greenhouse gases, and the protocol has delivered substantial climate benefits too.



Long-term changes in equivalent effective stratospheric chlorine (EESC)



#### Visit of the Department of Plant Protection by The King Hassan the second (1982)



### Some awards obtained for phasing out Methyl Bromide in climate temperate countries

A-National Medal of merit, awarded by the King Mohamed VI for contribution to the Moroccan sustainable agricultural development (2000).

2- Two UNEP Awards: 2007 and 2017







### Some awards obtained for phasing out Methyl Bromide in climate temperate countries

C- National Associations of fruits, vegetables and ornamental plants growers (Morocco)









### Some awards obtained for phasing out Methyl Bromide in climate temperate countries

 D-Moroccan Association for plant Protection, Two awards, 2008 and 2010

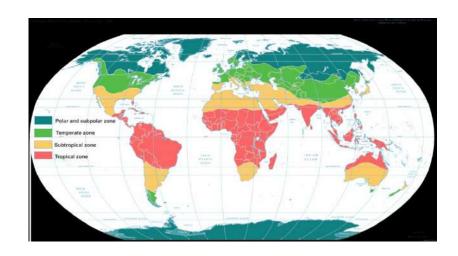


Others: FAO, Khalifa date Palm, UNIDO....

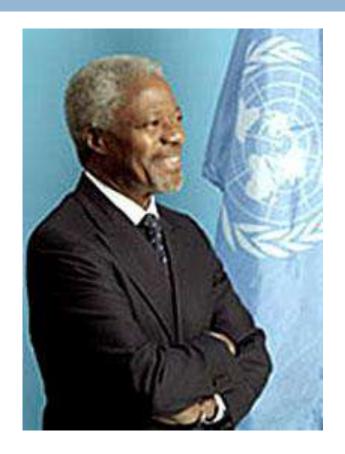
### Some countries located in non temperate climate zones and using some alternatives to MB

#### Subtropical:

- Africa: Morocco, Algeria, Tunisia, Egypt, South Africa
- Middle East: Lebanon, Turkey, Jordan, Syria, Irak...
- USA: California
- Latin America: Argentina (S), Brazil....
- Asia : India, China (S)
- Australia (S)
- Tropical:
  - Africa; Kenya....
  - Australia (N)
  - Latin America: Mexico, Brazil, Argentina....



# The Montreal Protocol on Substances that Deplete the Ozone Layer



<sup>&</sup>quot;Perhaps the single most successful international agreement to date has been the Montreal Protocol", Kofi Annan, Former Secretary General of the United Nations

### Conclusion

- Technically and economically effective alternatives to ODSs have been developed for all uses;
- The MP on substances that deplete the ozone layer is an international treaty designed to protect the ozone layer by phasing out the production and consumption of ODSs;
- The MP has been ratified by 197 parties (196 states and the European Union), making it the first universally ratified treaty in United Nations' history.

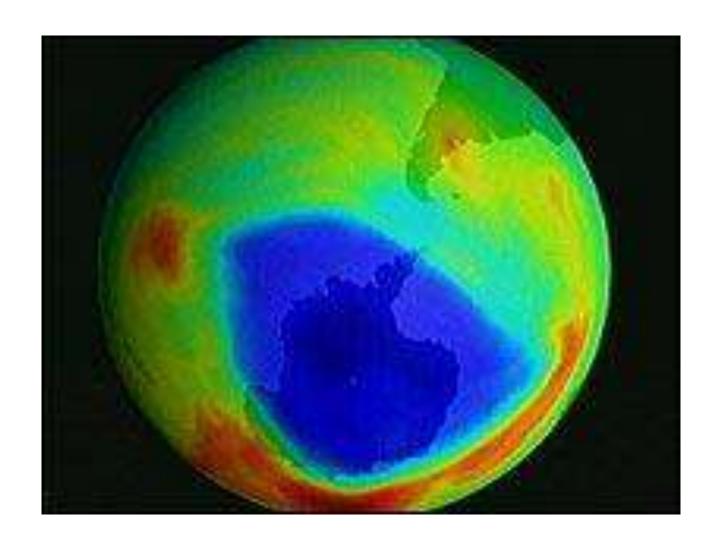
### Conclusion

- The implementation of the MP has shown that setting strict phase-out schedules for developed and developing countries have promoted research and innovation of alternatives to the ODSs and speeded their transfer, acceptance, and implementation;
- The ozone hole is slowly recovering, and it is expected that the ozone layer will return to 1980 levels between 2050 and 2070;
- This will be the first time in history that humankind has reversed an environmental problem of such magnitude. The MP is considered as one of the most successful and effective environmental treaties ever negotiated and implemented.

# Conclusion: Lessons to be learned from the MP

- In addition to the ODSs and many other dangerous chemical compounds, currently, about 70 synthetic highly toxic pesticides to humans and to the environment have already been banned in developed countries but, unfortunately, continue to be used in many developing countries, including the Islamic ones.
- Therefore, an agreement and an action plan are needed to reduce and then completely phase out these toxic synthetic pesticide. Many lessons can be learned from the MP.

### Thank you for your attention



#### PLANT SCIENCES: A TOOL TO ACHIEVE TARGETS OF SDGS

#### ZABTA SHINWARI FIAS

Vice President, IAS
Professor Emeritus, Quaid-i-Azam University, Pakistan

#### **ABSTRACT**



Pakistan is sitting on a gold mine of well-recorded and traditionally well-practiced knowledge of herbal medicine. Folk medical (Hakeems or Pansars) have deep foundations in Pakistan. "Greeco-Islamic medicines", "Yunani Tibb" or "Yunani Dawakhana" are most commonly used traditional systems in Pakistan. Approximately 75118 registered *Unani* medical practitioners are practicing both in the public and private sector in urban and rural areas. About 360 *tibb* dispensaries and clinics provide free medication to the public under the control of the health departments of provincial governments. The treasure of Biodiversity resources in Pakistan can be used to address the SDGs.

For example: SDG-1: End poverty in all its forms everywhere:

The inhabitants of rich biodiversity areas are the poorest, these resources can be sustainably used to reduce poverty. Unfortunately, the indigenous people sell these treasures on negligible prices and get almost nothing in return. If SDG 1 is addressed, it can help to achieve not only SDG 2 but 3 also. Because if proper guidance is given, it will end hunger, achieve food security and improved nutrition, and promote sustainable agriculture by introducing off seasons vegetables, high price medicinal plants etc.

To address SDG 3 regarding healthy life: there are complains that herbal products are not scientifically proven and no proper clinical trials conducted. Clinical trials are performed to investigate if a therapeutic strategy is effective and safe for human... The results gathered as a result of clinical trials can be used for health care decision making. Herbal medicine has become a popular form of healthcare; even though several differences exist between herbal and conventional pharmacological treatments. Herbal medicines are not always safe and do carry risks so the research should be intensified in terms of clinical trials.

- Ayurveda in India, Unani in Pakistan, Traditional Chinese Medicine, and other systems, have been written down and codified for centuries, but other traditional practices emerge and evolve more organically and have fewer controls over their safety and practice, or guarantees of their effectiveness.
- The World Health Organization (WHO) had a traditional medicine strategy in place from 2002, since updated to a 2014-2023 strategy.
- Current WHO strategy aims to support WHO Member States in developing proactive policies and implementing action plans to strengthen the role traditional medicine plays in keeping people healthy. The way to achieve it in addressing SDG 4 & 5, "Ensure inclusive and equitable quality education and gender equality and empower all women and girls". Major collectors of medicinal plants being women and children.

The way to achieve the first 6 SDGs would be involving these indigenous people and involving the in sustained, inclusive and sustainable economic growth hence addressing SDGs 8 & 9. The poor countries are rich in natural resources while developed world has technology, if SDG 10 is considered "Reduce inequality within and among countries", we can achieve the goals. That is the only way to achieve the targets of SDGs 13 to 16 and possible through international partnership (SDG 17).

The real issue is: how does science cater to the poor? Misidentifications or adulteration of materials lead to reduced effectiveness of herbal products or accidental poisonings. Current research in the lab is focused on molecular barcoding of medicinal plants, therapeutic applications of medicinal plants, and bio-synthesis of nanoparticles.

# Plant Sciences: A tool to achieve targets of SDGs



Zabta K. Shinwari T.I., S.I.; UNESCO Laureate

Distinguish National Prof./Prof. Emeritus, Quaid-i-Azam University, Islamabad-Pakistan.

Fellow, TWAS; Pakistan Academy of Sciences & Vice President Islamic World Academy of Sciences Immediate Former V Chair UNESCO-World Commission for Ethics in Sci. Know & Technology





### These goals focuses on ending poverty, protecting the planet, and ensuring prosperity for all (United Nations, 2015).

The sustainable development goals.

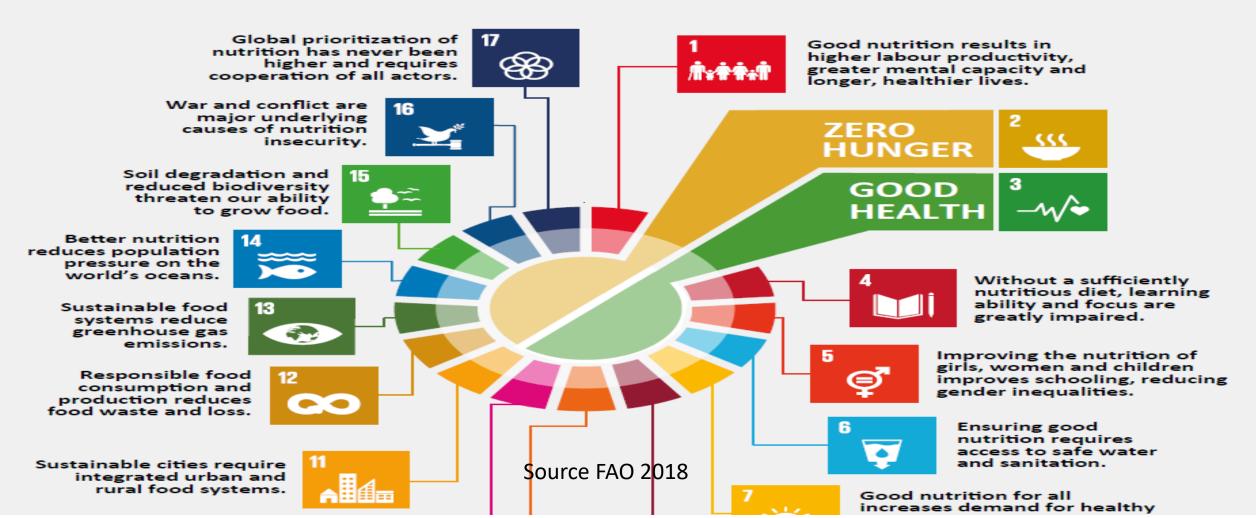
- 1 End poverty in all its forms everywhere
- 2 End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
- 3 Ensure healthy lives and promote well-being for all at all ages
- 4 Ensure inclusive and equitable quality education and promote life-long learning opportunities for all
- 5 Achieve gender equality and empower all women and girls
- 6 Ensure availability and sustainable management of water and sanitation for all
- 7 Ensure access to affordable, reliable, sustainable, and modern energy for all
- 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- 10 Reduce inequality within and among countries
- 11 Make cities and human settlements inclusive, safe, resilient and sustainable
- 12 Ensure sustainable consumption and production patterns
- 13 Take urgent action to combat climate change and its impacts (in line with the United Nations Framework Convention on Climate Change)
- 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development Goals listed in bold relate to sustainable development through Natural Resource Management Tourism Management Perspectives 30 (2019) 33–42

SDG 2

• End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

# 2 ZERO HUNGER

### NUTRITI©N AND THE SDOCENTRAL TO THE 2030 AGENDA



### Mass Poverty and Inequality

- Phenomenal Growth per capita in 300 years
- Yet, every second 4 people die because of starvation or related diseases
- 1% of world population has 50% of world wealth
- The top 26 billionaires own \$1.4 trillion as much as 3.8 billion other people
- The world's billionaires are growing \$2.5 billion richer every day, while the poorest half of the global population is seeing its net worth dwindle. Billionaires, who now number a record 2,208, have more wealth than ever before.





# Plant Sciences may help in reducing Mass Poverty and Inequality

- 1.Improving agricultural productivity: Pest control, Increase agricultural yields, improve food security, and provide farmers with greater incomes.
- 2.Enhancing nutrition:
- 3. Creating employment opportunities:
- 4.Developing sustainable and climate-resilient agriculture: Reduce the vulnerability of farmers to the impacts of climate change and contribute to poverty reduction by improving food security and increasing the resilience of agricultural livelihoods.
- 5. Preserving biodiversity:

Overall, plant sciences can play a vital role in reducing mass poverty and inequality by improving agricultural productivity, enhancing nutrition, creating employment opportunities, developing sustainable agriculture systems, and preserving biodiversity.

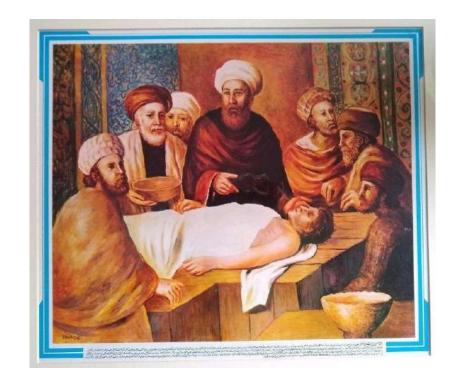
### WHY HERBAL MEDICINE

- It is being used by about 80% of the world population primarily in the developing countries for primary health care.
- LESSER SIDE EFFECTS.
- Ancient literature also mentions herbal medicines for age-related diseases namely <u>Memory Loss</u>, <u>Osteoporosis</u>, <u>Diabetic Wounds</u>, <u>Immune And Liver</u> <u>Disorders</u>, etc. for which no modern medicine or <u>only</u> palliative therapy is available.



### Herbal Medicine then and now??

 "Most illnesses, even those which lead the sufferer to the specialist, arise solely from long-continued errors of diet and regime." Ibn Sina (also known as Avicenna) 'Prince of Physicians' 980-1037 CE



### Global Burden of Disease report

- Poor diet linked to one in five deaths
- Obesity (Which is preventable) will be an economic & social burden to the world in future & by the year 2040
- The obese population within past 40 years has tripled worldwide.
- Diabetes rose from the 17th to the 9th leading cause of death in low-middle income countries.
- HUMAN DIET CAUSING 'CATASTROPHIC' DAMAGE TO PLANET
- five kilos of grain to produce a kilo of meat, about 30 percent will wind up in the garbage bin.
  - Changing people's behavior and circumstances is proving more difficult than fighting infectious disease.
  - "triad of troubles" obesity, conflict, and mental illness.

Pills and

Surgery

Lifestyle

Change

# Extinction of Indigenous languages leads to loss of exclusive knowledge about medicinal plants

- 3,597 vegetal species with 12,495 medicinal uses and linked this data with 1361 Indigenous languages from three biologically and culturally diverse regions—the northwestern Amazon, New Guinea and North America. In a regional study on the Amazon, New Guinea and North America, researchers concluded that 75% of medicinal plant uses are known in only one language.
- The study evaluated 645 plant species in the northwestern Amazon and their medicinal uses, according to the oral tradition of 37 languages. It found that 91% of this knowledge exists in a single language, and that the extinction of that language implies the loss of the medicinal knowledge as well.
- "Every time a language disappears, a speaking voice also disappears, a way to make sense of reality disappears, a way to interact with nature disappears, a way to describe and name animals and plants disappears,"
- The project <u>Ethnologue</u> concluded that 42% of the world's more than 7,000 existing languages are endangered. Of the 1,000 Indigenous languages spoken in Brazil prior to the arrival of the Portuguese in 1500, only about 160 are still align.

### The Future Of Nutraceuticals Market In Pakistan?



Present worth is \$1.2 billion.

- However, the industry is expanding rapidly.
- Estimated worth \$3 billion, by the end of 2020 with CAGR 20%

I would rather have a short life with width rather than a narrow one with length.

### Why use Nutraceuticals?

Life few decades back and today....

Avicenna Living long Dying Short

EARLIER





### **Exploring Traditional Medicine**

- Among the targets of SDG3 are access to safe, effective, quality and affordable essential medicines for all.
- In Africa, Asia, Latin America and the Middle East, for example, between 70 and 95 per cent of the population still use traditional medicine for their primary healthcare.
- Ayurveda in India, Unani in Pakistan, Traditional Chinese Medicine, and other systems, have been written down and codified for centuries, but other traditional practices emerge and evolve more organically and have fewer controls over their safety and practice, or guarantees of their effectiveness.
- The World Health Organization (WHO) had a traditional medicine strategy in place from 2002, since updated to a 2014-2023 strategy.
- Current WHO strategy aims to support WHO Member States in developing proactive policies and implementing action plans to strengthen the role traditional medicine plays in keeping people healthy.



#### From the other side

Examples of species being endangered because they are reputed (falsely) to possess medicinal properties.

#### BUSINESS

### Why Does a Rhino Horn Cost \$300,000? Because Vietnam Thinks It Cures Cancer and Hangovers

A rhino-head heist spree is sweeping the world and destroying rhino populations, mostly because of some ridiculous myths

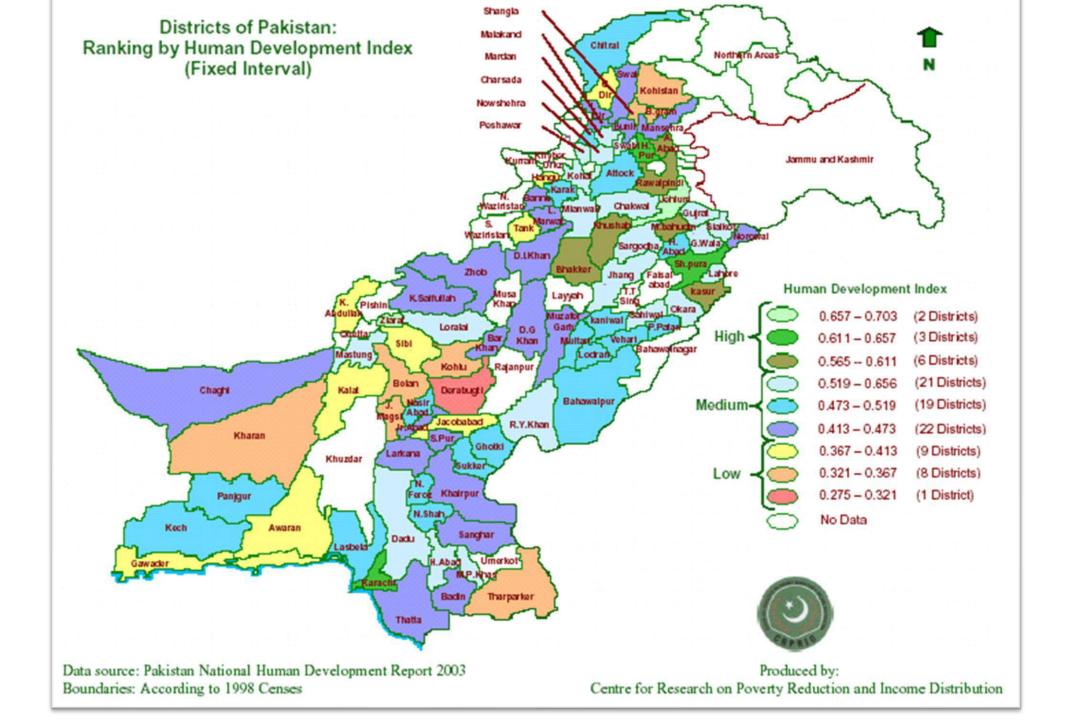
**GWYNN GUILFORD** MAY 15, 2013

Avoiding fooling ourselves

Risking finding that we were wrong



https://www.theatlantic.com/business/archive/2013/05/why-does-a-rhino-horn-cost-300-000-because-vietnam-thinks-it-cures-cancer-and-hangovers/275881/



### Poverty & Terrorism: Is there any link?

- There is strong anecdotal evidence but very little analytical work establishing the link between poverty and terrorism in Pakistan
- Concentration of extremists and religious fanatics against the most deprived districts in Pakistan, also rich in biodiversity



www.images.google.com





- SDG 4: Ensure inclusive and equitable quality education and promote life-long learning opportunities for all
- SDG 5: Achieve gender equality and empower all women and girls
- SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

#### The cost of terror

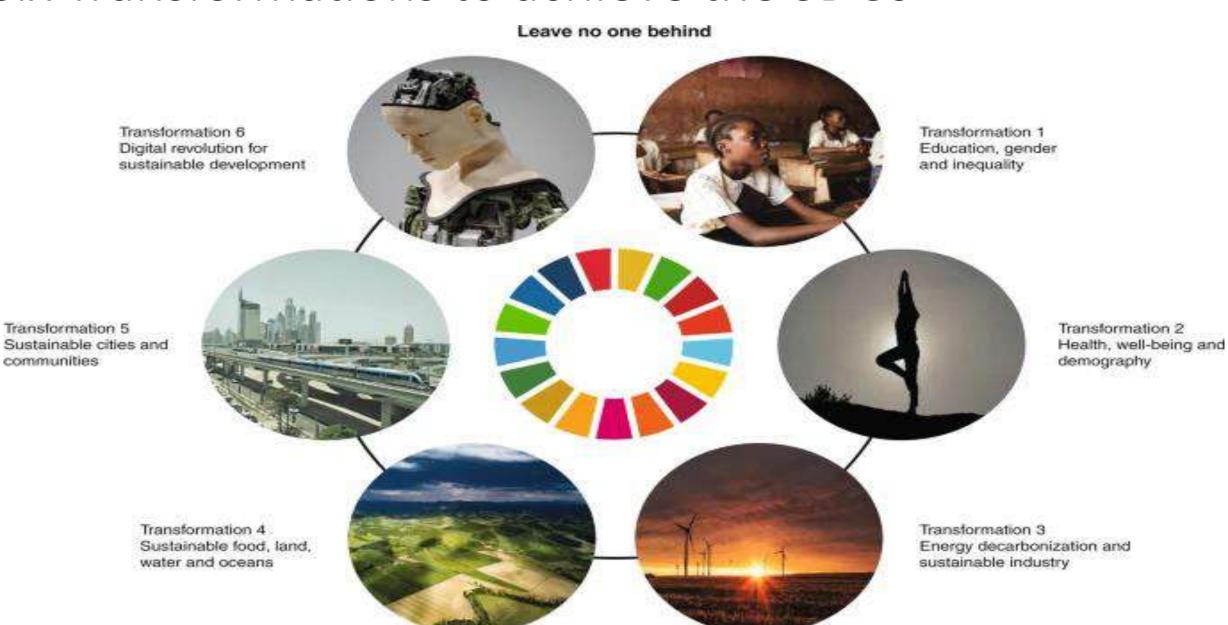
- The last category that is causing a decline in the world's health lies outside of the control of the individual; war, conflict or environmental factors.
- The largest increase in deaths from injuries was from:
- 1. conflict
- 2. Terrorism
- which have doubled over the past decade.
- Recent conflicts, such as those in Syria, Yemen, South Sudan and Libya, are major public health threats, both in regard to casualties and because they lead to long-term physical and mental health consequences.



https://www.weforum.org/agenda/2017/10/the-world-s-biggest-killers-diseases-linked-to-human-behavi

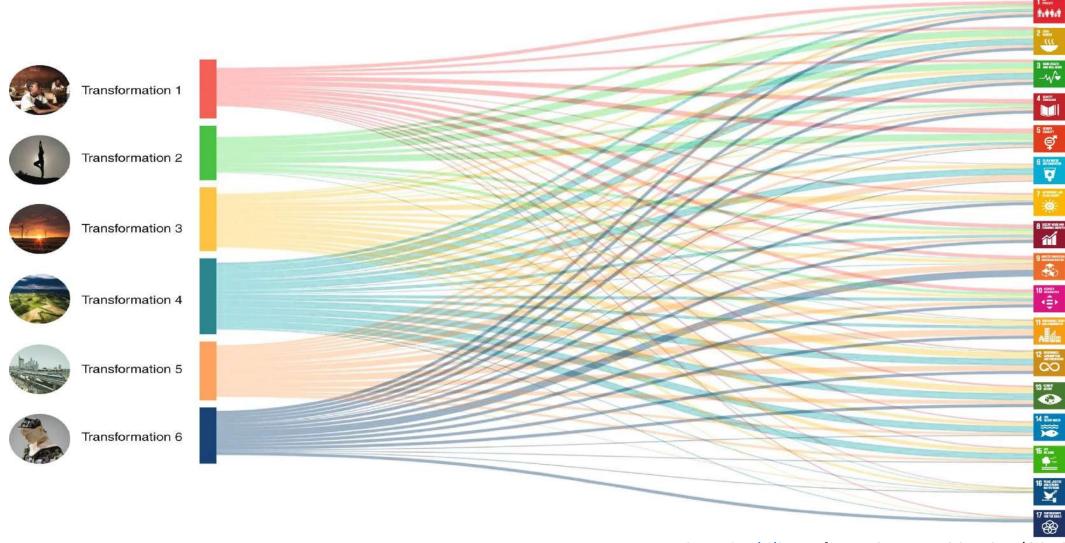
- 10 Reduce inequality within and among countries
- 11 Make cities and human settlements inclusive, safe, resilient and sustainable
- 12 Ensure sustainable consumption and production patterns
- 13 Take urgent action to combat climate change and its impacts (in line with the United Nations Framework Convention on Climate Change and Pakistan
  - Rice yield would reduce by 16.2% in 2050 under medium pace of climate change
  - There will be 13% yield reduction of wheat crop due to changing climate
  - There would be increase of 2.8°C in day and 2.2°C in night temperature in Punjab for mid-century (2040-2069).
  - Increase in CO<sub>2</sub> concentration is expected from 390 to 571 ppm
  - Glacier reservoirs will retreat in 50 years and will become empty, resulting in decrease of flows up to 30% to 40% over the subsequent 50 years (World Bank, 2006).
     (AgMIP-Pakistan; Ahmad et al., 2015)

### Six Transformations to achieve the SDGs



*Nature Sustainability* **2**: 805–814(2019)

### Six Transformations to achieve the SDGs



#### **Quality Education**



Health



**Gender Equality** 







**No Poverty** 



**Economic Growth** 



# Sustainable Health and Well Being one Health

SDG Goals 1-3, 5, 9, 14

- Human population is not only increasing in number but also moving into areas which were the preserve of animals causing disruption of habitat, deforestation.
- Animals serve as early warning signals and spread:
  - 6 of 10 infectious diseases (rabies, salmonella) and 3 of 4 emerging new infections (avian flu) in man
- One health refers to more than zoonotic diseases and includes environmental factors such as climate and land use changes
  - It is multidisciplinary, involves physicians, veterinarians, environmentalists, behavior scientists etc.
  - Its reach is beyond borders and impinges on global health security

### Major problems with TM

- Uncritical Enthusiasm
- Uninformed skepticism (Biased)
- Commercial Interest of Major comp.
- Incorrect diagnoses
- Improper dosage
- Low hygienic
- Secrecy of Formula (IPR & Patent)
- Clinical Trials data
- Limited Scientific Data available
- Mistrust & Perception of People
- Marketing
- Scientific Evidence (Toxicology eval. Standardization, Efficacy & Safety, Value addition, New Products of Phytochemical & Pharmacological)

Studies in the UK have found that there has been adulteration with steroids of some traditional dermatological preparations. In an analysis of herbal creams prescribed for dermatological conditions, Keane *et al.4* (1999) found that eight of eleven creams analysed contained steroids.



### THE ORIGIN OF PAKISTAN'S PHYSICAL DIVERSITY



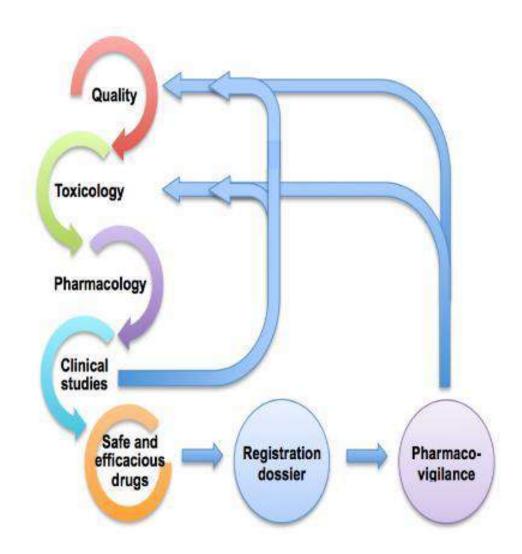


### Key requirements for regulation

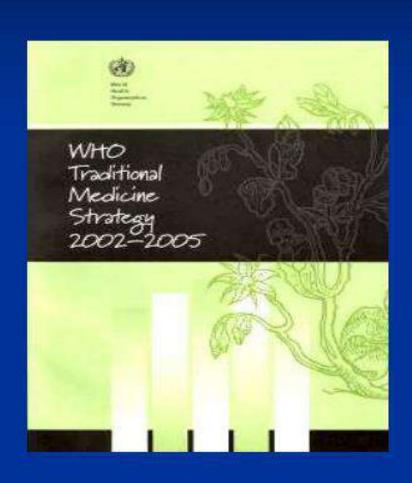
- Safety?
- Efficacy? (science based evidence)
- Quality?
- History of use?
- Claims?
- Trials?

#### **Required Legislation:**

Full marketing authorization (efficacy, clinical trials) to NCT Fraudulent Acts for Unlicensed manufactured tibb medicines Statuary assurance



# WHO Traditional Medicine Strategy 2002-2005



- Policy: integrate TM/CAM with national health care systems
- Safety, efficacy and quality: provide evaluation, guidance and support for effective regulation
- Access: ensure availability and affordability of TM/CAM, including essential herbal medicines
- Rational use: promote therapeutically-sound use of TM/CAM by providers and consumers



### Amphibian species

- Nearly one third of the approximately 6,000 known amphibian species are threatened with extinction.
- Promising Treatment for Peptic Ulcers Lost (Brooding frog (Rheobatrachus)
- Alkaloids made by species like the Ecuadorian Poison Frog, which could be the source of a new and novel generation of pain-killers.
- Antibacterial compounds produced in the skin of frogs and toads such as the African Clawed Frog and South and Central American leaf frogs.
- One compound, known as ziconotide, is thought to be 1000 times more potent than morphine and has been shown in clinical trials to provide significant pain relief for advanced cancer and AIDS patients. Another cone snail compound has been shown in animal models to protect brain cells from death during times of inadequate blood flow.



Marine snail

# Lab studies suggest medicinal plants can help repair human bone and tissue



- biomedical engineering techniques that can restore lost tissue and bone.
- <u>tissue engineering and regenerative medicine</u>. to reactivate biological processes to form products that can help with bone regeneration and tissue loss caused by trauma.
- two plants commonly used by South African traditional healers and herbalists to treat bone fractures and ease pain caused by osteoarthritis. compounds drawn from these medicinal plants could offer a valuable way to support bone regeneration and tissue loss in people who've suffered trauma.
- Tissue engineering and regenerative medicine is based on three key requirements working together: signals from body tissues and organs, responding stem cells, and scaffolds.
- <u>Scaffolds</u> are materials that work with biological systems to evaluate, treat, augment or replace any of the body's tissues or functions such as mature bone stem cells, cartilage, skin cells, and brain cells and neurons.
- next step is to carry out our work on animal models. The value of biomedical scaffolding is predicted to reach \$1.5 billion by 2024.

#### **Endophytic Microbes**

#### "Microbes that live within plants without causing them disease"

- Live in a symbiotic realtionship with their host
- Provide phytohormones, acquisition of nutrients and inhibit phytopathogens and pests in return for food and shelter
- Both fungi and Bacteria

## • Fagonia cretica (Family Zygophyllaceae)



## Applications of Endophytes

#### **Industrial & Medical**

- Antibiotics (Cryptocin, Ecomycins, Ambuic acid)
- Antiviral (Cytonic acids A and B)
- Anticancer (Paclitaxel)
- Immunosuppressant (Subglutinol A and B, Cyclosporine)
- Antioxidants (Pestacin, Isopestacin)
- Anti-diabetic agent (L-783,281)
- Biofuels

#### Plant Health & Protection

- Antimicrobial compound production
- Induced Systemic Resistance (ISR)
- Bio-insectisides (Nodulisporic acids)

#### **Bioremediation**

- Phenols
- Chloro-phenols
- MTBE
- TCE
- 2,4-D
- TNT
- BTEX

#### Plant Yield & Growth promotion

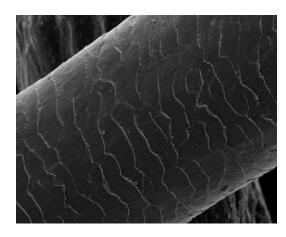
- Growth Hormones (IAA)
- Nitrogen fixation
- P solubilition
- Nutrient availability
- Phyto-stimulation

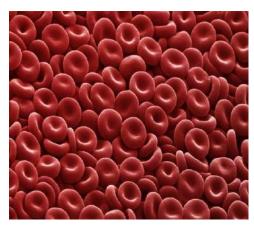
## "Being Small is Excellent, Being Nano is exciting"

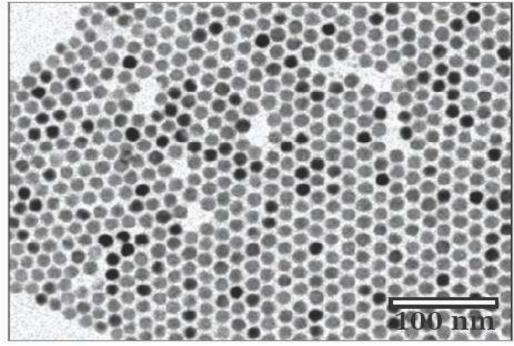
- "Nano" is Greek for "dwarf"
- Nanotechnology can be a key driving force for the accomplishment of SDGs
- Nanotechnology is applied in diverse applications.
- Apprehension at nanoscale with at least one dimension ranging from 1 to 100 nm in size
- Shape and size of the nanoparticles below 100 nm has a profound impact on their chemical, physical and biological properties
- These properties can be tuned through providing different conditions

## Understanding Nano

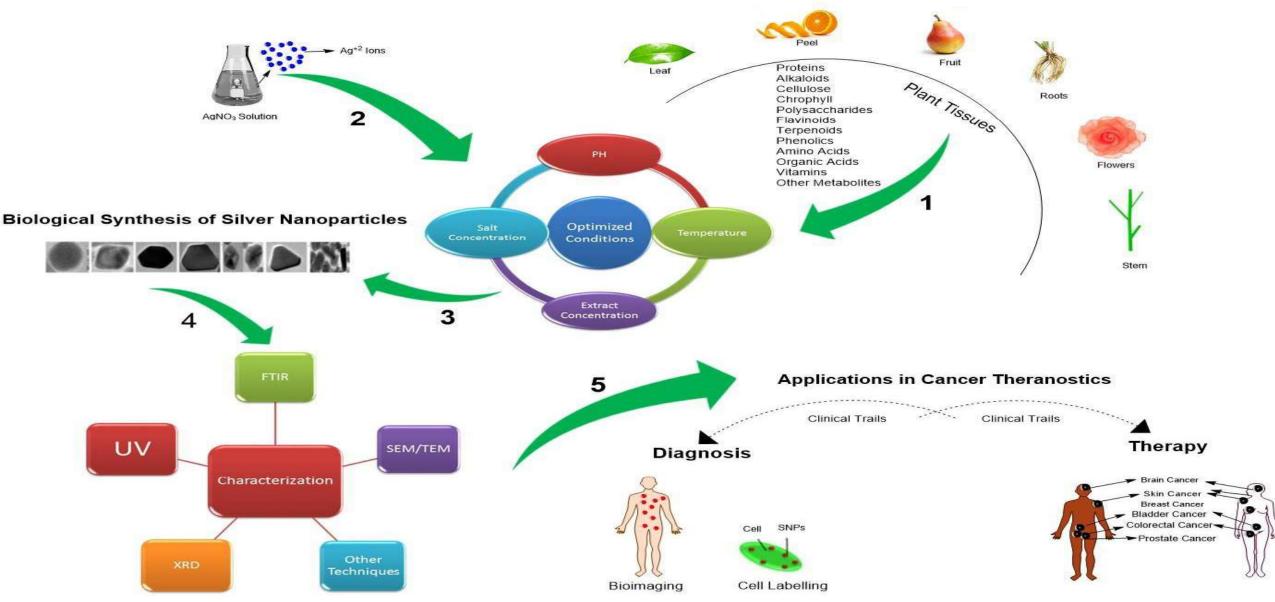
- A human hair is about 100, 000 nm in diameter
- A red blood cell 8000 nm
- Bacteria are approximately 1000 nm
- A virus particles is around 100 nm
- A hemoglobin molecule is around 5 nm
- Nanoparticles (1-100 nm).







### Phytonanotechnology: A novel approach



Ovais M et al., "Green synthesis of silver nanoparticles via plant extracts: beginning a new era in cancer theranostics." Nanomedicine, 2016, 12(23): 3157-3177.

## Applications (already performed)

#### Medicinal

- Antibacterial
- Antifungal
- Antioxidant
- Enzyme inhibition
- Anticancer
- Antileishmanial
- Antiviral
- Compatibility
- Alzheimer Disease
- Nanoscosmaceutical cream (Patent)

#### Energy

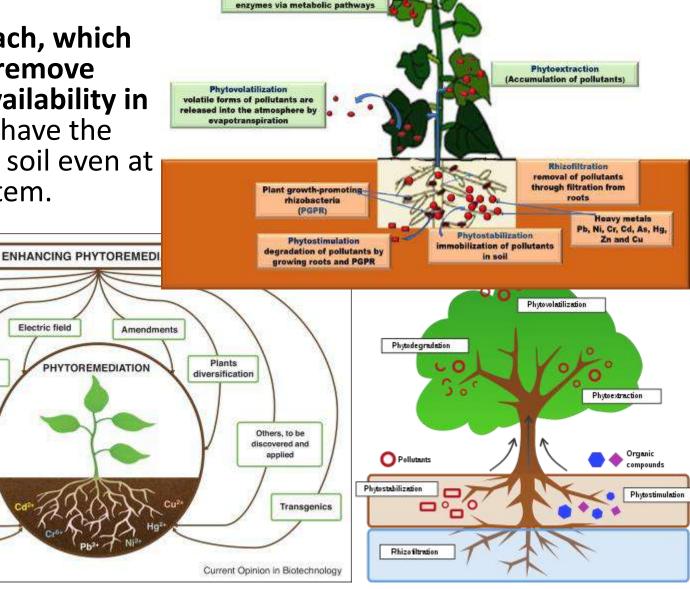
- Super capacitors
- Metal oxide based electrode material (Patent)

- Environmental
  - Dye degradation

Electric field

## A natural cleaning process

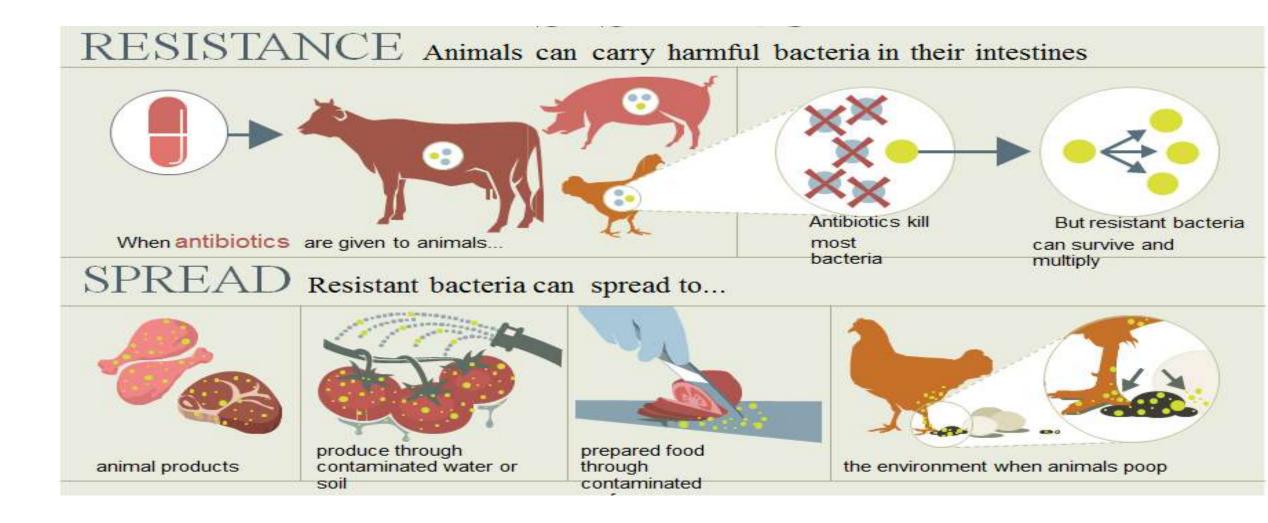
• Phytoremediation is a plant-based approach, which involves the use of plants to extract and remove elemental pollutants or lower their bioavailability in soil (Berti and Cunningham, 2000). Plants have the abilities to absorb ionic compounds in the soil even at low concentrations through their root system.



**Phytodegradation** transformation of organic pollutants and polycyclic aromatic hydrocarbon to innocuous forms by metabolic

## **Antibiotic Resistance**

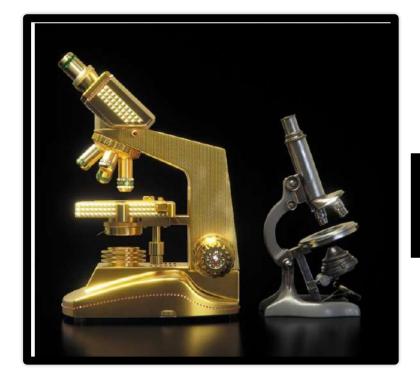
https://www.cdc.gov/onehealth



# WDF and IDF launch effort to improve diabetes care for displaced people | World diabetes foundation.



An unprecedented 66 million people worldwide have been forced from their homes - the highest levels of displacement on record, according to (UNHCR)



A special issue explores the study of inequality, and how socio-economic divides affect the science workforce

## Science and inequality

- In every society some citizens find their talents being sacrificed to poverty, prejudice, poor schooling and lack of opportunity.
- On the subject of inequality, it seems, science still has a lot of work to do

# Poverty forces Afghan families to sell their kidneys, children

- Afghan families struggle to survive amid looming economic and humanitarian crisis.
- Extreme poverty forces families to make life-altering decisions like selling kidneys.
- Father sells daughters for the sake of meeting basic needs.



## Financial crisis forcing Afghans to sell their kidneys to feed families

- Jobless, debt ridden, and struggling to feed his children, Nooruddin felt he had no choice but to sell a kidney one of a growing number of Afghans willing to sacrifice an organ to save their families.
- The practice has become so widespread in the western city of Herat that a nearby settlement is bleakly nicknamed "one kidney village".
- A kidney for \$1,500
- It is illegal to sell or buy organs in most developed nations, where donors are usually related to the recipient or are people acting out of altruism.
- In Afghanistan, however, the practice is unregulated.
- "There is no law... to control how the organs can be donated or sold, but the consent of the donor is necessary,"
- "I sold my kidney for 250,000 Afghanis (around \$2,500),"
- In developed nations, donors and recipients usually go on to lead full and normal lives, but their after-surgery health is usually closely monitored and also dependent on a balanced lifestyle and diet.

# Support at-risk, displaced and refugee scientists

Every two seconds, an individual is forcibly displaced from their home. Among them are countless scientists, engineers and others with advanced training, who may be displaced internally or forced into exile, unable to continue their vital research and teaching work and their contributions to science.

This a loss for the entire scientific community, as well as for society more widely.

"Science represents a shared asset for all humanity — one that may be directed at rebuilding and bettering communities, economies and the environment. Securing the fractured science communities of regions in turmoil is essential to healing and regrowth."

- 15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development

### International debate: Need for a Balance

- The vast majority of plant genetic resources and other forms of biodiversity are found in or originate from - developing countries
- Need to find a balance between:
  - Developed countries' needs to access biodiversity resources
  - Developing countries seek to ensure that access is regulated so as to ensure fair and equitable sharing of benefits, including through transfer of technology and finance
  - 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development

Why not Developing Countries Themselves Utilize These Resources ?

### We can choose

 Business as usual in a materialistic society ignoring the future



Retreating to a fortress world of old values

 Making a transition to sustainability with science and religion in harmony Step

"Only Health Spirit is Guarantee of Health".

## Old Civilization may resolve current issues: Leadership role in defining right from wrong

- With the old adage that with great power comes great responsibility, it's time for the data science community to take a leadership role in defining right from wrong.
- Much like the Hippocratic Oath defines Do No Harm for the medical profession, the data science community must have a set of principles to guide and hold each other accountable as data science professionals.
- To collectively understand the difference between helpful and harmful.
- To guide and push each other in putting responsible behaviors into practice.
- To help empower the masses rather than to disenfranchise them.
- Data is such an incredible lever arm for change
- We need to make sure that the change that is coming, is the one we all want to see.

7 AFFORDABLE AND CLEAN ENERGY



A field of rice could be used to generate electricity

Geo-engineering and plants

: the current speed at which the effects of global warming are starting to manifest themselves is giving a strong impetus to the development and implementation of climate engineering technologies, either to capture CO2 or to 'dim' the intensity of the sunlight. These technologies also bring many risks, and challenge our ethical frameworks. How to deal with the intrinsic value of 'nature' when nature becomes an engineering project? Whose moral rights should be respected: those of currently living human beings, or also those of future generations? Should we also attribute moral rights to nature: to oceans, rivers, ice caps? And how to deal with intercultural differences in ethical frameworks?



#### Plant Production Systems "Phactories"

#### 1. Industrial products

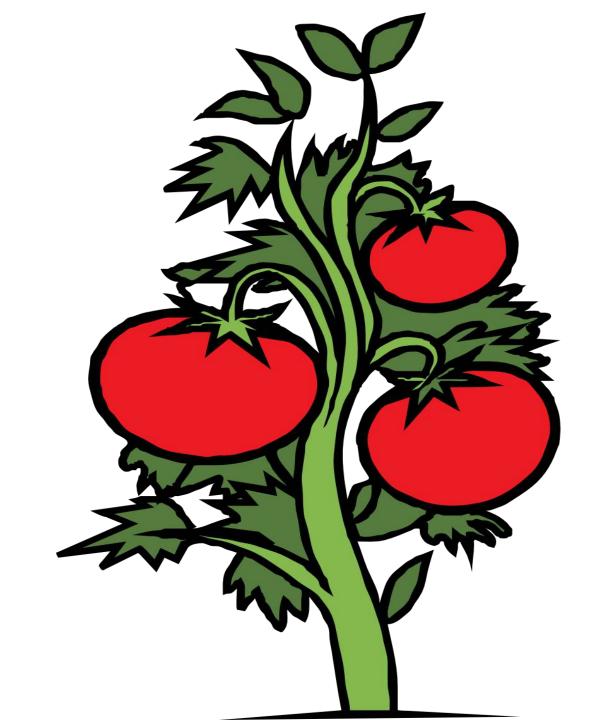
- Proteins
- Enzymes
- Modified starches
- Fats
- Oils
- Waxes
- Plastics

- Nutritionally enhanced crops
- Plant production systems "Phactories"

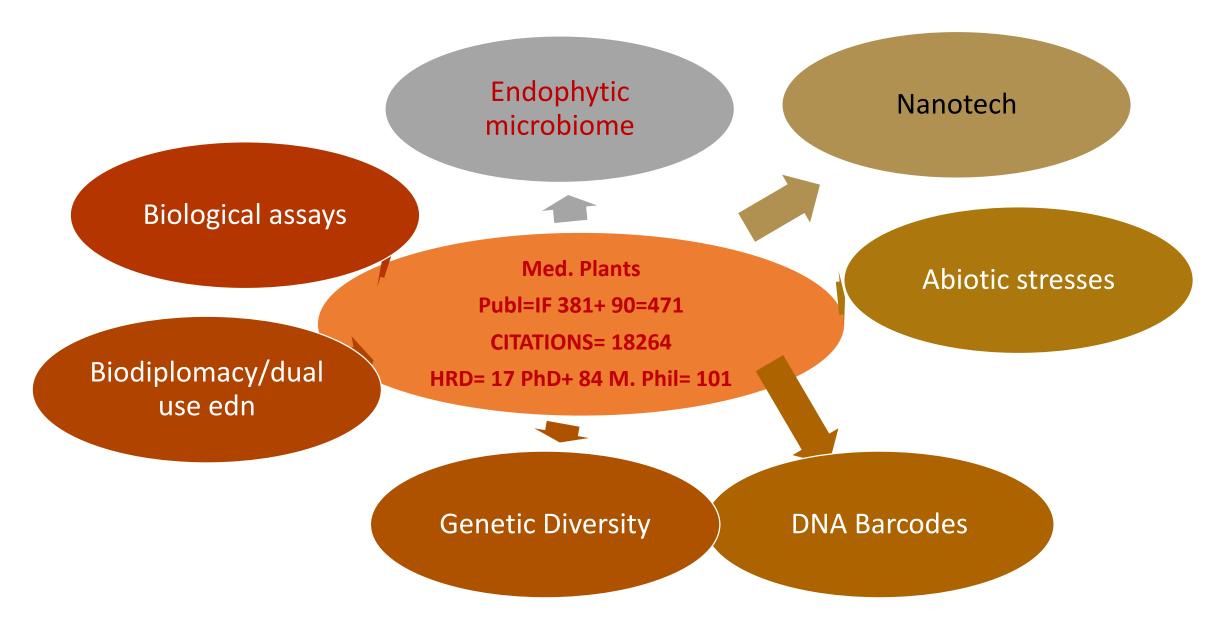
#### 2. Pharmaceuticals (Pharmcrops)

- Enzymes
- Antibodies (Plantibodies)
- Vaccines





## Summary of research work at MoSAEL labs



# Achieving targets of SDGs: Strengthening contributions from academia

- Existing bibliometrics that assess the quality of academic work are usually quantitative and self-referential, reducing the focus on real-world issues. The same measurements are often adopted by funding bodies, pressuring researchers to increase compliance, and further reducing integrity and real-world impact.
- Suggestions to assist greater adoption of the SDGs and targets as a measure of impact included: aligning governmental and institutional funding; changing key performance indicators; increasing cross-disciplinary work; aligning mission/vision statements; and legitimizing SDG-focused projects at conferences.
- The changing nature of academia as neoliberal policies are stripping away the autonomy of universities (Harris, 2005), requiring a pedagogy that challenges the social and political construction of knowledge, and implanting that in curricula. These embedded neoliberal ideologies lean towards a market-based system in which education becomes training for the global industry, rather than a public good enhancing society as a whole. In this system, scholars are no longer seen as the experts in the field, but rather as facilitators or trainers for preparing the next generation of employable workers (Jankowski & Provezis, 2014).



#### HEALTH AS AN ETHICAL ISSUE: LESSONS FROM THE COVID-19 PANDEMIC

#### LIAQUAT ALI

Honorary Chief Scientist & Advisor, Pothikrit Institute of Health Studies Former Vice-Chancellor, Bangladesh University of Health Sciences, Bangladesh

#### **ABSTRACT**



The COVID-19 Pandemic has created unprecedented health and economic challenge in the history of mankind. At the same time, human civilization is facing a great ethical crisis. The duty- vs right-based moral values led to justified dilemmas in the ethical decision-making process of the health care providers, specially physicians. The duty towards the patients affected by the highly contagious virus (often in the face of PPE shortages) on the one hand and the right (as individuals) of preservation of self and family members on the other hand, is difficult to be solved only by a legal framework. The rationing of life saving measures (like HFNC, ICU bed or Ventilator), in the context of acute shortages, is

another example where the Physicians and Managers need to make very difficult ethical choices. Revelation of the self-centered nature of individual human beings, families, social groups and even countries have been widely noticed during the pandemic and it may not be a surprising phenomenon. But, the crisis has brought into forefront the traditional debates on the relative merits of the utility-, duty- and right-based ethics in a wider social perspective. In particular, the illusory blessings of the globalized market economy and associated neoliberal ethical principles have been facing critical questions during the whole year. The rise of ultranationalism has been exposed with its vulgar faces all over the world. It is now obvious that the worst sufferers of the pandemic are poorer and marginalized people (forming the major bulk of the world population) who are now increasingly subject to rapidly increasing health and socioeconomic inequality and injustice due to the existing world order. Managing the pandemic through authoritarian approaches (lockdown, tracking etc) have also raised certain fundamental ethical issues related to human dignity, freedom and autonomy, and, in many cases, the pandemic has been used as a tool to justify certain ideological platforms. Ethics of biomedical and health related research (and their dissemination) are also facing some basic questions regarding the sacrifice of some age-old scientific and moral practices in the face of urgent need of the humanity. Critical discussion and working consensus on those ethical issues have now become urgent for future advancement of biomedical research.

# HEALTH AS AN ETHICAL ISSUE: LESSONS FROM THE COVID-19 PANDEMIC

#### **Prof (Dr) Liaquat Ali**

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24 IAS CONFERENCE KARACHI PAKISTAN 08 MARCH 2023

#### **COVID-19 PANDEMIC**

- Unprecedented health and economic challenge in the history of mankind
- > Human civilization facing a great ethical crisis
- Justified dilemmas in ethical decision making process of health care providers
- > Physicians as examples-
  - Duty- vs right-based moral values
  - Duty towards patients affected by the highly contagious virus (often in the face of PPE shortages)
  - Right (as individuals) of preservation of self and family members

#### **COVID-19: RATIONING OF LIFE-SAVING MEASURES**

- Example: HFNC, ICU bed or Ventilator in the context of acute shortages
- Physicians and Managers need to make very difficult ethical choices
- > Difficult to be solved only by a legal framework

#### REVIVAL OF TRADITIONAL DEBATE

- Revelation of the self-centered nature of individual human beings, families, social groups
- > Traditional debates on the relative merits of the utility-, duty- and right-based ethics in a wider social perspective
- Illusory blessings of the globalized market economy and associated neoliberal ethical principles facing critical questions
- > Rise of ultranationalism with its vulgar face
- Worst sufferers of the pandemic poorer and marginalized people, forming major bulk of world population
- > Rapidly increasing health and socioeconomic inequality and injustice due to existing world order

#### **APPROACHES IN MANAGING THE PANDEMIC**

- Liberal approaches relatively unsuccessful, but more compatible with ethical principles
- Populist approaches utter failure
- Authoritarian approaches relatively successful in the beginning, but raises fundamental ethical issues related to human dignity, freedom and autonomy
- Authoritarian/Popular approaches use of the pandemic as a tool to justify certain ideological platforms and dogmas
- Individual vs State dilemma

#### ETHICS OF HEALTH RESEARCH AND DISSEMINATION

- Facing some basic questions sacrificing some age-old scientific and moral practices in the face of urgent need of the humanity
- Examples- Hasty clinical trials, Challenge studies, Noncompliance to Helsinki Declaration
- ➤ Dissemination: Relative validation of non-peer reviewed publications – eg, Press briefings and Preprints

### **KEY VALUES IN PUBLIC HEALTH ETHICS**

Value	Other relevant values or concepts	
Health	Utility, wellbeing, benefits, harms, etc.	
Fairness	Equality, equity, distributive justice, procedural justice, etc.	
Freedom	Liberty, autonomy, human rights, respect for persons, etc.	

#### PRINCIPLES OF PUBLIC HEALTH ETHICS

Public Health Ethics Principle	Interpretation/Example	
Need for evidence	Evidence of likely benefits is needed to justify imposition of potentially burdensome public health interventions.	
Least restrictive alternative	Where two interventions are expected to be equally effective, the intervention that involves the least restrictions of liberty should be selected.	
Least harmful alternative	Where two interventions are expected to be equally effective, the intervention that involves the least harms should be selected.	
Proportionality	The burdens (and/or harms) involved in an intervention should be outweighed by public health benefits achieved.	
Equity	The intervention should be implemented (and burdens imposed) in an equitable, non-discrimintory manner.	
Reciprocity	Those who benefit from public health policies/interventions have a reciprocal duty to assist and/or compensate those on whom burdens are imposed.	
Due legal process	Appropriate legal procedures should be followed and individuals should have the right of appeal.	
Transparency	Policymaking should be transparent and democratic.	

Table 1. Role of Values in Decision Making during Public Health Emergencies.			
Point at Which Values Enter into Pandemic Decision Making	Explanation	Sample Policy Questions	
When explicitly invoking values	Equity, fairness, solidarity, trust, security, and transparency are all examples of values explicitly invoked by decision makers.  Values reflect judgments about what is important or of worth, which can form the basis for ethical action. Ethics involves the systematic study of the values that do, or ought to, underpin choices in pandemic response.	<ul> <li>What does equity require in the allocation of scarce vaccines?</li> <li>Does solidarity mean ensuring that people in low- and middle-income countries receive first and second vaccine doses before people in high-income countries receive booster doses?</li> <li>What does a commitment to transparency or inclusion mean for decision-making processes?</li> </ul>	
When establishing policy objectives	Because policy objectives reflect judgments about what is important or of worth, they are closely linked with values, even if that link is not always made explicit. Science alone cannot tell us which objectives are important or of worth; value judgments are required.	<ul> <li>In a vaccine rollout, should we aim to minimize deaths, protect frontline workers, or protect critical infrastructure (e.g., services essential to the health and well-being of the public)?</li> </ul>	
When navigating trade-offs	When two or more objectives come into conflict, values come into conflict. Decision makers must determine how much weight to give certain values and assess whether the promotion of one or more values should be traded off against the promotion of other values.	<ul> <li>Should we prioritize suppressing a pandemic virus even if doing so could harm the economy?</li> <li>Should we jeopardize in-person schooling for the sake of reducing community transmission of a pandemic virus?</li> </ul>	
When navigating uncertainty	When decisions must be made in the context of uncertainty, they may turn out to be wrong. Values inform the weight we attach to the consequences of these possible errors and our judgments about how much risk to accept.	<ul> <li>Should vaccinated persons be exempted from public health measures such as isolation and quarantine?</li> <li>Should the interval between vaccine doses be extended to ensure that more people receive first doses more quickly?</li> </ul>	

Table 2. Fundamental Values Affecting Allocation of Scarce Medical Resources.			
Value	Definition		
Maximizing benefits and preventing harms	Prioritization of a good or service should maximize benefits and minimize harms. Harms may be broad and include both health harms (e.g., morbidity and mortality) and non-health harms (e.g., poverty). They can also derive directly from the disease or indirectly, as health system functioning is compromised.		
Mitigating disadvantage	Special concern and prioritization should be given to people who are disadvantaged because of their income or because of discrimination based on their race, ethnicity, religion, or other factors.		
Reciprocity	Preferential allocation of medical resources should be given to people who, in the past, have mitigated harm for others and faced a disproportionate burden (e.g., research participants and food-processing workers).		
Instrumental value	Benefits should be provided and harms mitigated for people who can, in the future, mitigate harms and disadvantage for others. Instrumental value is not an independent value but facilitates realizing the other values, particularly maximizing benefits.		
Equal moral concern	People should be treated as moral equals, and discrimination on the basis of morally irrelevant characteristics such as race, ethnicity, or religion should be avoided. People in different circumstances (e.g., in communities with higher or lower burden of disease) can typically be treated differently given unique needs.		



Fig. 1 Natural experiment on the effectiveness of "hard and fast" lockdown. In mid-2021, the Australian states of Victoria (VIC) and New South Wales (NSW) faced similar outbreaks of a similar variant of covid19 at similar times. Victoria instituted an immediate hard lockdown and experienced a higher peak of cases of covid19, whereas New South Wales gradually instituted a range of measures over several weaks and a experienced a lower peak of cases. Data available at https://www.covid19data.com.au/compare-lockdowns [accessed 1 September 2022].

#### **AN ETHICAL CRISIS**

- ➤ Moral errors may explain why other failures can lead to situations of crisis. Three levels of analysis.
- ➤ Moral failings of individuals, manifested in inappropriate behaviors that can lead to a crisis.
- Organizational level: because the strategies and cultures of health facilities show the existence of ethical lapses at an organizational level.
- Social and theoretical ethics, whose failures have hampered corrective mechanisms or aggravated the moral consequences of individual or organizational decisions.
- Vices are always present in one way or another in all human activity. And a cause present irrespective of whether or not the effect occurs cannot be a satisfactory explanation.
- ➤ If many agents have been motivated by greed in many places and for centuries, why did the crisis occur now and in these countries, and not at other times and in other places?
- ➤ A society has long developed protective mechanisms, not against immoral behavior itself but against its consequences, ranging from law, courts and fines to the social rejection of offenders. It is possible that these social mechanisms have relaxed in recent years

#### OPERATIONALIZING ETHICAL APPROACHES IN HEALTH

- ➤ Policymakers should heed the les sons of the pandemic by appreciating the ethical, not just the technical, dimensions of all chal lenges faced during emergencies; by starting from existing knowl edge about the right values and principles to guide policy
- ➤ Ethical values cannot apply themselves or resolve conflicts among themselves. Positioning ethics to meaningfully inform decisions requires changing the policymaking proces.
- > Ethics must be considered at the start of any response to a health emergency
- ➤ Government policies should be expected to be not just evidence-informed but also explicitly ethics-informed
- ➤ During an emergency, policymakers call on epidemiologists and others to bring their expertise and experience to policy formulation; they should also call on ethicists to inform a coherent ethical response
- ➤ How can this approach be operationalized? First, like epidemiology and vaccine development, ethics cannot simply be switched on during an emergency
- ➤ Institutional capacity and memory cannot be built or restored ad hoc
- The agencies responsible for responding to public health emergencies need to have trained ethicists on staff, regularly participating in scenario planning and advising

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### CONCLUSION

Critical discussion and working consensus on ethical issues have now become urgent for future advancement of healthcare and biomedical research. Organizations like IAS and COMSTECH may play a role in creating such consensus

# Thank You

#### **BIODIVERSITY ECONOMICS**

#### ABDULLAH AL MUSA

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#### **ABSTRACT**



The biodiversity economics consider the biosphere (Natural Capital) as a self regenerative asset or stock with humans being part of it. Since the biosphere is inherently bounded, the global output of goods and Services are inevitably bounded. The standard economics, however, use the biosphere as an arena to accumulate produced capital and human Capital as indicated by GDP and HDI while ignoring the natural capital. The notion of Sustained growth and development in global Output, speculated by the development economists and promoted by the world bank, is thought to be possible when investing in future science and technology coupled with the application of proper institutions.

While natural capital is similar to produced capital in being consumed and depreciated, its regenerative capacity may slow down or cease to exist abruptly at a

tipping point without warning as a result of continuous cumulative sight disturbances. This is ascribed to the fact that the biosphere renders its goods and Services through myriad of healthy and functional ecosystems. The ecosystems could occur in different stability regimes where biodiversity acts as enabling asset and exerts non-linear impact on its productivity and resilience. The temptation to overuse or undervalue natural capital stems from the intrinsic characteristics of nature being silent, invisible and mobile. Often, it's goods and Services are free at the source and are not subjected to property rights. This is aggravated by governmental subsidies and institutional failure.

The pervasive human activities to improve the standard of living give rise to externalities that transcend space and generations. Currently, we experience the rise of global temperature, Climate Change, sea water rise and acidification, frequent environmental extreme events, biodiversity loss and shift in 9 of biosphere biophysical processes known as planetary boundaries, with the biodiversity loss and nitrogen biochemical flows had already crossed their boundaries.

The biodiversity economics calls for proper management of the whole capital portfolio (produced, human and natural) taking into account that most of natural capital goods and services come free or low cost, so they don't appear scarce to a private entity or person.

The government subsidies and institutional imperfections create a gap between market price of the goods and services rendered by the biosphere and their social worth as reflected by their accounting price. This translates into disparity between private incentives in accumulating profits regardless of the externalities and the social aspiration for well-being. In essence, the biodiversity economics advocates the concept of inclusive wealth which essentially reflects the social worth of an economy's portfolio value of capital goods as reflected by the quality of life or the well-being but not mere accumulation of produced capital (through raising GDP).

This concept Calls for the portfolio manager (the government) to compare the assets in his portfolio employing the rate of return to account for the depreciation of the capital. In this sense, he is expected not to choose an asset with a lower rate of return. To exercise prudent management of his portfolio he has to evaluate the set of choices and remain neutral among various forms of capital goods. Accounting prices but not the market prices should be employed for fair valuation of assets' yield (rate of return).

In this regard Field et al (1988) estimated the planetary net primary production at the end of the 20th century to be 105 trillion Kg/year. The global stock of biomass was estimated by Bar-on et al (2018) to be 550 trillion

kg/year. Thus, the biosphere average yield on the Stock (105/550) per year equals 19% a year. This figure deviated from the long-run global yield on Prudent management of produced capital which was calculated by Jorda *et al* (2019) to be 5%. The difference is 14%. Knowing that the demand for natural capital does not necessarily equal the regenerative rate of the biosphere. The difference is accommodated by exhausting or consuming the stock. It follows that we are actually overusing our natural resources by 14%. This Condition creates Impact Inequality which is driven by excessive demand on the biosphere. It is proportional to the everincreasing world population (N) and our consumption pattern or standard of living (Y) as proxied by GDP and inversely proportional to the technology and institution with which the goods and services are converted into GDP and the extent to which the biosphere is transformed by global waste ( $\infty$ ). When such demand exceeds the regenerative rate of the biosphere (G), Impact Inequality is substantiated. The above relationship is reflected in the formula NY/ $\infty$ >G.

For sustainable development in the context of considering the current and future human societies' well-being, we are to strive to achieve Impact Equality where by our demand on the biosphere goods and services are to be within the limit of its regenerative capacity  $(NY/\alpha = G)$ .

The Global Ecological Footprint is a ratio between our demand and the regenerative capacity of the biosphere  $(\frac{Ny}{\alpha}/G)$ ; its current value is 1.7 meaning that we need extra 0.7 earth to satisfy our current consumption sustainably. The above argument raised a legitimate question of whether the UN SDGs could be fulfilled by 2030 under business as usual practices. In other words, can the average annual increase in the rate of technology as suggested by the development economists neutralize the externalities of our excessive demand on the biosphere? To examine this Dasgupta calculated the current global rate of annual increase of technology and what it should be if to achieve sustainably by 2030 by applying this formula using data generated by different authors regarding the global average rate of increase in GDP (proxy of consumption) and the global average rate of change in the biosphere regeneration.

$$g(\frac{Ny}{\propto}/G) = g(Ny) - g(\propto) - g(G)$$

Where g(x) is the rate of change of any variable.

He found that the current global average rate of annual increase in technology ( $\propto$ ) is 3.5% whereas he calculated the needed value for ( $\propto$ ) to be 10% to achieve sustainable growth which necessitates that we reduce our Global Ecological Footprint from 1.7 to 1.0; a condition at which the demand (Ny/ $\propto$ ) will be equal to the Supply (G).

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#### المجلس الأعلى للعلوم والتكنولوجيا The Higher Council for Science & Technology (H.C.S.T.)

# **Biodiversity Economics**

- 1. Biodiversity Economics vs. Standard Economics.
- 2- Characteristics of Natural Capital and its goods and services mechanism of delivery:

Ecosystem

**Biodiversity** 

3- Econometrics of Natural Capital:

Demand

Supply

**Impact Inequality** 

**Impact Equality** 

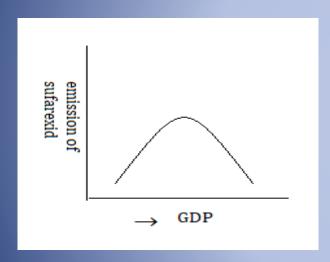
**Ecological foot print** 

- 4- Inclusive wealth and Portfolio Management.
- 5- Are UN SDG<sub>s</sub> achievable by 2030? (quantitative analysis)

The biodiversity economics consider the biosphere (Natural Capital) as a self regenerative asset or stock with humans being part of it. Since the biosphere is inherently bounded, the global output of goods and Services are inevitably bounded.

The standard economics, however, use the biosphere as an arena to accumulate produced capital and human Capital as indicated by GDP and HDI while ignoring the natural capital.

The limited view of the place of nature in economy can be traced to the World Bank (1992), which propagated the Kuznets Curve which illustrated that the emission of Sulfur oxides is related to GDP/capita in the form of inverse U. Emission of sulfur oxides is not representative of environmental harm.



Consider: 1. destroying mangrove forest in favor of shrimp farms.

Loss of goods and services of water sheds for downstream farmer in forest being destroyed for logging.

The development economists thought that because there is no obvious limit on human ingenuity; technological progress and institutional improvement can enable the global output (GDP) of final goods and services to grow indefinitely.

This has been illustrated in 15 X increase in global GDP over the past 70 years. But this has been translated into ecological footprint that exceeds the biosphere's ability to deliver its goods and services on a sustainable base.

The development economists speculated that the global population and the global output /capita (GDP/capita) or both could increase with extra demand on the biosphere if we are able to increase the rate of science invention and technology innovation coupled with proper policies and institutions correspondingly. This notion, advocates the idea of indefinite economic growth, which is encountered in the literature on economy of Climate Change.

Examples: decarbonizing the economy, raising the supply of biosphere  $(G_{(s)})$  through technology and institution to bridge the gap in the inequality equation.

However the biodiversity economics considered humanity as embedded in the biosphere. It says that the global population and the global output can't be increased indefinitely. It is instead bounded. It involves a dynamic resource allocation problem. The demand we make on the biosphere doesn't have to equal the biosphere's ability to supply goods and services, because the difference is naturally accommodated by a change in the biosphere's stock.

A nation could choose to draw on the biosphere and use the goods and Services it supplies so as to accumulate produced and human capitals. This is the core of economic development and Standard economics.

The Biodiversity Economics calls for proper management of the whole capital portfolio taking into account that most of natural capital goods and services come free or cheap. So they don't appear scarce to private entity or person. This even get worse by government subsidies. Such institutional imperfections create a gap between the prices (market price) of goods and services and their social Worth (accounting price). These in turn create disparity between private incentives and public aspiration.

The economic value of the biosphere In an attempt to persuade the skeptics, the global flow of goods and services was estimated towards the end of the 20<sup>th</sup> century worth us \$ 16-56 trillion annually with an average figure of US \$ 33 trillion. This figure is larger than global national product in mid-1990 which is estimated at the time to be US \$ 18 trillion annually.

Characteristics of Natural Capital and its goods services mechanism of delivery:

- 1- Natural capital is similar to produced capital, in being consumed and depreciated but it is durable (regenerative). However their regenerative capacity may slow down or cease abruptly at a tipping point without warning as a result of continuous cumulative slight disturbances.
- 2- Natural capital as a stock is accounted for by biodiversity economics as a social scarcity value that contributes to wealth along with produced capital and human capital.
- 3- Most of natural capital is free at the source and undervalued and open to all rendering it vulnerable to degradation due to over use or misuse.
  - Institutional failure, the characteristics of natural capital being mobile, silent and invisible or being subjected to inadequately enforced or weakly defined property rights contributed to this end.
- 4- Production and consumption possibilities involving biosphere are characterized by non-linearity; a characteristic that is at odds with the requirement of a well-functioning market system.

The biosphere's regeneration is carried out through the ecosystems processes and functions and these constitute the key to sustainability. Biodiversity decline disrupts these processes such as these governing the climate system. Thus the economics of biodiversity is the economics of the biosphere which combine abiotic environment and the self-organizing, regenerative functional biotic forms that control the flow of energy, nutrients and organic matter.

- A)Ecosystems are thus constitute a capital goods. like produced capital, they depreciate if they are misused or overused but they differ from the produced capital in three ways:
  - 1. Depreciation in many cases is irreversible or at best can take tedious work and long time to recover.
  - 2. It is not possible to replicate a depleted or degraded ecosystem.
  - 3. Ecosystems can collapse abruptly without much prior warning.
- B) Ecosystem regenerates via function and processes, that are non-linear and are mediated by biodiversity which:
  - 1- Connect biotic and nonbiotic components of ecosystem by nutrient cycles and energy flow.
  - 2- Form the basis for ecosystem's productivity and resilience as an important feature that contribute to ecosystem integrity.

Biodiversity reduces uncertainty under stress condition akin to diversity function in financial portfolio:

- 1. Variation among diverse species and within species will increase the capacity of the ecosystem resilience to shocks. Some Species have obscure presence, but become prominent once the dominant species became weak due to disturbance. (Otters, urchins, kelp and fish).
  - It plays a complementary role in the ecosystem productivity through various functional groups and traits through mutual dependence among species. Examples Lipid-rich fruits are adapted for animal dispersal. which mean that the demise of the birds-eating fruits can have adverse consequences for forest regeneration.
- 2. It is analogous to complementarities among inputs in industrial production, if one component is lacking, the whole process will come to halt.
- Biodiversity affects the productivity of natural capital like skills, health and education affect the human capital and the infrastructure affects the produced capital "It is an enabling asset".

From the Anthropocentric point of view biodiversity exerts non-linear Impact on the ecosystem's productivity where it declines at accelerated rate as biodiversity loss increases. In addition, loss of biodiversity across trophic levels has the potential to influence ecosystem functions even more strongly than diversity loss within trophic level.

- 1. If you divide an ecosystem into parts by creating barriers, the sum of the productivities of the parts will typically be lower than the productivity of the whole. (Dams, fragmentation and corridors may lead to extinction of some species).
- 2. Non-linearity is a reason markets are inadequate system of institutions for protecting the biosphere from overuse, or ensuring that our consumption and investment decisions are based on reflective balance between our own well-being and well-being of our descendants.

The Millennium Ecosystem Assessment (MA 2005) recorded biodiversity loss in the last 3 decades as follows 50% of marches, 35% of mangroves, 40% of reefs.

Buceini et al (2017) estimated that forest captured around 435 million tonns of Carbon annually, but lost 860 million tonnes, 70% (602 million) due to deforestation and land degradation.

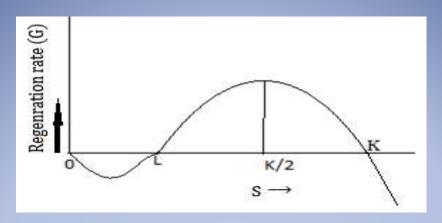
Biodiversity is maximized at intermediate level of disturbance due to successional sequence where species trade off Colonization ability with competitive advantage until the Climax species take over.

Unfortunately, increasing level of disturbance can drive the System backwards to low diversity.

Resilient ecosystem harbor redundancy, where species sit in the wings like spare capacity in economic production System. Reduced variation means reduce capacity for adaptation and consequent loss of resilience.

Ecosystems occur in different stability regimes where the stability regimes states are Well defined, but the uncertainty lies in the location of the states that separate the regimes, so the magnitude of disturbance the ecosystem can tolerate before it moves to a different stability regime could not be determined exactly.

### **Example:** the fishery stock in the lake.



Dynamic of ecosystem and prudent management of a fishery in lake ecosystem

S = the stock; (G) = Regenerative rate birth rate-death rate; L = the stock threshold (If it falls below, the fishery would be doomed); K = the carrying capacity of the system; K = the reproductive rate.

$$\frac{ds}{dt}$$
 = G<sub>(s)</sub> = r S [1-S<sub>(t)</sub>/K] [(S<sub>(t)</sub>-L)/K]

There are three stationary points in the system

When S=0 stable; S=L non stable; S=K stable  $\leftarrow$  attained when no interference with system

If finishing took place at the rate of  $R_{(t)}$ ; Than  $dS_{(t)}/d_{(t)} = rS_{(t)}[1-S_{(t)}/K][(S_{(t)}-L)/K] - R_{(t)}$ 

Good management practice would demand that the stock be prevented from dropping below L. The prudent management calls for harvesting at K/2.

# Some example of extreme disturbances in ecosystems:

- 1. Sea otter in North East pacific by preying on urchins enable Kelp forest to thrive As kelp provide habitat for many fish. An explosion of urchins can create Kelp barren and depress the fish population.
  - A balance between native Species is reached in ecosystem over extended span of time.
- 2. Introduction of non-native Species may change the composition and reduce the resilience of the ecosystem.
  - "Nile perch" a predatory fish introduced to Lake Victoria in 1950 decimated native species.

### **Econometrics of Natural Capital**

### **Definitions**

- A market Price: is the price at which a good, service or asset is exchanged in a market
- An Accounting price: Is the price that reflects the true value to society of any good, service or asset.
- (It augments value of externalities that emanated from the destruction, degradation of natural capital).
- The inclusive wealth is the aggregate value of the nation produced capital, human capital and natural capital.
- The changes in the inclusive wealth can point to the Status of Sustainable development.
- Ecological foot print: is identified as a ratio of demand /Impact over the supply or the regenerative rate of the biosphere:  $[NY/\infty]/G$ .

# **Natural Capital Econometrics**

# Supply

It is the regenerative rate of the biosphere  $G_{(s)}$  which is a function of the biosphere's stock (S).

 $G_{(s)}$  can be affected by policy:

# Examples

- 1. Transplanting heat tolerant corals for more survival under bleaching conditions.
- 2. Importing foreign species into the ecosystem may result in unintended, detrimental consequences.
- 3. Intervention involving using genetically modified Crop is Controversial.

### Demand

- A) Demand (impact)
  - Humanity exerts its impact on the biosphere through
- a) the global population size (N).
- b) Individual demand on the biosphere proxied by GDP/Capita (standard of living) (Y)
- c) Technology and institution (∝) Which is a numerical value of the efficiency with which the goods and Services are converted into GDP and the extent to which the biosphere is transformed by global waste.

The Demand = 
$$\frac{NY}{x}$$

The demand is a function of the population (N) and its activity (Y) which inevitably associated with waste and inversely related to  $(\infty)$ .

# Impact Inequality occurs when

$$\frac{NY}{\propto} > G_{(s)}$$

The left side is the impact (demand)

The right side is the supply

If the global Impact (I) exceeds the biosphere's regenerative rate (G), the biosphere Stock diminishes as a result of the presence of a gap between I and G.

# **Impact Equality**

The condition under which we can attain Sustainable development points to ways in which we stabilized the biosphere Stock.

This requires that the Impact must equal the biosphere's regenerative rate.

That is

$$NY/_{\propto} = G_{(s)}$$

The many paths that we opt to achieve this becomes a dynamic portfolio management problem that must satisfy the arbitrage conditions among all assets (produced, human, and Natural).

### Inclusive wealth and portfolio management

- The inclusive wealth is the social value of an economy's portfolio of capital goods.
- It is the sum of accounting values of produced capital, human capital and natural capital
- Inclusive wealth should be the instrument to evaluate economic change
- The social well-being is maximized if inclusive wealth is maximized
- A society could raise its inclusive wealth and thereby its well-being by improving its institutions and practices with regard to providing protection to environment.

Then we are talking about 2 equities: the wealth and well-being

The biodiversity economics apply the wealth/wellbeing equivalence theory which requires the policy analysis at a point of time to evaluate alternatives to which capital good and yield can be put for sustainable assessment which measure prosperity (does not mean high GDP) as reflection of the quality of life or the well-being. Its task is to weigh change in the asset structure.

- So the study of biodiversity economics become the study of inclusive capital Portfolio (produced, human and natural) under arbitrage conditions.
- Comparing the assets in the portfolio employs using its own rate of return (yield) but this is misleading since it doesn't account for depreciation of the capital or yet we can use the rate of return which means its yield plus appreciation or depreciation of the capital. This value then measures the wealth which is calculated on the basis of the accounting price but not the market price.

#### The Arbitrage Condition

#### At the local level

The portfolio manager "The government in this case" will not choose an asset with lower rate of return than others.

Assume the asset is mineral deposit in a forest (S) and the market price for the mineral is (X) that its yield, however its accounting price (or rate of return) is

The market price (X) + (-Y) where (Y) has negative value due to externalities created by environmental damage

The ideal situation is achieved when the market value of a portfolio would equal its accounting value but this is not the case because private incentives and social imperatives differ. So, the agent task is to put into practice polices that bring the two into alignment as close as possible (This done by using accounting price as an option to act as proxy for inclusive wealth to maximize social well-being).

#### At the global level

Assets that are open to all to use as each see fit, free of charge. They are known as open access resources

- 1. Like the atmosphere as a sink of CO<sub>2</sub>.
- 2. Marine fisheries beyond nation's jurisdiction (200 mile from cost) in open seas.

Estimates of own rate of return (yield) on global primary producers compared to own rate of return (yield) on representative financial assets points to the fact that global investments in produced capital, and human capital have come in tandem with enormous deterioration of natural capital.

Managi and Kumar (2018) estimated the global per capita accounting values of the 3 classes of Capital Goods over the period 1992-2014 They found produced capital increase by 100%.

Human capital increase by 13%

Natural capital decreased by 40%

Net primary production calculations and the own rate of return (yield) of an ecosystem

Let  $S_{(t)}$  is the plant biomass at time (t)

Let X<sub>(t)</sub> is the herbivores biomass at time (t)

Let  $Z_{(t)}$  is the carnivore's biomass at time (t)

Where r is the intrinsic rate of increase.

K is the Carrying Capacity of the ecosystem

NPP = 
$$r S_{(t)} (1 - S_t/K) - \propto S_{(t)} . X_{(t)}$$

The ecosystem total biomass

$$S_{(t)} + X_{(t)} + Z_{(t)}$$

The yield = 
$$\frac{rS_{(t)}\left(1-\frac{S_{t}}{k}\right)-\propto S_{(t)}X_{(t)}}{S_{(t)}+X_{(t)}+Z_{(t)}}$$

### Rate of Return on Primary producers

- -Planetary NPP estimated at the end of 20<sup>th</sup> century to be: 105 trillion kg/year (field et al 1988)
- Global Stock of biomass = 550 trillion kg/year (Bar-on, Philips and Milo, 2018) The biosphere average yield on the Stock 105/550 per year = 19% a year.
- Now Jorda et al (2019) estimated the long-run global yield on produced Capital to be around 5%
- Assume we manage our global portfolio of assets in an efficient manner. The difference is 14% which means that the difference had been generated at the expense of the capital
- That is, we are overusing our natural capital by 14% as compared to prudent management of our produced Capital. This simply means that the accounting price of primary producer's relative to that of produced capital is declining by 14% a year.

Are the UN SDG<sub>s</sub> achievable by 2030?

I) Given Data

The impact equality offers a way to device policies and behavioral changes required to achieve UN SDG<sub>s</sub> by 2030.

Are these attainable?

#### **Calculations:**

The global foot print Network (GFN) =  $\frac{NY/\infty}{G_{cs}}$  = global ecological foot print

- 1. Wackernagel and Beyers 2019 calculated that global ecological footprint increased from 1.0 in 1970 to 1.7 in 2019; this means the ratio increased at an average annual rate of [1.1%]
- 2. The global GDP has increased since 1970 at annual average rate of 3.4%
- 3. The global natural Capital decline per capita was estimated to be 40% between 1992 and 2014 (Managi and Kumar 2018) Accordingly, the calculated global capital decline annually = -1.2% (Dasgupta 2021).

The global Ecological footprint could be calculated using this formula (Dasgupta 2021):

$$g\left[\frac{NY}{\propto}/G\right] = g(NY) - g(\propto) - g(G)$$

Where g (x) is % rate of the change of any variables

- g (NY) = represents the average ratio of annual increase of global consumption of biospheres goods and services represented by increase of global GDP.
- g (∝) = The average ratio of annual increase of technology that can neutralize waste and increase efficiency by which we convert the biosphere's goods and services into products (It augments also the institution foam)
- g (G) = The average ratio of annual increase (decrease) in the regenerative rate of the biosphere
- $g\left(\frac{NY}{c}/G\right)$  = Average ratio of annual increase or decrease of global footprint Network

$$+1.1\% = 3.4\% - 9 (\propto) (-1.2\%)$$

$$g(\propto) = 3.5\%$$

This is the calculated global increase in annual ratio of technology that aimed at neutralizing global waste and pollution.

Now suppose we want to reach impact equality by 2030.

as stipulated by UN SDGs: How much annual increase in technology we need to neutralize our waste and pollution?

This requires  $(\frac{NY}{\propto}/G)$  should shrink from 1.7 to 1. To achieve this the ratio of annual decline in global foot print should be (-5.4%)

Assume that GDP will maintain Its course of increase (+3.4%)

and the global annual decline in the regenerative rate of biosphere will be the same (-1.2%).

g 
$$(\frac{NY}{\infty}/G) = (Ny) - g(\infty) - g(G)$$
  
-0.054 = 0.034 - g(\infty) - (-0.012)  
g (\infty) = 0.1 = 10%

This means that to achieve UN SDGs we need to increase  $\propto$  by 2.9 times its current rate, and this is far fetched.

Suppose now that the global output (GDP) is to remain constant (that means the rate of annual increase is zero, from now till 2030, and we depress the deterioration of the biosphere so drastically to annual rate of 0.1%.

Calculation of the % of (∝) technology needed to neutralize our waste will be according to this formula

g 
$$(\frac{NY}{\propto}/G)$$
 = g (NY) - g( $\propto$ ) - g(G)  
-0.054 = 0.0 - g( $\propto$ ) - (-0.001)  
g ( $\propto$ ) = 0.055 = 5.5%

This means that if we even keep our output constant, we need a hike in  $\propto$  to 5.6% which is higher than the Current increase (3.5%).

(x) represent technology and institutions. Both have mutual influence on each other. Since Institution is the seat of incentives and incentives that shape technology. The climate change economist ascribed degradation of the biosphere to institutional failure. They also advocates that progress in science can put things right.

But advance of technology also can enhance the biosphere degradation (clearing the rain forest, fishing, solar panels can raise demand for biosphere's goods and services (i. e, Zink, Cadim and other minerals needed to manufacture solar panels; and this may require forests to be destroyed).

# Thank you

#### METAMATERIALS AND THEIR APPLICATIONS

#### HALA EL-KHOZONDAR FIAS

Professor, Electrical Engineering Department, Islamic University, Gaza, Palestine

#### **ABSTRACT**



Nanomaterials have distinctive optical, mechanical, electrical, and magnetic properties. Thus, they have salient applications including but not limited to sensors, solar cells, optoelectronic devices. In particular, the sensor and solar cell technologies have high leap in the technology world due to the use of nanotechnology and nanomaterials.

In this talk, I will give a preview about nanomaterials and a specific type of nanomaterials named metamaterials (MTM). MTMs is a man-made material with parameters can be tuned easily to fit certain application. Various classes of MTM are defined both experimentally as well as

theoretically based on either wavelength region or design of metamaterial atoms.

I will focus in this talk on fabrication of sensors and solar cells with different structures consists of multilayers. The proposed structures are made of variant type of materials including nanomaterials to enhance their working efficiencies.

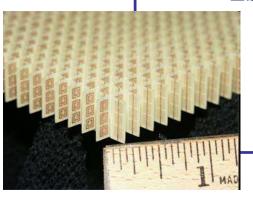


#### Metamaterials and their applications

# Prof. Dr. Hala J. El-Khozondar Electrical Engineering Department Islamic University of Gaza

The 25<sup>th</sup> General Assembly Meeting of the Islamic World Academy of Sciences (IAS)

**Karachi – Pakistan** Wednesday, 8 March 2023



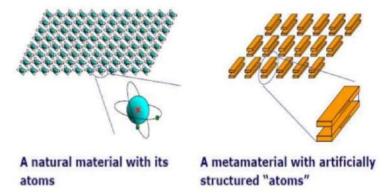
### **Abstract**

MTMs is a man-made material with parameters can be tuned easily to fit certain application. Various classes of MTM are defined both experimentally as well as theoretically based on either wavelength region or design of metamaterial atoms.

I will focus in this talk on fabrication of sensors and solar cells with different structures consists of multilayers. The proposed structures are made of variant type of materials including nanomaterials to enhance their working efficiencies.

## **Metamaterials-Introduction**

- metamaterials (MTMs) engineered materials -various applications.
- atoms are arranged periodically with a distance of less than one nm.
   This value is much less than the wavelength of the visible light.
   Incident light experiences homogenous distribution in these materials.



- Unit cell plays a key role in adjusting the properties of metamaterials.
- Different ways to fabricate MTMs are presented in literatures.

#### What is an Electromagnetic Metamaterial?

- A composite or structured material that exhibits properties not found in naturally occurring materials or compounds.
- Metamaterials are periodic or quasi-periodic, subwavelength metal structures. The electro-magnetic material properties are derived from its structure rather than inheriting them directly from its material composition.
- Double negative materials have electromagnetic properties that are distinct from any known material, and hence are examples of metamaterials.

### **Metamaterial-the name**

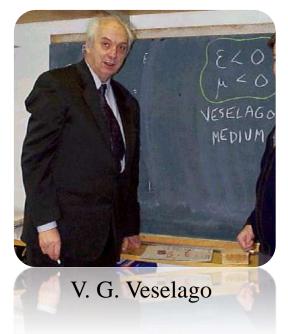
- "Meta-" means "altered, changed" or "higher, beyond".

#### **Metamaterials?**

- Existing materials only exhibit a small subset of electromagnetic properties theoretically available.
- Metamaterials can have their electromagnetic properties altered to something beyond what can be found in nature.
- Can achieve negative index of refraction, zero index of refraction, magnetism at optical frequencies, etc.

# Metamaterial DN / Veselago Material-history

- Theoretically 1968, V. G. Veselago
- Experimentally proposed 1999, John Pendry
- D. R. Smith experimentally achieved 2000





John Pendry

#### **Negative index of refraction??**

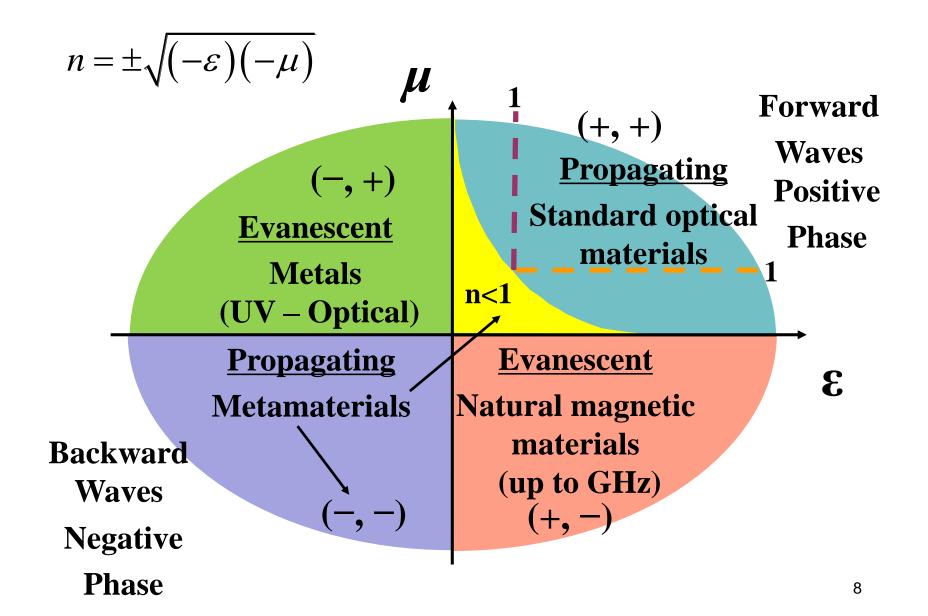
We are interested in how waves propagate through various media; therefore, we consider solutions to the wave equation.

$$\nabla^2 \mathbf{E} = \varepsilon \mu \frac{\partial^2 \mathbf{E}}{\partial t^2} \qquad n = \sqrt{\mu_r \varepsilon_r} \qquad k = \omega \sqrt{\varepsilon \mu}$$

$$\sqrt{\mu_r \varepsilon_r} = \left( (e^{-j\pi})(e^{-j\pi}) \right)^{1/2} = (e^{-j\pi/2})(e^{-j\pi/2}) = e^{-j\pi} = -1$$

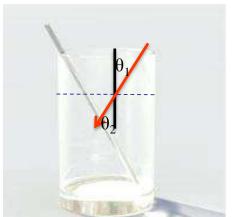
- $_{
  m extstyle}$  negative refraction can be achieved when both  $\mu_{r}$  and  $\epsilon_{r}$  are negative
- > negative  $\mu_r$  and  $\epsilon_r$  occur in nature, but not simultaneously
- $\rightarrow$  silver, gold, and aluminum display negative  $\varepsilon_r$  at optical frequencies
- resonant ferromagnetic systems display negative μ<sub>r</sub> at resonance

#### Classification of materials



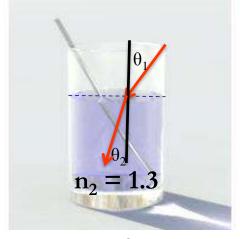
## **Negative refractive index**

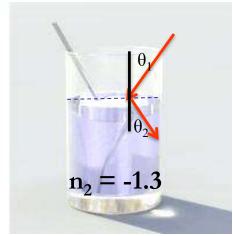
empty glass



regular water







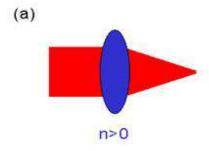
**Snell's Law** 

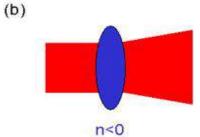
$$n_2 > 0$$

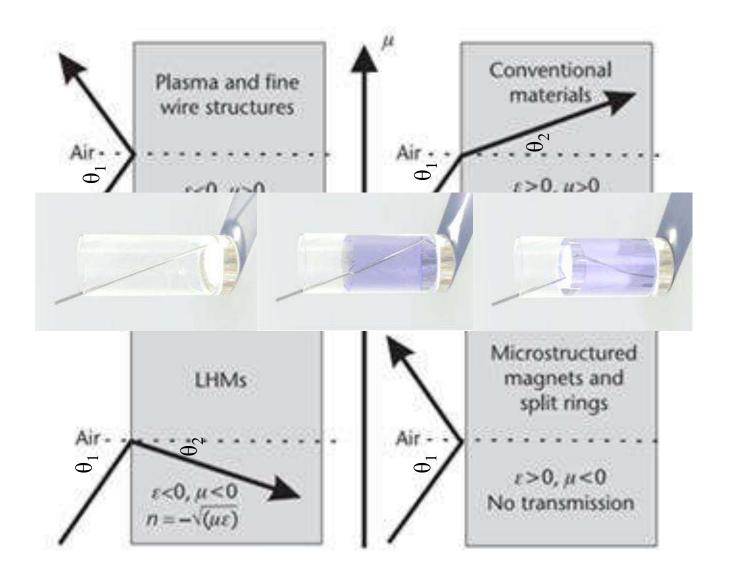
$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$n_2 < 0$$

$$n_1 \sin \theta_1 = -|n_2| \sin \theta_2$$







## **Left-Handed Waves**

• If 
$$\mathcal{E}>0,\,\mu>0$$
 then  $\left(\vec{E}\,,\vec{H}\,,\vec{k}\,\right)$  is a *right* set of vectors:

$$\vec{E} \qquad \vec{k} \times \vec{E} = \frac{\omega}{c} \mu \vec{H}$$

$$\vec{k} \times \vec{E} = \frac{\omega}{c} \mu \vec{H}$$

• If 
$$\mathcal{E} < 0, \, \mu < 0$$
 then  $\left( \vec{E} \,, \vec{H} \,, \vec{k} \, \right)$  is a **left** set of vectors:

$$\left( ec{E}\,,ec{H}\,,ec{k}\,
ight)$$

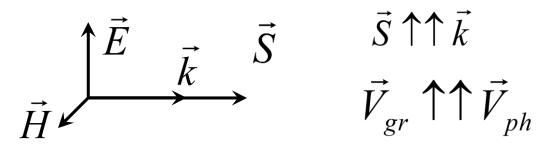
$$\vec{k}$$
 $\vec{H}$ 

$$\vec{k} \times \vec{H} = -\frac{\omega}{c} \varepsilon \vec{E}$$

#### **Energy flux in plane waves**

• Energy flux (Poynting vector):  $\vec{S} = \vec{E} \times \vec{H}$ 

- Conventional (right-handed) medium



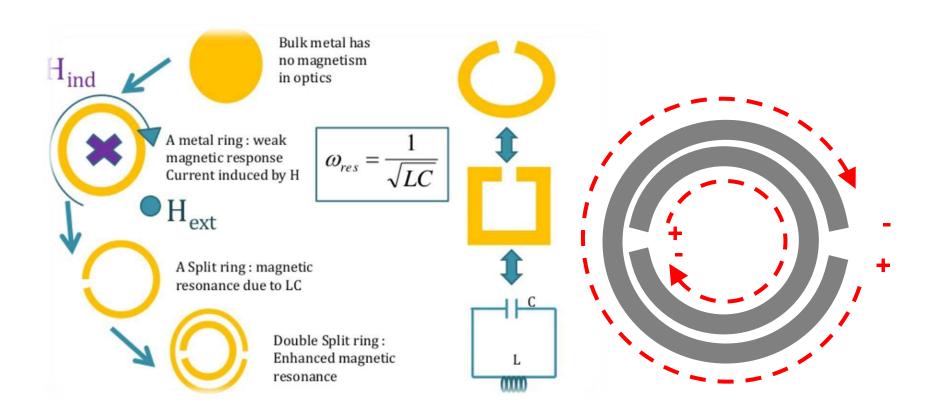
Left-handed medium

$$\vec{k}$$
 $\vec{K}$ 
 $\vec{K}$ 
 $\vec{K}$ 
 $\vec{K}$ 

$$\vec{S} \uparrow \downarrow \vec{k}$$

$$\vec{V}_{gr} \uparrow \downarrow \vec{V}_{ph}$$

#### The Split Ring Resonator (SRR)



SRR resonant structure is much smaller than the resonance wavelength.

#### **Array of Metallic Wires**

Long  $\lambda$ , Array of metallic wires interacts with electromagnetic waves as a plasma  $\rightarrow$  negative permittivity relative to the plasma frequency:



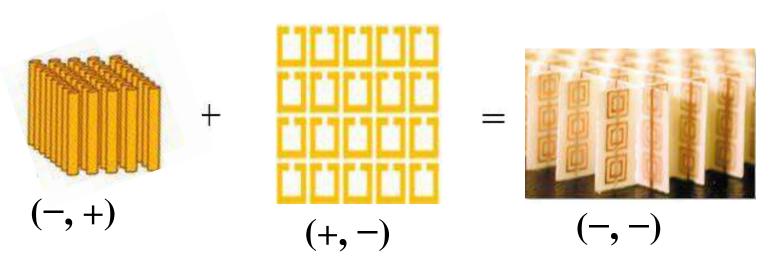
#### **Realisation of Metamaterials**

#### **Negative ε**

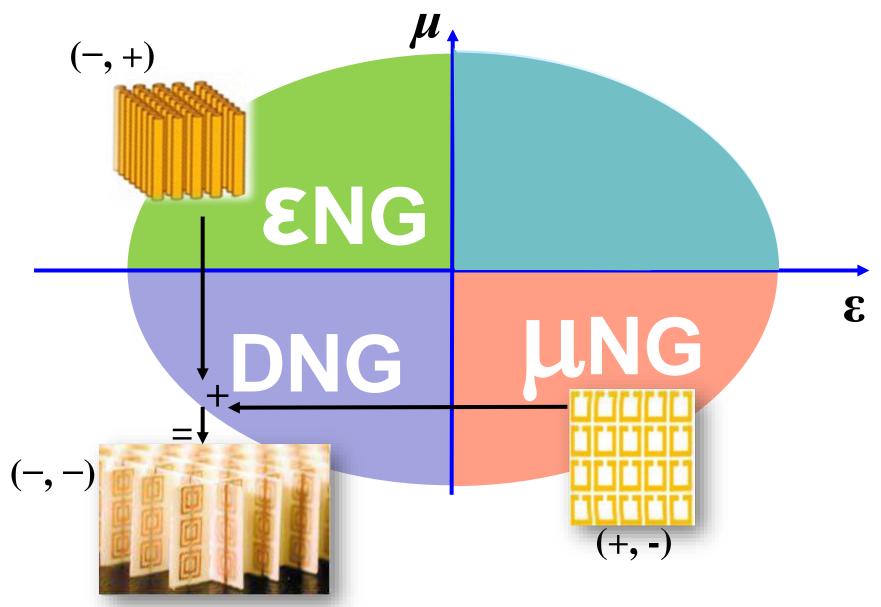
- Thin metallic wires are arranged periodically
- Effective permittivity takes negative values below plasma frequency

#### Negative µ

An array of split-ring resonators (SRRs) are arranged periodically



#### **Classification of materials**



17

## **Material Dispersion**

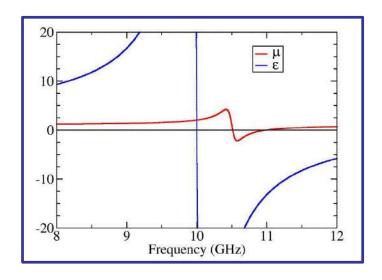
$$\frac{\mathcal{E}}{\mathcal{E}_0} = \frac{\omega_{e_p}^2 - \omega_{e_0}^2}{\omega_{e_p}^2 - \omega^2 - i\,\omega\gamma_e} \quad \frac{\mu}{\mu_0} = \frac{\omega_{m_p}^2 - \omega_{m_0}^2}{\omega_{m_p}^2 - \omega^2 - i\,\omega\gamma_m}$$

 $\omega_{e_n}$ : Electric plasma frequency

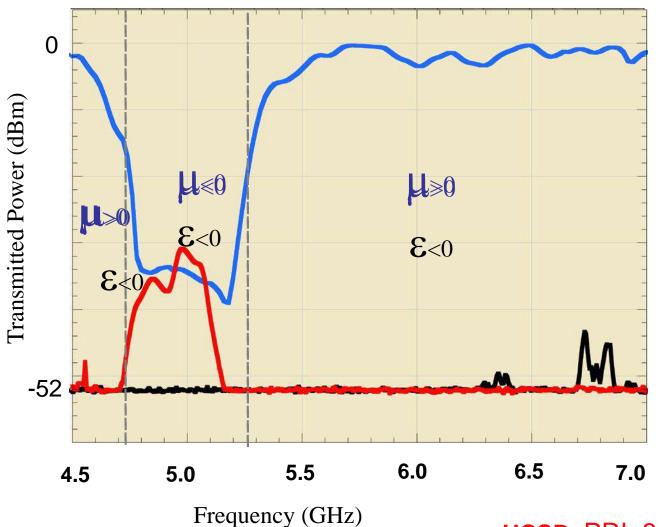
 $\omega_{e_0}$ : Electric resonance frequency

 $\omega_{m_p}$ : Magnetic plasma frequency

 $\omega_{m_0}$ : Magnetic resonance frequency.

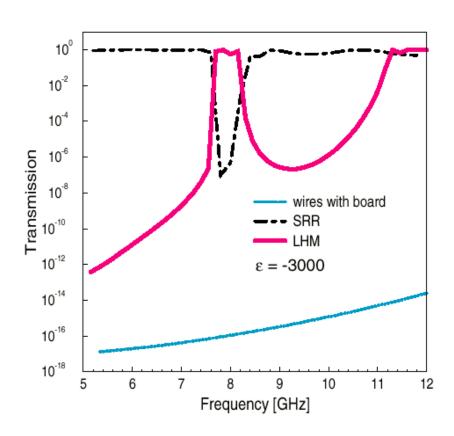


## **Transmission Measurements**

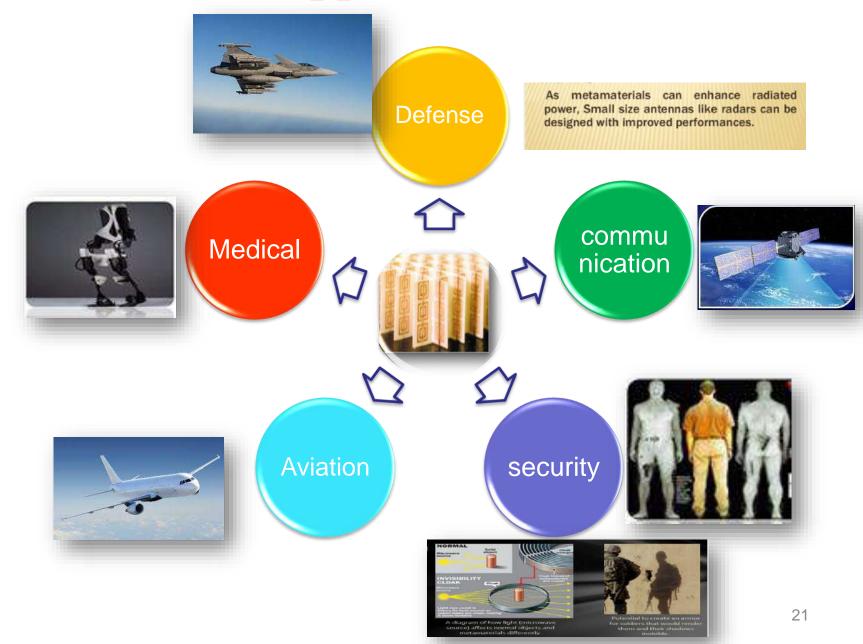


**UCSD**, PRL 84, 4184 (2000)

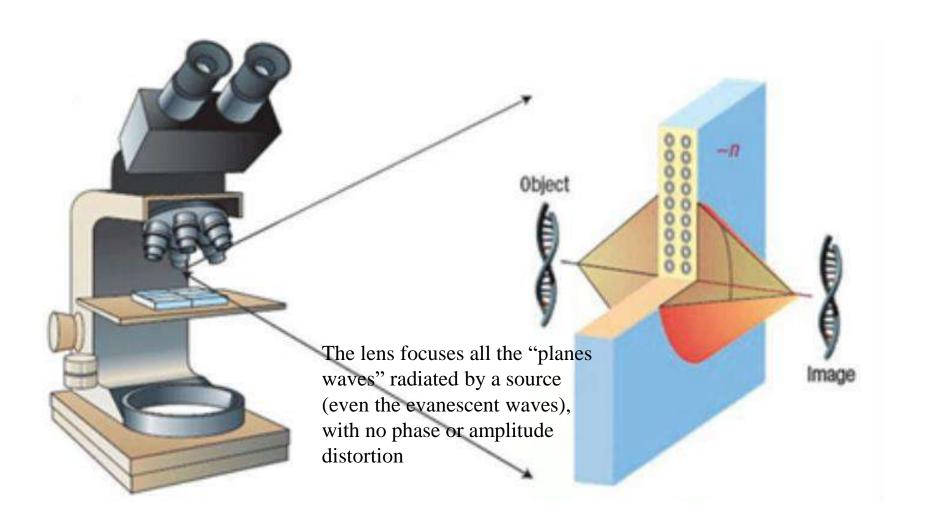
# Left-handed material: array of SRRs and wires



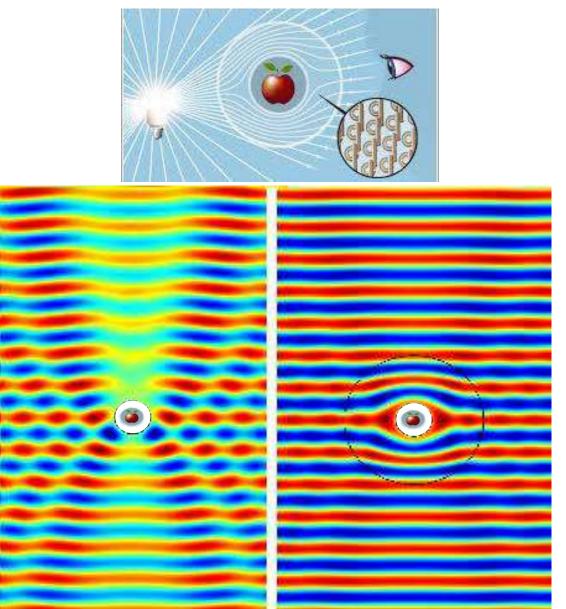
## **Applications**



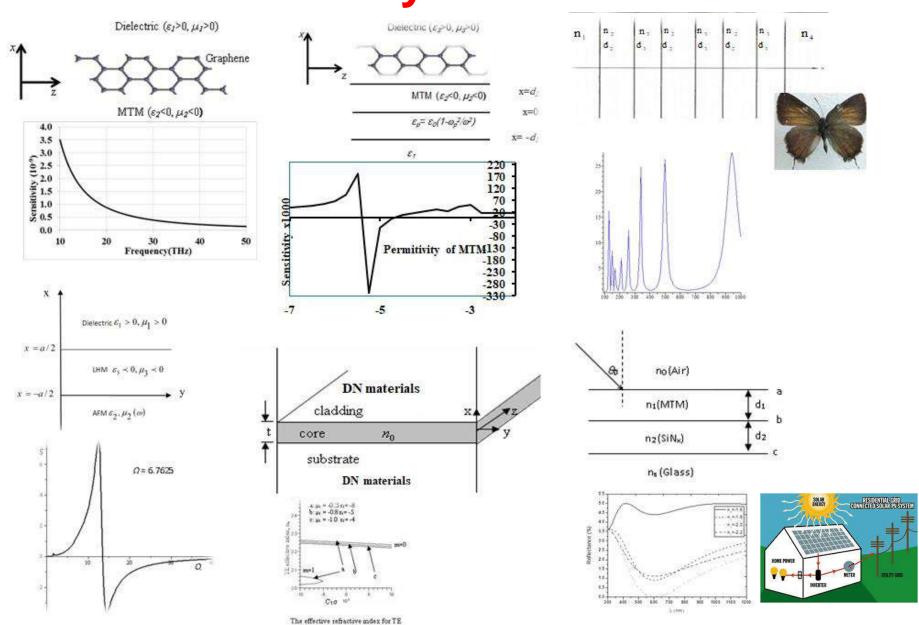
## Pendry Perfect Lens, 2000



## **Cloaking Devices**



## My work

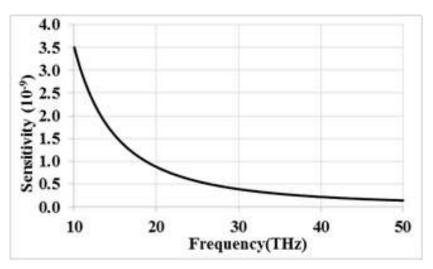


as a function of stress, t=1 um.

#### sensors

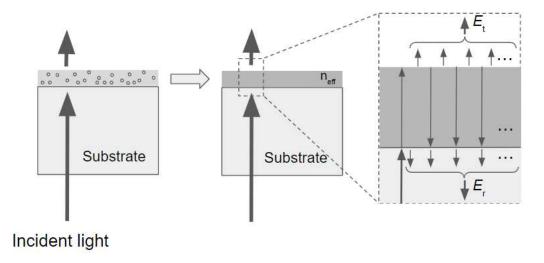
- sensor senses the changes exists of an analyte.
- discriminate among species.
- range of applications in medical, pharmaceutical, environmental, defense, bioprocessing, or food technology.





## Nanoparticles thin film for sensing

homogeneous thin film formed by impurities impeded inside a dielectric host medium



## Nanoparticles thin film for sensing-continue

The resulted reflection coefficient,  $r = |E_r|/|E_i|$ , is

$$r = r_{12} + \frac{t_{12}t_{21}r_{23}\exp(i2k_on_{eff}d)}{1 - r_{23}r_{21}\exp(i2k_on_{eff}d)}$$

$$r_{21} = -r_{12} = \left(\mu_2n_{eff} - \mu_1n_1\right) / \left(\mu_2n_{eff} + \mu_1n_1\right)$$

$$r_{23} = \left(\mu_2n_{eff} - \mu_3n_3\right) / \left(\mu_2n_{eff} + \mu_3n_3\right)$$

TE: $\mu_1$ ,  $\mu_2$ ,  $\mu_3 = 1$ 

TM:  $\mu_1, \mu_2, \mu_3 \rightarrow 1/n^2$ 

## Nanoparticles thin film for sensing-continue

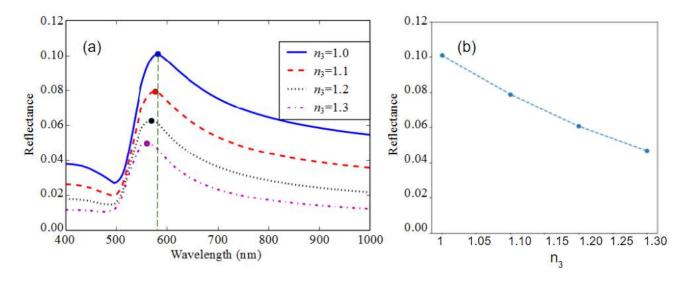
#### To find sensing

$$\frac{dR}{dn_3} = \frac{dr}{dn_3} \cdot r^* + r \cdot \frac{dr^*}{dn_3}$$

$$\frac{dR}{dn_3} = 2 \operatorname{Re} \left\{ \frac{dr}{dn_3} \cdot r^* \right\} = -2 \operatorname{Re} \left\{ r^* e^{-i\phi} \frac{\left( r - r_{12} \right)^2}{r_{23}^2 \left( 1 - r_{12}^2 \right)} \cdot \left( \frac{2n_{eff}}{\left( n_{eff} + n_3 \right)^2} \right) \right\}$$

## Results

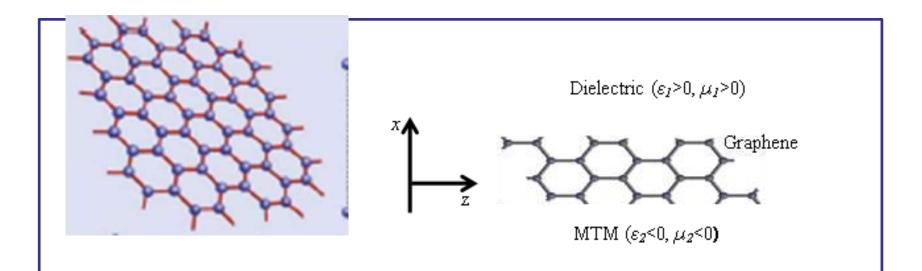
The plots are calculated for gold NPs in a polymer ( $n_h$  = 1.446) and a glass substrate ( $n_1$  = 1.5) for f = 0.06 when TE wave is considered. glass substrate (n3 = 1.5) and varying the superstrate index from n3 = 1 to 1.3. The film thickness is set to 80 nm.



Calculated reflectance spectrum. The Reflectance at the air LSPR peak (580.6 nm) as a function of n3.

$$\frac{dR}{dn_3} = -0.181$$

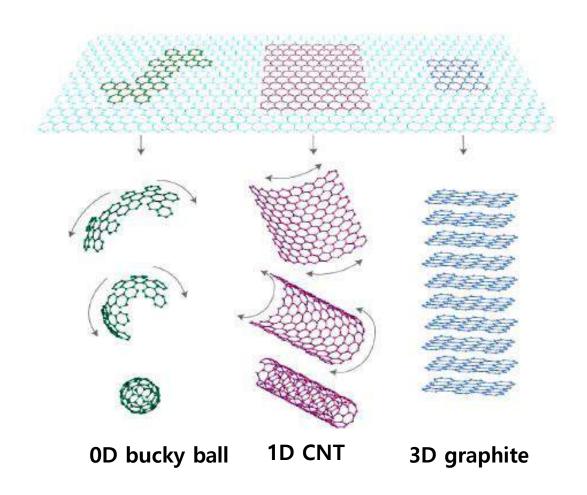
# **Enhancing sensor sensitivity using Graphene-MTM interface**



The graphene monolayer is characterized by a surface conductivity  $\sigma$ .

## Graphene-Introduction

#### 2D graphene sheet



## Transverse Magnetic field (TM)

$$\sigma = \sigma' + j \sigma''$$

$$\sigma'' > 0$$

Thus, graphene can only support surface Plasmon (SP) in Transverse Magnetic field (TM). The graphene layer functions as a thin metal layer.

$$H_{y} = \begin{cases} A_{1}e^{-\gamma_{1}x} & 0 < x < \infty \\ A_{2}e^{\gamma_{2}x} & -\infty < x < 0 \end{cases}$$

## TM is a direction of the field

## Sensitivity

• Using Maxwell's equation to obtain  $E_x$  and  $E_z$ , the dispersion relation for TM modes can be written as

$$\frac{\mathcal{E}_1}{\gamma_1} + \frac{\mathcal{E}_2}{\gamma_2} + j \frac{\sigma}{\omega \mathcal{E}_0} = 0, \qquad \gamma_i = k_0 \sqrt{N^2 - \mathcal{E}_i \mu_i}$$

The homogenous sensitivity (S)

$$S = \frac{dN}{d\varepsilon_1} = \frac{k_o^2}{\gamma_1} \left[ \frac{\varepsilon_1}{\gamma_1^3} + \frac{\varepsilon_2}{\gamma_2^3} \right]$$

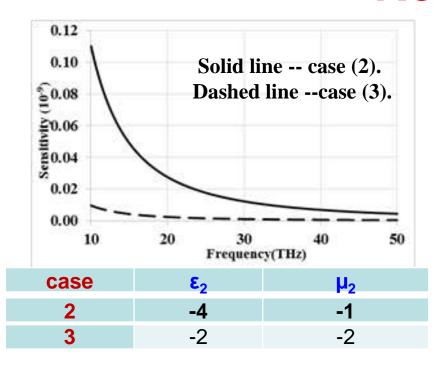
#### **Calculations**

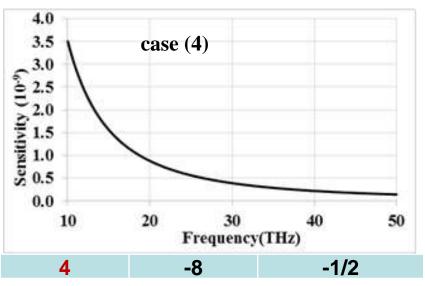
$$\varepsilon_{I}$$
 =2.25   
  $\sigma$ =0.772+j0.386  $\mu$ S.m MTM parameter

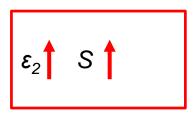
case	ε <sub>2</sub>	$\mu_2$
1	-1	-4
2	-4	-1
3	-2	-2
4	-8	-1/2
5	-8 -1/2	-8

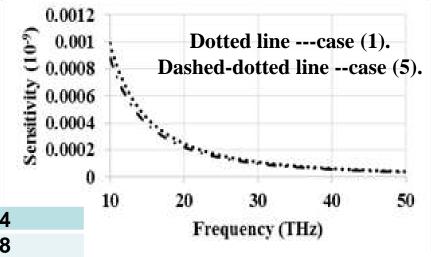
Then values of effective refractive index obtained from dispersion Equation is used to solve for the sensitivity.

#### Results

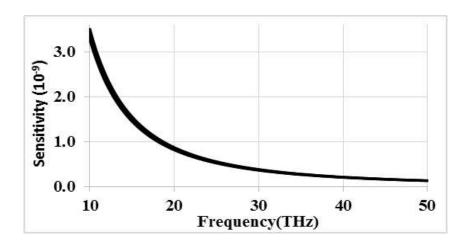








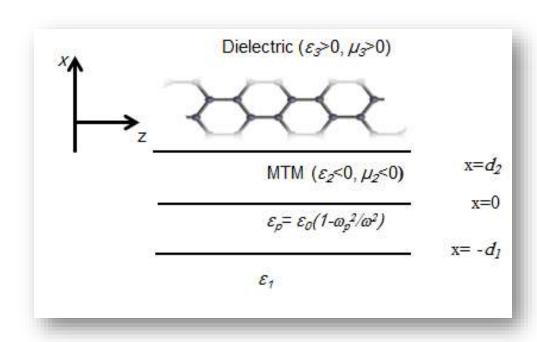
#### dependence on $\sigma$ .



case	σ(10 <sup>-5</sup> )
1	7.72+i3.86
2	6.72+i2.86
3	5.72+i1.86
4	4.72+i0.86

The curves from top to bottom are for cases (1) to cases (4) stated in table 2.

## 4-layer sensor



## The plasma layer

has permittivity constant  $(\varepsilon_p)$  that described by

$$\varepsilon_p = \varepsilon_0 \left( 1 - \frac{\omega^2}{\omega_p^2} \right)$$

Where  $\varepsilon_0$  is the vacuum permittivity and  $\omega_p$  is the plasma frequency, and  $\omega$  is the angular frequency of the applied field.

### The nanocomposites layer

The effective permittivity for the nanocomposite layer ( $\epsilon_1$ ) is calculated using Dynamical Maxwell-Garnett theory which is an extended version of Maxwell-Garnett theory (Kitsomoboonloha et al., 2011).

The theory assume that the host (in our case is polyacrylic acid (PAA)) is the majority and the metal nanoparticles (Au and Ag) are the annexation materials with chosen metal fraction in the composite (Shi et al., 2009; Ruppin, 2000; Kitsomboonloha et al., 2011).

#### The permittivity ε<sub>1</sub>

$$\frac{\varepsilon_{1}-\varepsilon_{h}}{\varepsilon_{1}+2\varepsilon_{h}}=f_{Ag}\frac{\varepsilon_{Ag}-\varepsilon_{h}}{\varepsilon_{Ag}+2\varepsilon_{h}+\left(\varepsilon_{h}-\varepsilon_{Ag}\right)\left(1-f_{Ag}\right)\alpha}+f_{Au}\frac{\varepsilon_{Au}-\varepsilon_{h}}{\varepsilon_{Au}+2\varepsilon_{h}+\left(\varepsilon_{h}-\varepsilon_{Au}\right)\left(1-f_{Au}\right)\alpha}$$

The particle size effect is introduced via  $\alpha$  (Ruppin, 2000; Kitsomboonloha et al., 2011) as follows

$$\alpha = x^2 + i\left(\frac{2}{3}\right)x^3$$

Where  $x = \varepsilon_h \sqrt{(\omega a)/c}$ ,  $\omega$  is the angular frequency, a is the radius of the metal nanoparticle, and c is the speed of light. The value of a is assumed to be an average value which equals to 20 nm.

## The dispersion Equation

Apply Maxwell's equation on each layer and solve for boundary conditions.

$$\frac{\gamma_{2}\gamma_{p}\varepsilon_{1} + \gamma_{1}\gamma_{2}\varepsilon_{p} \tanh(\gamma_{p}d_{1})}{\varepsilon_{2}\gamma_{2}\Gamma + \gamma_{3}\varepsilon_{2} \tanh(\gamma_{2}d_{2})} + \frac{\gamma_{1}\gamma_{p}\varepsilon_{p} + \gamma_{p}^{2}\varepsilon_{1} \tanh(\gamma_{p}d_{1})}{\gamma_{3}\varepsilon_{p} + \Gamma\gamma_{2}\varepsilon_{p} \tanh(\gamma_{2}d_{2})} = 0$$

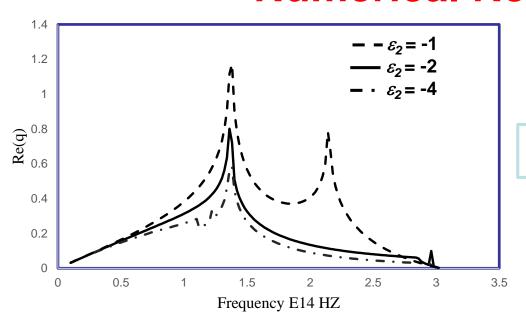
$$\Gamma = \frac{\varepsilon_3}{\varepsilon_2} + i \frac{\sigma q}{\omega \varepsilon_2} \qquad q^2 - \gamma_i^2 = \frac{\varepsilon_i \omega^2}{\varepsilon_0 c^2} \qquad (i = 1, 2, 3, p)$$

 $q = N\omega/c$  is the propagation constant, N is the effective refractive index.

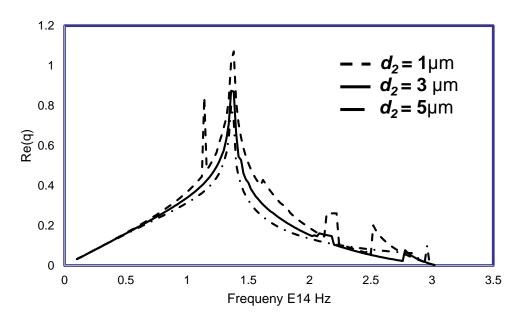
The dispersion equation can be simplified by ignoring the retardation effect as *c* is much lager than the Fermi velocity of the graphene.

$$\varepsilon_{p} \frac{\varepsilon_{1} + \varepsilon_{p} \tanh(qd_{1})}{\Gamma + \tanh(qd_{2})} + \varepsilon_{2} \frac{\varepsilon_{p} + \varepsilon_{1} \tanh(qd_{1})}{1 + \Gamma \tanh(qd_{2})} = 0$$

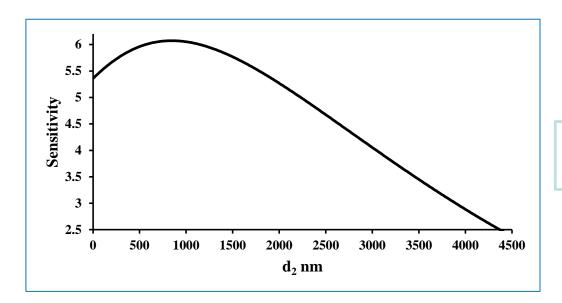
#### **Numerical Results**



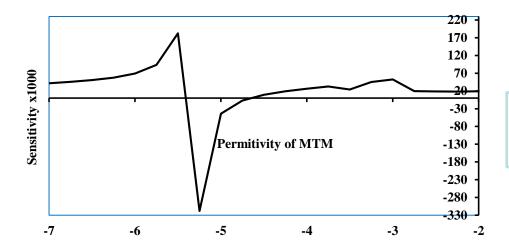
 $\sigma$ = 6.089E-6 and  $d_1$ = $d_2$ =5 $\mu$ m



 $\varepsilon_2$ = -1,  $d_1$ =5µm

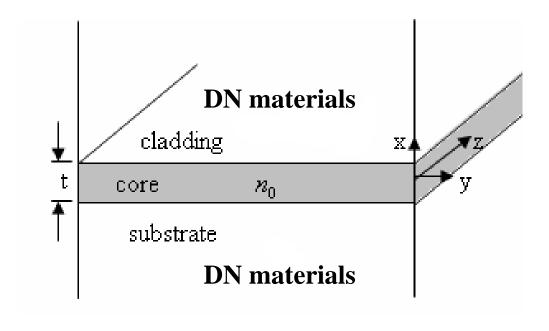


σ= 6.089E-6,  $ε_I$ = 3.9,  $ε_2$ = -1,  $ε_3$ = 1,  $d_I$ =5μm, ω=1.36E14 Hz.



 $σ = 6.089\text{E-6}, ε_I = 3.9, ε_3 = 1, d_I = d_2 = 5\mu\text{m}, ω=1.36\text{x}10^{14} \text{Hz}.$ 

## Double-Negative (DN) material Optical waveguide Behavior Subjected to Stress



$$t \sim \lambda$$
,  $n_{core} > n_{surrounding}$ 

#### Anisotropic and inhomogeneous media, ε

$$\varepsilon = \begin{pmatrix} n_{xx}^2 & n_{xy}^2 & n_{xz}^2 \\ n_{xy}^2 & n_{yy}^2 & n_{yz}^2 \\ n_{xz}^2 & n_{yz}^2 & n_{zz}^2 \end{pmatrix}$$

*n* is refractive index which depends on temperature, stress, and wavelength

#### By using the stress-strain relations

$$\begin{pmatrix} \mathbf{n}_{xx} \\ \mathbf{n}_{yy} \\ \mathbf{n}_{zz} \\ \mathbf{n}_{yz} \\ \mathbf{n}_{xz} \\ \mathbf{n}_{xy} \end{pmatrix} = \begin{pmatrix} \mathbf{n}_{0} \\ \mathbf{n}_{0} \\ \mathbf{0} \\ \mathbf{0} \\ \mathbf{0} \end{pmatrix} - \begin{pmatrix} \mathbf{C}_{1} & \mathbf{C}_{2} & \mathbf{C}_{2} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{C}_{2} & \mathbf{C}_{1} & \mathbf{C}_{2} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{C}_{2} & \mathbf{C}_{2} & \mathbf{C}_{1} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{C}_{3} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{C}_{3} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{C}_{3} \end{pmatrix} \begin{pmatrix} \mathbf{\sigma}_{xx} \\ \mathbf{\sigma}_{yy} \\ \mathbf{\sigma}_{zz} \\ \mathbf{\sigma}_{xz} \\ \mathbf{\sigma}_{xz} \end{pmatrix}$$

C's stress-optic constants

E: Young's modulus

G: shear modulus

v: Poisson's ratio

Waveguide is very long in one direction, z, the shear stresses can be ignored.

$$\varepsilon = \begin{pmatrix} n_{xx}^2 & n_{xy}^2 & 0 \\ n_{xy}^2 & n_{yy}^2 & 0 \\ 0 & 0 & n_{zz}^2 \end{pmatrix}$$

## **Hydrostatic stress**

$$\sigma_{xx} = \sigma_{yy} = \sigma_{zz} = \sigma \text{ and } \sigma_{xy} = 0$$

$$n_{xx} = n_{yy} = n_{zz} = n = n_0 - (C_1 + 2C_2)\sigma$$

TE

$$P \tan\left(\frac{kt}{2}P\right) = \frac{q}{\mu_1}; \text{ even}$$

$$\frac{q}{\mu_1} \tan\left(\frac{kt}{2}p\right) = -P; \text{ odd}$$

$$P = \sqrt{n^2 - n_i^2}$$
 and  $q = \sqrt{n_i^2 - \mu_1 \varepsilon_1}$ 

TM

$$P \tan\left(\frac{kt}{2}P\right) = \frac{q}{\mu_1}; \text{ even}$$

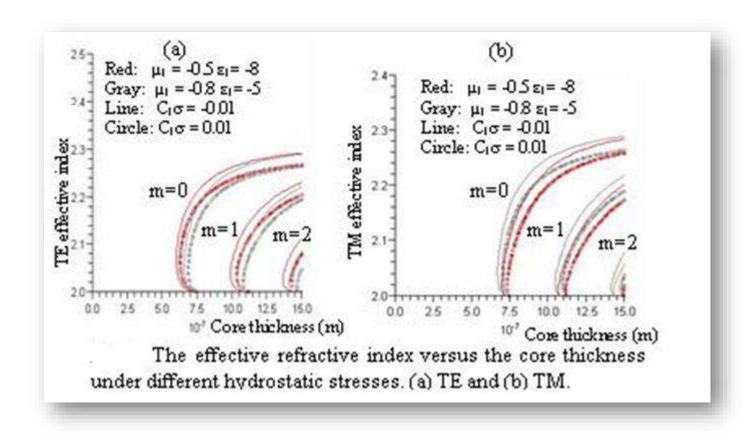
$$\frac{q}{\mu_1} \tan\left(\frac{kt}{2}p\right) = -P; \text{ odd}$$

$$i = e \ or \ h$$

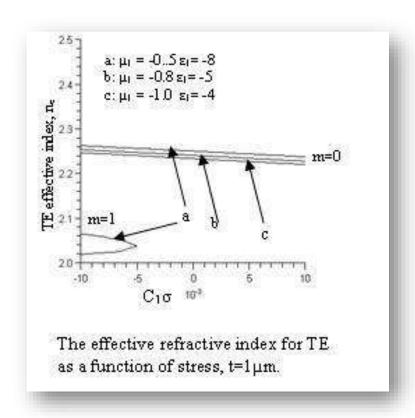
# Solving for effective refractive index $\epsilon_1\,\mu_1{=}4$

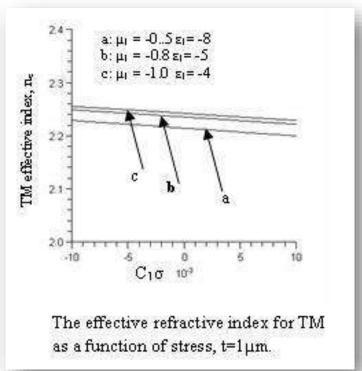
cases	ε <sub>1</sub>	$\mu_1$
а	-8	-0.5
b	-5	-0.8
С	-4	-1

#### Results



#### Results



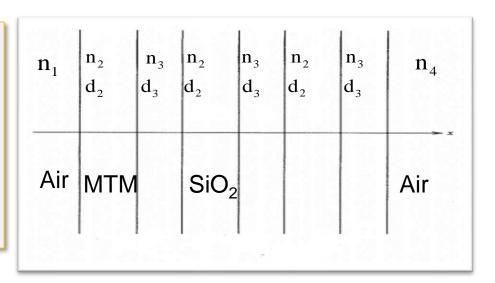


## Metamaterial-dielectric photonic crystal waveguide structure

we have studied 1-D MTM- dielectric (SiO<sub>2</sub>) photonic crystals (MTM-D-PC's).  $d_2$ = 4nm,  $n_3$  =1.54427 and  $d_{3=}$  340nm.

d and n determine optical properties

Shift forbidden and allowed bands

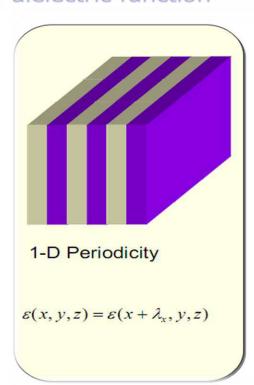


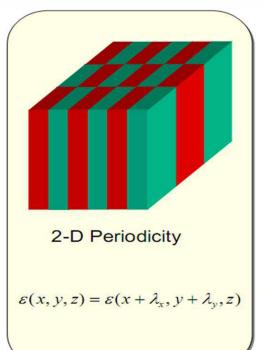
We used the transfer matrix method (TMM) to study the transmittance. Comparing the results for different refractive indices of metamaterial show that the transmittance depend on the MTMs parameters.

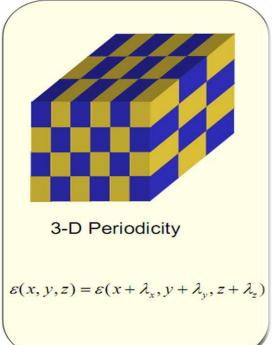
#### **Applications**

- integrated optical devices
- linear waveguides
- resonant cavities and switches

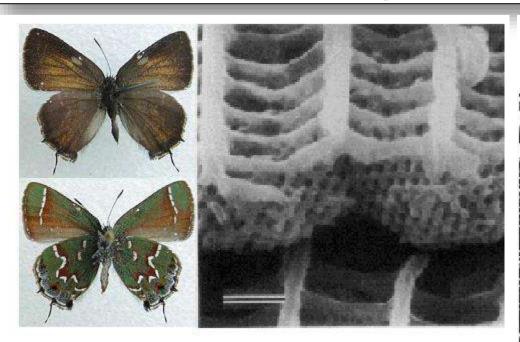
## Photonic crystals are periodical structures with 1D, 2D or 3D periodic dielectric function



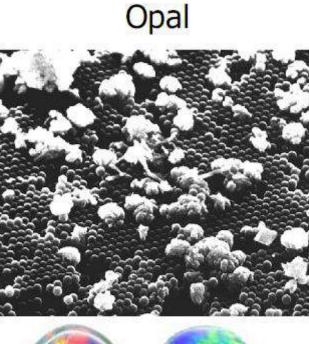




### Some of the naturally occurring photonic crystals:

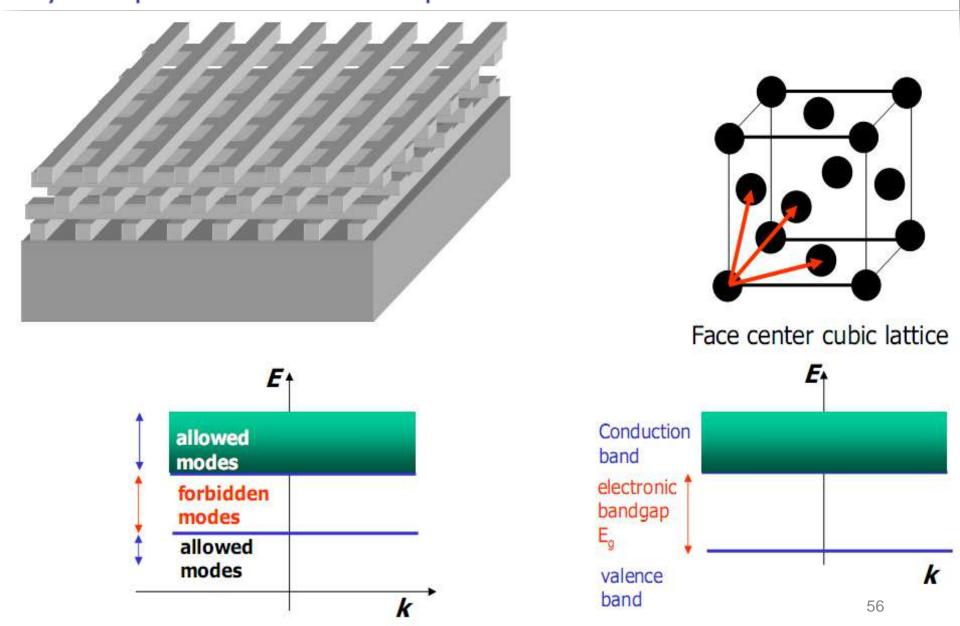


**Butterfly wings** 

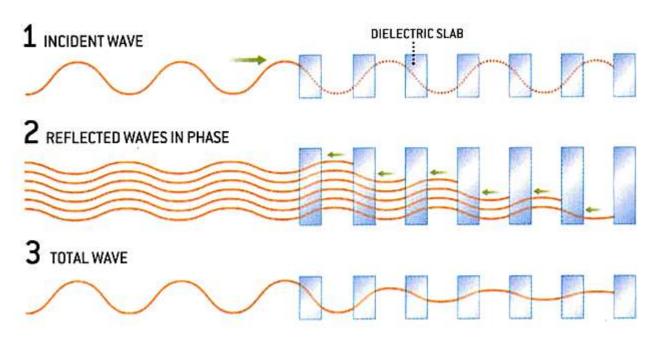




## Photonic crystals are in some sense analogous to semiconductors if you replace electrons with photons



## Simple Photonic Crystals



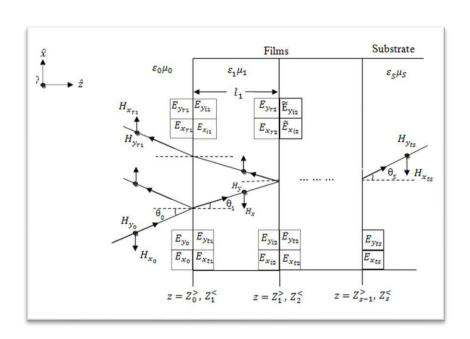
Alternating materials of higher & lower refractive indices

Periodicity: on the order of wavelength of light

Functionality: semiconductors for light

#### **Mathematical calculations**

$$\begin{pmatrix} E_{out} \\ H_{out} \end{pmatrix} = \begin{pmatrix} \mathbf{M}_{11} & \mathbf{M}_{12} \\ \mathbf{M}_{21} & \mathbf{M}_{22} \end{pmatrix} \begin{pmatrix} E_{in} \\ H_{in} \end{pmatrix}$$



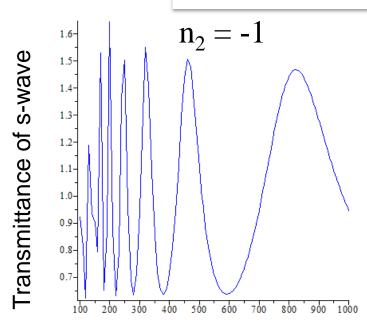
#### **Mathematical calculations**

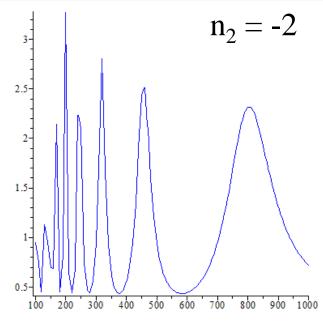
#### For TE

$$R = |\mathbf{r}|^2 = \left| \frac{M_{21}}{M_{11}} \right|^2$$

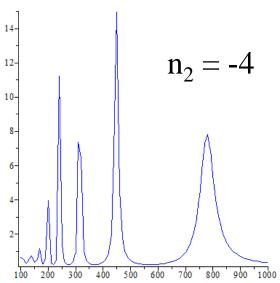
$$T = \frac{n_4 \cos \theta_4}{n_1 \cos \theta_1} \left| \frac{1}{M_{11}} \right|^2$$

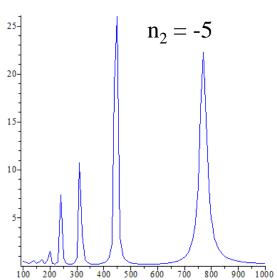
#### **Results**

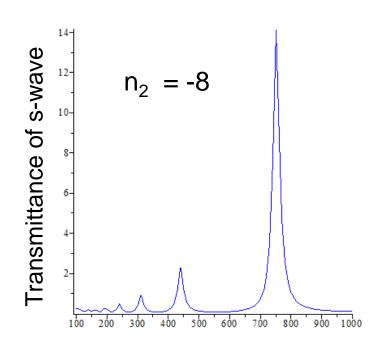


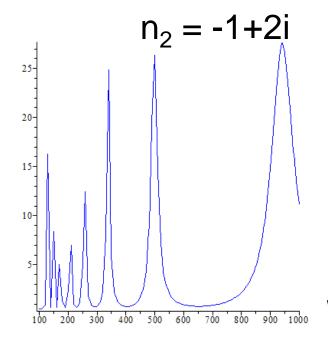


Wavelength (nm)

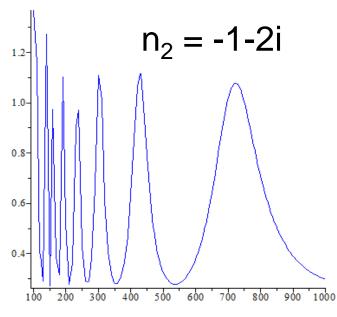








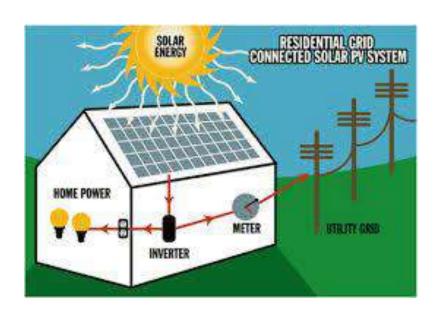
Wavelength (nm)

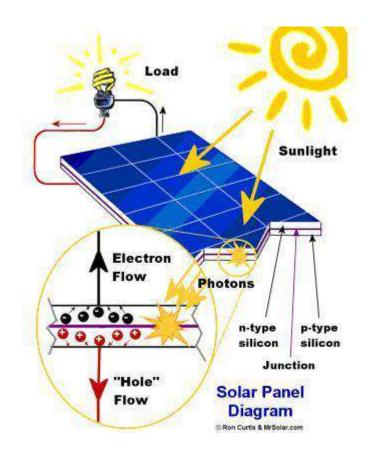


Wavelength (nm)

### Photovoltaic (PV) cells

A photovoltaic system is a power system designed to supply usable solar power by means of photovoltaics.





PV systems range from small, rooftop-mounted or building-integrated systems with capacities from a few to several tens of kilowatts, to large utility-scale power stations of hundreds of megawatts.

Solar cells is the building unit of the solar system convert the sunlight to electricity.

## Solar cell generations

- Si (crystalline) cells : 1<sup>st</sup> generation cells
- (thin film) Cadmium telluride (CdTe), copper indium gallium selenide solar cell (CIGS), α-Si : 2<sup>nd</sup> generation cells
- Dye cells, organic cells and related ones: 3<sup>rd</sup> generation cells
- There are newer ones and 'generation number' becomes fuzzy at this stage

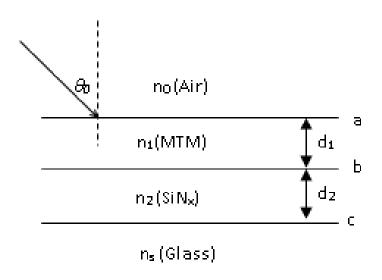
## What makes PV Production interesting?

- PV addresses the energy problem which many passionately, want to solve.
- By 2050 the world will need ~ 30 TW of power.
- Some think PV could provide 20 % of that.

#### **Thin Film Solar Cells**

- A thin film of semiconductor is deposited by low cost methods.
- Less material is used
- Cells can be flexible and integrated directly into roofing material

#### **Proposed Model PV**



Glass  $n_s=1.47$ , air  $n_0=1$ .  $d_1$  and  $d_2$  are chosen  $(d_m=\lambda_m/4)$ , where  $\lambda_m=\lambda/n_m$ ,  $\lambda$  is the peak of the solar spectrum  $(\lambda=600\text{nm})$ .

The spectral response of  $SiN_x$  goes 300-1200nm. This range is taken to limit the spectrum of the incident light.

#### Transfer Matrix Method (TMM)

$$M_k = \begin{bmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{bmatrix} = \begin{bmatrix} \cos(\delta_k) & \frac{i\sin(\delta_k)}{\gamma_k} \\ i\gamma_k \sin(\delta_k) & \cos(\delta_k) \end{bmatrix}$$

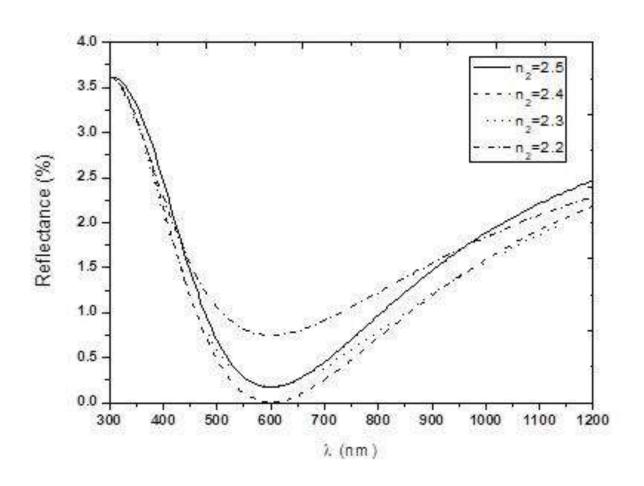
$$\gamma_k^{TE} = \frac{1}{\eta_0 \mu_k} n_k \cos \theta_k \qquad \qquad \gamma_k^{TM} = \frac{1}{\eta_0 \mu_k} \frac{n_k}{\cos \theta_k}$$

$$M_T = M_1 M_2 \dots M_m = \prod_{k=1}^m M_k$$

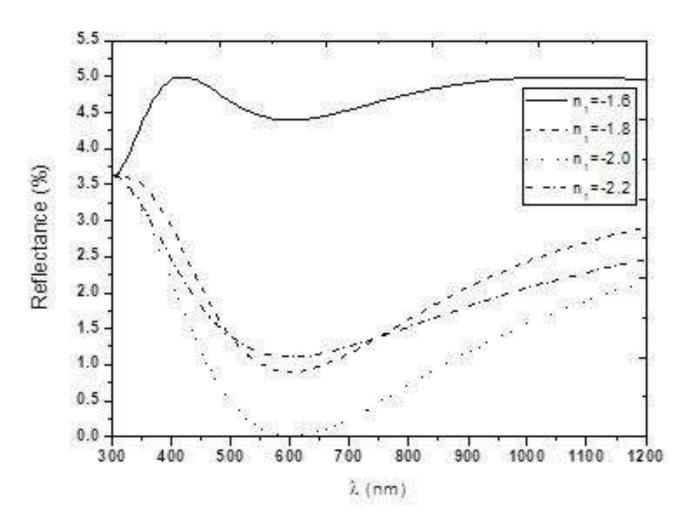
$$R = \frac{R^{TE} + R^{TM}}{2}$$

#### **Results**

Normal incidence with  $n_1=-2$ .

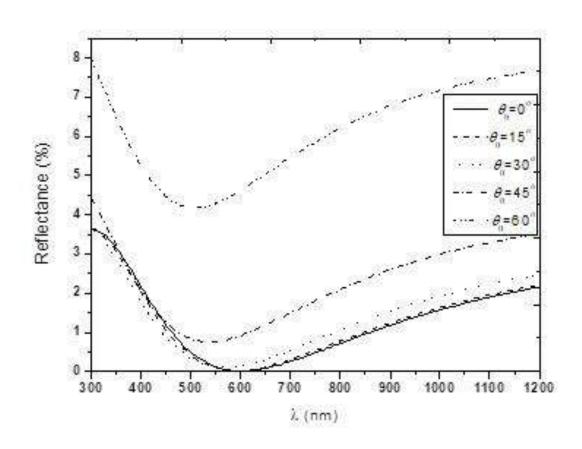


#### **Results**



The reflectance for  $n_2=2$  and under normal incidence.

#### **Results**



#### A compact very wideband amplifying filter based on RTD loaded composite right/left-handed transmission lines

- A Transmission lines(TL) is a device designed to guide electrical energy from one point to another. It is used, for example, to transfer the output radio frequency energy of a transmitter to an antenna.
- The composite right/left-handed (CRLH) transmission line (TL) is presented as a general TL possessing both left-handed (LH) and right-handed (RH) natures.
- to design and analyze nonlinear CRLH-TL transmission line loaded with resonant tunneling diode (RTD).
- The main application of this design is a very wideband and compact filter that amplifies the travelling signal. We used OrCAD and ADS software to analyze the proposed circuit.

### **Transmission lines (TL)**

$$Z = j \omega \mu_{eff}$$
  $Y = j \omega \varepsilon_{eff}$ 

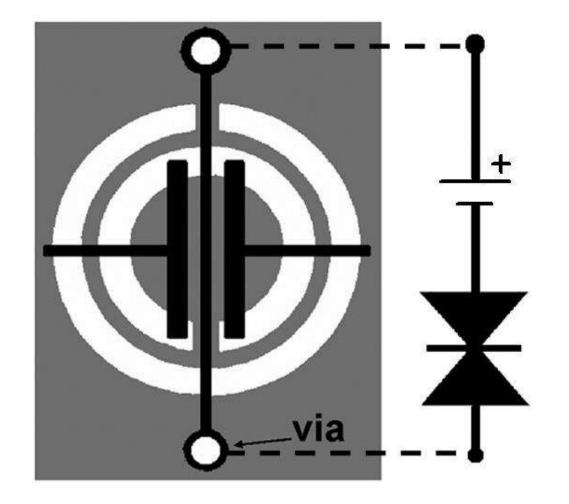
Impedance	admittance		
Z	Y	Medium	Propagating
>0	>0	Conventional TL. DPS	YES
>0	<0	SNG	NO
<0	>0	SNG	NO
<0	<0	Dual TL DNG	YES

### Composite Left/Right handed TL



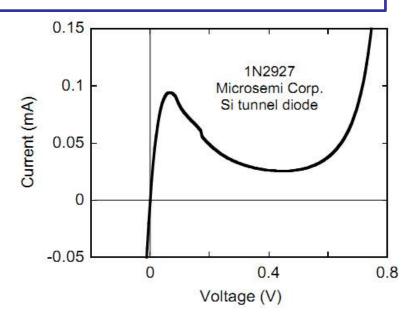
#### The model

- We put the RTD and DC voltage source at shunt with grounded stubs of CRLH-TL cell
- tune the DC voltage source until achieve the desired design.



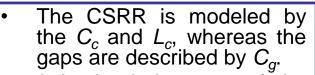
### Resonant tunneling diode (RTD)

 A resonant tunneling diode (RTD) is a diode with a resonant-tunneling structure in which electrons can tunnel through some resonant states at certain energy levels

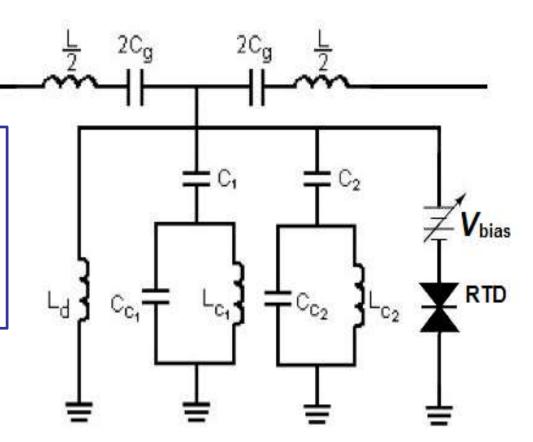


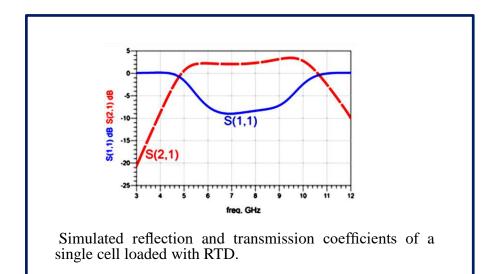
- have more interesting features referring to the high switching speed (can achieve a maximum frequency of up to 2.2 THz) and to the I-V characteristic that often exhibits negative differential resistance (NDR) regions.
- It is used in wide range of applications such as an amplifier, pulse generators, ADCs and oscillators.

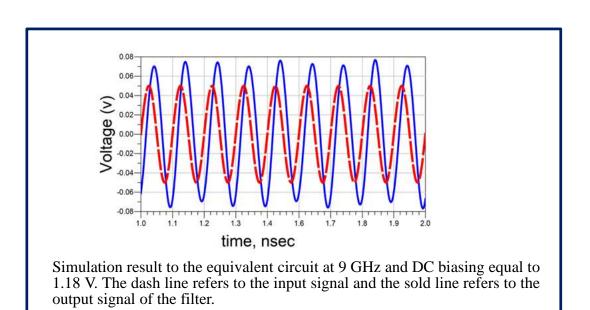
#### equivalent circuit model



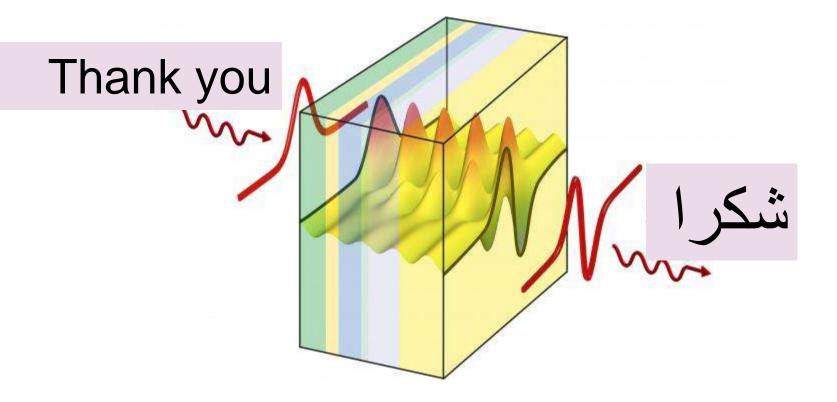
• L is the inductance of the line, while C is the electric coupling between the line and CSRR, and the two shunt stubs modeled by  $L_d$ .







- Our work is an ultra-wideband filter with amplification up to 50% at frequency range form 5-10.5 GHz.
- The filter is constructed by combining the RTD with CRLH-TL based on hybrid CSRR



#### RESEARCH AND INNOVATION FOR ECONOMIC DEVELOPMENT

#### IRFAN AHMAD

Assistant Dean for Research, Carle Illinois College of Medicine, University of Illinois at Urbana-Champaign, USA

#### **ABSTRACT**



Research and innovation are critical to poverty alleviation and economic development to build stronger communities. The sustainability of such endeavors is mostly based on capacity building and nurturing of skills locally. To achieve these objectives a multi-pronged approach is needed involving dedicated financial support for scientific research, technology, innovation, entrepreneurship, governmental policy-making structures, the parliament, viable communication, and most importantly across board transparency. Among some of the areas, which can benefit are bionanotechnology, digital health and agriculture, artificial intelligence, and machine learning-driven applications across the broad spectrum of the economy, energy, and the

environment. It is argued that innovation-based entrepreneurship is a precursor to a healthy economy.

For example, approximately 80% of the global R&D expenditure is spent by developed countries, of which 33.5% is by the USA, 23.5% by the EU, and 13.4% by Japan. Whereas, the OIC countries account for only 1.8% of the world's total Gross Domestic Expenditures on R&D; and according to the World Bank, Pakistan spends a measly 0.2%.

The federally funded research and development at the University of Illinois System in the U.S. is an engine for statewide and regional economic development, which contributes \$19 billion annually to the state's economy, and supports nearly 164,200 jobs, or one out of every 46 jobs in Illinois. Is this a model for the OIC countries to follow? What will it take to put the process in place? We will discuss this during the session with co-panelists Dr. Munir Nayfeh and Dr. Bulent Aydogan.



Irfan S. Ahmad

Research and Innovation for Economic Development

March 7-8, 2023 Islamic World Academy of Sciences ICCBS, Karachi, Pakistan

#### **I**ILLINOIS

Holonyak Micro &
Nanotechnology Laboratory
GRAINGER COLLEGE OF ENGINEERING



#### **Presentation Outline**

- Perspective
- Innovation Campus
- Benchmarking
- IUCRCs
- Summary and Conclusions
- Recommendations
- Acknowledgments



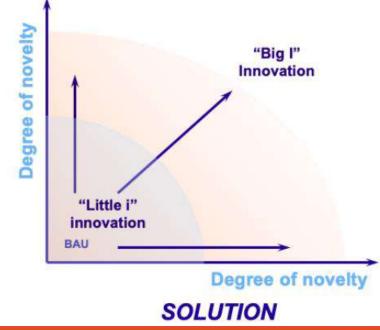
# **Defining Innovation**



### How do you Define Innovation?

"process of taking ideas from inception to impact"

- MIT's Innovation Initiative (MITii)



PROBLEM

# **Innovation Campus**

Discovery Partners Institute; Cornell Tech; Virginia Tech Innovation in Washington D.C.; U Mich in Detroit; Northeastern in Maine; USA



#### **US and UK-wide Innovation Hubs**

- Silicon Valley
- Boston
- New York
- Triangle Park
- Austin, TX

#### UK

- London
- Golden Triangle



### **Economic Development**

- Innovation-based Entrepreneurship: a Bedrock for Economic Development
- Knowledge Transfer and the free flow of ideas among OIC Countries- is the key to innovation
- Basic Research across borders with Translational Research in Developing Countries
- Basic Research Generates New Knowledge and Scientific Research Peaks at 8 years in comparison to 3 years (patents/licensing) for translational research
- Tech campuses solve two major needs: talent and technology (Collins, L.)



# From Rural-Urban to Metropolitan

DPI, Cornell Tech, Virginia Innovation Campuses



#### What it Takes

- Bold Ideas
- Willingness to take Risks
- Outward Facing
- Action-oriented Culture
- Innovation



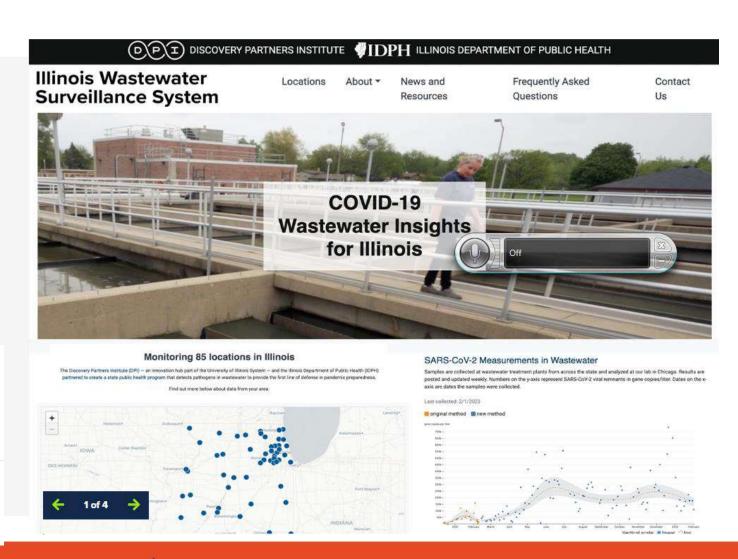


## Wastewater data in real time

Check out the new online COVID-19 dashboard from IDPH and DPI

Discovery Partners Institute receives \$2.36 million disease-control contract from Chicago Department of Public Health

The two-year extension will enable real-time monitoring of contagious diseases beyond COVID-19 February 21, 2023 (CHICAGO) —The ...



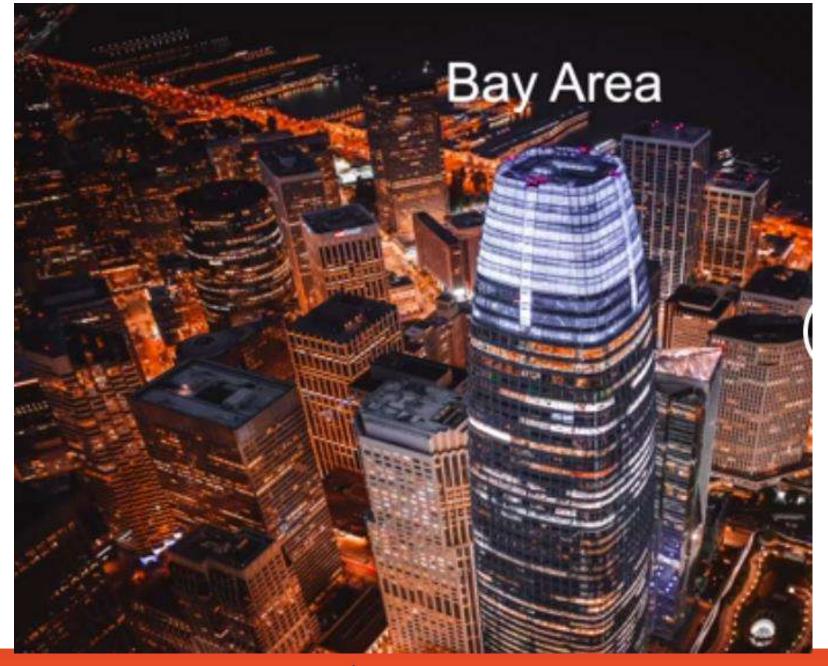
### Chan Zuckerberg Biotech Center in Chicago

In March 2, 2023:

The Chan Zuckerberg Initiative (CZI) announced the launch of a new biomedical research hub in Chicago

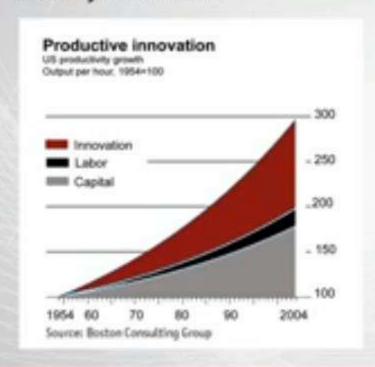
CZI that will bring together the University of Chicago, Northwestern University and the University of Illinois Urbana-Champaign, with the goal of solving grand challenges in science on a 10- to 15-year time horizon.





#### In the 21st Century innovation will be key to unlocking economic growth...

Growth in productivity is increasingly driven by innovation...



...and innovation is strongly linked with academic research.

"US employment and income growth over the next decade will depend critically on educational attainment in STEM fields."



Goldman Sachs Global Markets Institute, June 2010



### **Cornell Tech in NYC**







Collins, Lance, 2023





Collins, Lance, 2023





Collins, Lance, 2023





Driving a new era for the greater Washington, D.C. region's technology ecosystem.



# PURPOSE-DRIVEN RESEARCH





- Artificial Intelligence and Machine Learning
- \* "Next G" Wireless Communication
- Cloud/Edge computing
- Quantum Information Science and Technology (OIST)

- Immersive Technology (Virtual Reality, Augmented Reality)
- Technology Policy, Business & Entrepreneurship
- Human-Centered Technology Design



Ref. Lance Collins, 2023

# International Science, Research, Innovation, Technology Systems (SRITS)







### **Univ-Industry Collaboration in Asia**

VinhU TSMC



# EXAMPLE FROM UIUC



# Research and Innovation

University of Illinois at Urbana-Champaign

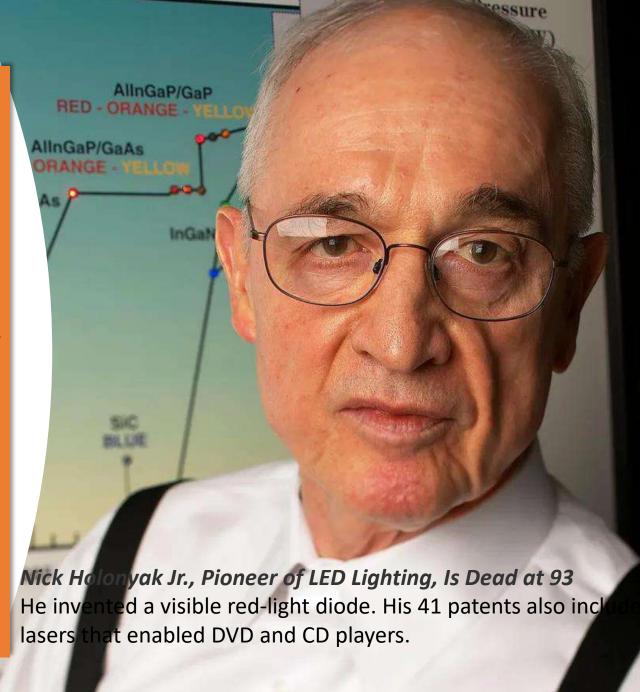


**Nick Holonyak Jr.,** a prolific inventor and longtime professor of electrical engineering and computing, died on 17 September at the age of 93.

In 1962, while working as a consulting scientist at <u>General Electric</u>'s Advanced Semiconductor Laboratory, **he invented the first practical visible-spectrum LED**. It is now used in light bulbs and lasers.

Holonyak left GE in 1963 to become a professor of electrical and computer engineering and researcher at his alma mater, the <u>University of Illinois</u> Urbana-Champaign. He retired from the university in 2013.

Holonyak received the 2003 <u>IEEE Medal of Honor</u> for "a career of pioneering contributions to semiconductors, including the growth of semiconductor alloys and heterojunctions, and to visible light-emitting diodes and injection lasers."



## Illinois Pedigree

Excellence in Science, Technology, and Engineering

and its broad societal impact



John Bardeen 1908-1991 Two-time Nobel Laureate, 1956, 1972

Transaco; and Superconductivity

Worldwide market \$17B, 2021



Jack S. Kilby 1923-2005 Nobel Laureate, 2000

Circuit

Worldwide

Worldwide market \$480B, 2022



Paul Lauterbur 1929-2007 Nobel Laureate, 2003

Resonance Imaging Worldwide market \$7.38 MRI



Anthony J. Leggett 1938-Nobel Laureate, 2003 Superfluidity

Set research directions to test the foundations of quantum mechanics



Nick Holonyak 1928-2022

National Medals of Science, and Technology, 1990, 2002

Oght Emitting Dinds: and Compact Disc

(Worldwide-matter) ( UFI) 5/95 (00)



Carl R. Woese 1928-2012 National Medal of Science, 2000; Crafoord Prize in Biology, 2003

Phylogenetic taxoniciny (F165 tinesumal RMA

Excellence

Innovation

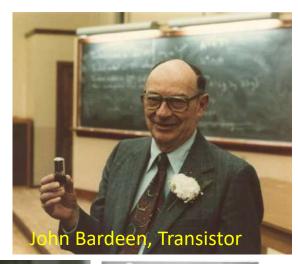
Leadership

and the tradition continues...

CNST University of Illinois Center for Nanoscale Science and Technology

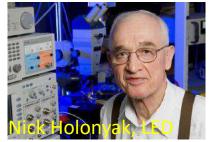


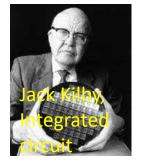
www.cnst.illinois.edu



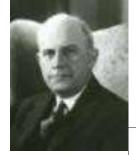






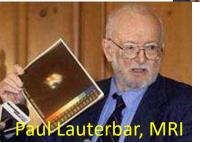














# **Innovations and Technology**

- Transistor (John Bardeen, Nobel Prize is the single most important invention of the last half of the century.
- A paradigm shifting- transformative phenomenon, and the building block for the microchip.
- We do take it for granted the modern day devices such as cellular phones, ipads, laptops, computers, ATMs, microwave ovens, automobiles, satellites and the list goes on.
- I say, if there was a single switch, and if it were turned off, the world will literally stop as we know it.

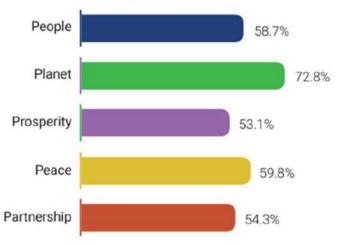


Figure 5: IsDB MCs SDGs Achievement by 17 Goals, 2021



Source: IsDB Institute "Reaching the SDGs: Progress of the IsDB Member Countries, 2021"

Figure 6: IsDB MCs SDGs Achievement by the Five Dimensions (5Ps), 2021



Source: IsDB Institute "Reaching the SDGs: Progress of the IsDB Member Countries, 2021"



# Science and Technology Investments

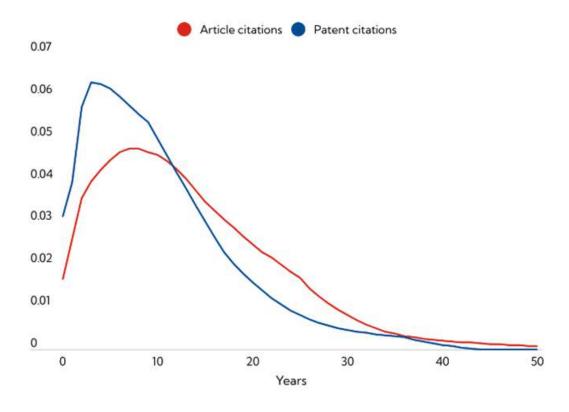
- Have systemic implications and complementarities that,
- Invested thoughtfully, could enhance opportunities to succeed across multiple objectives.



#### Relevant for longer

Scientific articles continue to be cited years after publication, suggesting basic research has a longer-lasting influence than applied research.

(density)



Sources: PATSTAT; Reliance on Science; and IMF staff calculations.

Note: Shows the temporal distribution of citations to basic (patent to article citations) and applied research (patent to patent citations) as a way to measure the influence of respective research in time. Basic research is found to be relevant for a longer time than applied research. The sample is restricted to patents from 2010–19. Axis truncated at 50 years.





US innovation ecosystem's mix of mission-based agencies helped create a revolution in computing:

"By funding a mix of work in universities and industry, [the United States] was able to marry long-term objectives to real-world problems. And, by channeling its funding through a variety of federal agencies, it was able to ensure broad-based coverage of many technological approaches and to address a range of technical problems."

-US National Research Council



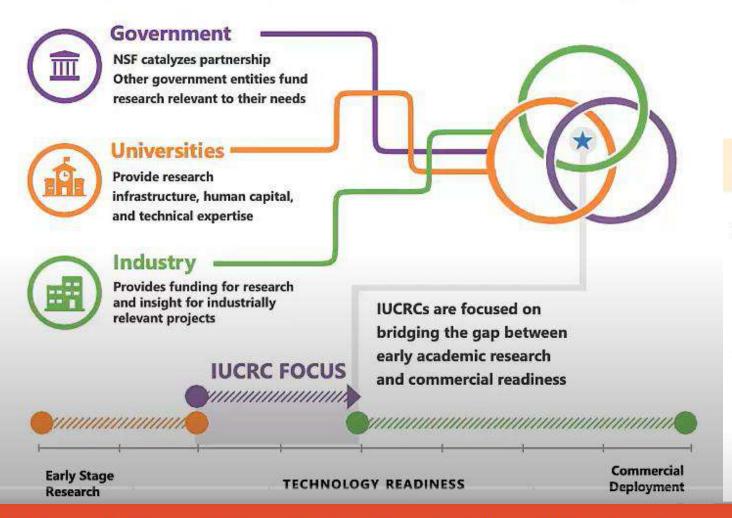
# Industry University Cooperative Research Centers

A Model for Industry-driven Translational Research for Economic Development



#### **IUCRC – A Collaborative Partnership**

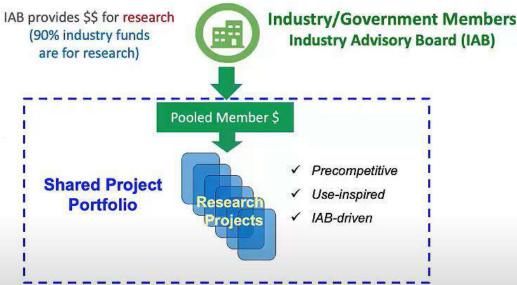
Perform cutting-edge pre-competitive basic research in science & engineering to drive innovation and societal impact



Every year, more than 2,000 students engage in industrially-relevant research at Centers nationwide, giving them on the job training for a career in the private sector. About 30% of these student researchers are hired by the member companies.

NSF created the IUCRC program in 1973 to foster long-term partnerships among industry, academe and government. These partnerships support research programs of mutual interest, contribute to the nation's research infrastructure base, promote workforce development, and facilitate technology transfer.

#### **IUCRC – Program Framework**



# **Industry University Cooperative Research Center**

#### Vision:

 To expand the innovation capacity of the nation's competitive workforce through partnerships between industries and universities (and government)

#### Mission:

- To contribute to the nation's research infrastructure base by developing long-term partnerships among industry, academe and government
- To leverage federal funds with industry to support graduate students performing industrially relevant research



## The Economic Benefit: Research to Innovation

- For over four decades the IUCRC Program has catalyzed partnerships among industry sectors, academe, and government.
- Until 2015, there were over 77 active centers involving approximately
   180 universities and 775 industry partners
- The NSF Directorates invested a combined total of approximately 20 million dollars in the IUCRC program; while the industry invested in excess of \$130 million dollars primarily in the form of center memberships.
- The vast majority of industry funds were used to provide direct research support.





**Medical Innovations** 

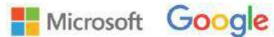
in eXtEnded Reality







**VR. Simulation** https://vimeo.com/772895813



























ADVANCED FECHNOLOGIES

smartlens









# Carle Illinois Students Perform Holographic Clinical Simulation with Asthmatic Patient, View Impact on the Lung, and Debrief

https://vimeo.com/772895813

Medicine.ilinois.edu









HOME ABOUT RESEARCH MEMBERS CONTACT REGISTER NOW TEAM



Industry University Cooperative Research Center (IUCRC), CARD is a "gateway" program designed to open up university research to member companies.

With projects focused on novel drying technologies, innovative sensor development, and smart oven technologies, CARD has the knowledge, resources, and creativity to make a significant impact on businesses worldwide.



























**Past Members** 











An NSF Industry-University Cooperative Research Phase 1 Center

Center for Advanced Semiconductor Chips with Accelerated Performance (ASAP)

Research V Industry Engagement V **Diversity and Outreach** News Events V People Addressing energy and performance challenges of data communication from microscale to macroscale



## Industry / University Cooperative Research Center Center for Innovative Instrumentation Technology





#### What is an Industry/University Cooperative Research Center?

- NSF funds operations, IAB members fund research areas of their interest
- Industry Advisory Board Members pay \$50k annually at 10% overhead
- Over 1000 I/UCRC memberships across ~70 centers
- Level of Interest and Feedback Evaluation (LIFE) Process
- NSF I/UCRC Program has been running for 40 years

# Center for Agricultural, Biomedical, and Pharmaceutical Nanotechnology (CABPN) National Science Foundation Industry/University Cooperative Research Center's VUCRCs Enable Discovery and Innovation through Collaboration To conduct industrially-relevant fundamental research, enhance graduate, education and research, and facilitate technology transfer to industry and facilitate technology transfer to industry project Delivery (Project Director). In the Industrial Project Delivery (Project Director). In the Industrial Project Delivery (Point of Care and Technology and Technology and Technology and Technology and Technology (Point of Care and Technology and Technology and Technology and Technology (Point of Care and Technology and Technology and Technology (Point of Care and Technology and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology (Point of Care and Technology and Technology and Technology (Point of Care and Technology and Technology and Technology (Point of Care and Technology and Technology and Technology and Technology and Technology (Point of Care and Technology and Tech

#### Sensor Platforms

- Optical Chem/Biosensors
- Microelectronic Sensors
- Imaging Modalities
- Smartphone-Based
- Micro/Nanofluidics

#### Nanosensors

- Diagnostics
- Food Safety
- Process Analytical
- Pharma Screening
- Point of Use/care
- Agricultural Sensors

#### **Applications**

- Life Science Tools
- Agricultural Systems
- Food Safety Sensors
- Mobile Systems
- Water Quality Monitoring



instrumentation.illinois.edu

CiiT Recently completed





#### Industry / University Cooperative Research Center Center for Innovative Instrumentation Technology

**Contributors** 



Members

Baxter

Dow AgroSciences

Kraft



Abbott

A Promise for Life

Daktari

#### **Facilities**



Micro and Nanotechnology

Beckman Institute

for Advanced Science and

Technology



Dr. Brian T. Cunningham ECE / BioE CiiT Director MNTL Director





Dr. Irfan Ahmad ABE, CiiT co-PI, CNST Exec. Director



Dr. Rashid Bashir ECE / BioE CiiT co-PI, BioE Head



Veterinary Medicine small and large animal clinics



Dr. Paul Hergenrother Chemistry CiiT co-PI



Dr. Lila Vodkin **Crop Sciences** CiiT co-PI



Frederick Seitz Materials Research Lab



Dr. Rohit Bhargava



Dr. Paul Kenis Chemical & Biomolecular Eng.



MONSANTO







Institute for Genomic Biology



Dr. Jianjun Cheng MatSE



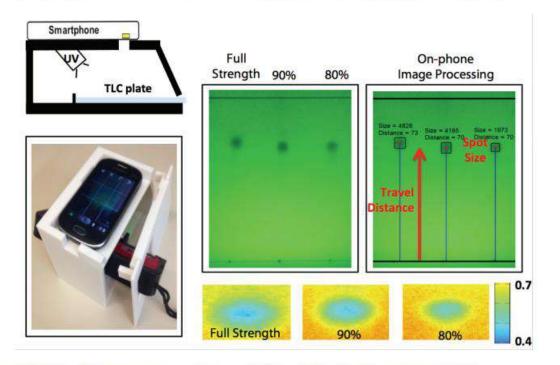
Dr. Logan Liu ECE / BioE

 Center for Innovative Instrumentation Technology (CiiT)

#### Smartphone Platform for Determining Prescription Drug Authenticity

Twenty-five percent (25%) of drugs distributed in Africa are counterfeit. CiT researchers developed an innovative system that uses Thin-Plate Chromatography, a smartphone cradle, and a smartphone calibrated camera that determines the authenticity of drugs. This is a novel device/instrument for the life sciences. In addition to fabricating devices, the CiT research group is also focused on the design, prototyping, and testing of biosensor instrumentation for high sensitivity, portability, and resolution.

Advanced instruments enable high resolution imaging of biochemical and cellular interactions. They provide the ability to monitor images of biochemical interactions as a function of time. Using the sensors and instrumentation, researchers are exploring new applications for optical biosensor technology including protein microarrays, biosensor/mass spectrometry systems, and microfluidics-based assays. All of these use nanoliter quantities of reagents. The methods and systems developed in the laboratory are then applied in the fields of life science research, drug discovery, diagnostic testing, and environmental monitoring.



Smartphone Thin Layer Chromatography. An example of testing Amodiaquine, a malaria therapy. Image provided by Brian T. Cunningham, University of Illinois at Urbana-Champaign.

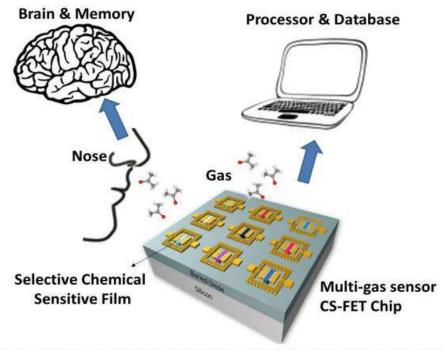
# Berkeley Sensors and Actuators (BSAC)

#### Berkeley Sensors and Actuators (BSAC)

University of California, Berkeley, Richard S. Muller, 510.642.0614, muller@berkeley.edu University of California, Berkeley, Michael Cable, 510.643.5663, mdcable@berkeley.edu University of California, Davis, David Horsley, 530.341.3236, dahorsley@ucdavis.edu

#### **Chemical Sensitive Field Effect Transistor**

Chemicals are all around us all. Sometimes they are toxic to our health. Knowing information about the chemical composition of our surrounding environment can allow us to take safety measures in attempts to protect our health; thus enabling preventive health-care to be practiced when needed more deliberatively. Current research on wearable technology indicates that vital information about our physiological state can be ascertained by measuring and quantifying specific chemicals in our breath and sweat. Because of this, there are increasing demands for sensitive, selective and low power chemical sensors that can be integrated with personal mobile consumer electronics.

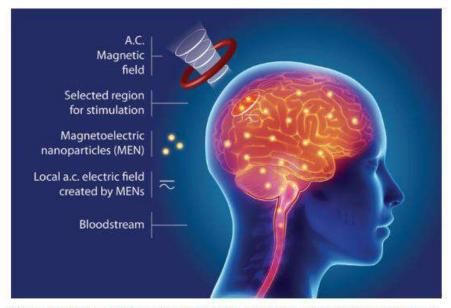


The CS-FET is a low power gas sensor technology platform providing sensitive and selective multi-gas detection in a miniaturized, scalable single chip form-factor. Enabled by conventional silicon processing techniques, the CS-FET is a biomimicry of the human nose. Image provided by Ali Javey, EECS, UC Berkeley.

#### Wireless Deep-Brain Stimulation With Magnetoelectric Nanoparticles

The brain is a complex bio-electric circuit made of billions of neurons that are inter-connected through chemical and electrical synapses. The ability to remotely stimulate selective neurons deep in the brain remains a major challenge. Overcoming it will enable highly personalized "pin-point" treatments for neuro-degenerative diseases such as Parkinson's and Alzheimer's Diseases, Essential Tremor (ET), Epilepsy, and others. Furthermore, by the law of reciprocity, this nanotechnology can pave a way for reverse-brain engineering.

This FIU team has invented and patented a technology (S. Khizroev and M. Nair, "Wireless brain stimulation," U.S. Patent application 13/900,305, filed 05/22/2013, granted 01/26/2016) to answer the above challenge by using a novel class of multifunctional nanoparticles known as magnetoelectric nanoparticles (MENs). Because of MENs capability to couple magnetic and electric fields at the sub-neuronal level, they enable a unique way to combine the advantages of both the high efficacy stimulation by the electric fields and the external-control capability of the magnetic fields. They therefore open a novel pathway to control the brain.



Wireless deep-brain stimulation with Magnetoelectric Nanoparticles administrated into the brain via an IV injection. Image provided by CAKE.

This study, conducted on mice, demonstrated for the first time the feasibility of using MENs as externally controlled "smart" nanoparticles for wireless navigation and selective control of specific functions deep in

22 2016 Compendium of Industry-Nominated NSF I/UCRC Technological Breakthroughs

Economic impact: According to the 2011 technology assessment by experts at the California Institute of Technology, the deep-brain stimulation (DBS) market was around \$360 million. Conservative projections indicate that the technology can impact the multi-billion-dollar medical and information processing market segments

# Role of AI/ML in Digital Health, Agriculture, Cybersecurity

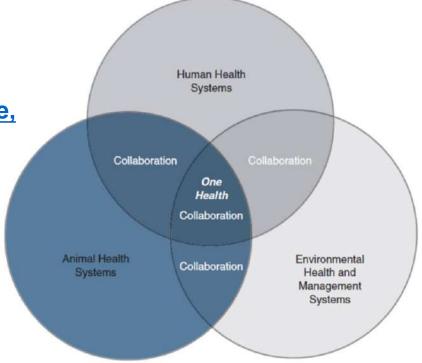
- Pandemic-driven digital transformations
  - o Telehealth
  - Adaptive and Agile Technologies
  - Work Flexibility
  - Decentralization
- Digital Trust
- Trustworthy Technologies/Systems
- Deploying AI as a Strategic Approach
- Scalability through AI
- Optimization of solutions through Multidisciplinary Teams



### **One-Health**

- Climate-Smart Agriculture. Or Environment-Friendly Agriculture
- One Health: Animal, Human, and Ecosystem Health

• The "One Health" approach proactively engages different disciplines, such as human medicine, veterinary medicine, and environmental health sciences, to attain optimal health for people, animals and our environment



# Advancing Local Economic Development Universities

- Outside of major metropolitan areas have the potential for promoting economic development due to their scope and scale of resources, which are often abundant in comparison to other relevant public and private entities in their region.
- Universities in this context often surpass other organizations in spending power, talent generation, technical expertise, and the creation of knowledge-based companies.
- Many universities are not aware of local government or economic development groups that could help them to increase their local impact. They may be missing out on opportunities, such as using empty industrial space for colocation space or startups. At the state level, they may be missing out on procuring monies through third-party tax credits.

https://uidp.org/wp-content/uploads/2020/08/U-I-Engagement-Outside-Major-Metropolitan-Areas-and-Megacities-Identifying-Issues-and-Finding-Solutions.pdf



# Digital Transformation

Agriculture, Health, E-Governance



## The World Bank Data Speaks for itself

India	2020	474	1
Indonesia	2020	1,889	1
Iran, Islamic Rep.	2020	2,331	j
Norway	2020	39,030	
Oman	2020	262	<i>\</i>
Pakistan	2020	72	
Palau	2020	946	5.



The real promise of AI is unlocking that 97% of the data that goes underutilized. Al technology is a tool. It is not an answer, but it's a tool to help you get to the answer. Director Platforms and Technologies in Health and Life Sciences International Tech Company

# **Economic growth is the systematic**

- A defining feature of modern economic growth is the systematic application of science to advance technology.
- Many innovations that spurred economic growth in the twentieth century, including synthetic fibers, plastics, integrated circuits, and gene therapy, originated from advances in the natural sciences, engineering, and medicine.
- Science, by producing "a potential for technology far greater than existed previously," clearly distinguishes modern economic growth from previous economic epochs (Kuznets 1971).



# The Old Innovation Ecosystem: 1850–1940

- Late nineteenth and early twentieth centuries independent inventors were the primary source of American inventions, the locus of innovation shifted during the interwar years from such inventors and small firms to large corporations and their labs.
- After World War II, corporate labs reached their zenith, with corporate scientists winning a number of Nobel Prizes.
- By the 1980s, however, small firms (often founded by university scientists)
  regained their advantage because the postwar period also saw the rise of
  the research university. Universities went from merely being the producers
  of human capital to becoming the dominant producers of scientific
  knowledge.



# The Innovation Ecosystem in Transition: 1900–1940

#### The Beginnings of Corporate Research

- Several pushes and pulls propelled American corporations to create large R&D laboratories. First, the German precedent of industrial research in chemical firms allowed for firms such as BASF, Bayer, and Agfa to thrive in organic synthetic dyes in a highly competitive international market (Reich 1985, 41).
- Second, the strategy of acquiring patents was becoming difficult to implement because of the rising complexity of technologies. For example, DuPont had repeatedly failed in its attempt to use the Bevan, Cross and Topham patents from the United Kingdom to start a viscose rayon process in the United States in the 1910s. It lacked the internal technical and scientific capability to understand these patents and the know-how to use them. Eventually, a joint venture with Britain's Samuel Courtauld & Company (which had the know-how and manufacturing expertise) was necessary to start viscose rayon production in America (Hounshell 1988). Third, American inventions were challenged by science-based competition across the Atlantic. General Electric's (GE) control over electric lighting in the 1890s, for instance, was solely based on the carbon-filament high-vacuum incandescent variety, first invented by Thomas Edison in 1879. German chemists Carl Welsbach and Walther Nernst, the 1920 Nobel Laureate in Chemistry, respectively, invented incandescent mantels for gas lamps (a substitute product) and a glower that required no vacuum to operate that was 50% more efficient. Patent rights to the Nernst glower in turn were first sold to the German firm AEG for \$1 million and then sold to GE's rival, Westinghouse, in 1894 (Wise 1985). GE management took notice of this "pandora effect" of innovative activity that was difficult to circumscribe and control and thereby approved electrochemist Charles Steinmetz's proposal to establish the GE Research Laboratory (GERL) in 1900. The payoffs were not long in coming: William Coolidge in 1906 developed a method using tungsten instead of carbon filaments to increase bulb life, and Irving Langmuir in 1913 invented the inert gas-filled lightbulb to reduce blackening, which became the industry standard.

# **Policy-driven Innovation**

- Government Regulation is key to nurturing of the innovation ecosystem
- Lot of discovery
- Particularly meaningful to fail fast, and failure should be seen as a learning experience, most investors actually value that!



# Think Globally Act Locally

- The issue is not being like the Silicon Valley or the Triangle Park
- But to be uniquely local
- So what can we do within OIC countries, within Pakistan



# **Science and Engineering**

- Science is the foundation for facts and arriving at the truth
- Universities are the foundations for generating scientific knowledge
- Scholarship
- Truth
- Integrity
- Reputation
- Culture



## Aspects to be Considered

- Technical competence
- Expertise in the organization and management of large scale enterprises
- Financial Institutions and Markets capable of mobilizing capital at a large scale
- Honesty and integrity
- Political stability of the government and its effectiveness in promulgating rules and enforcing them



## What are we talking about

- Invention (patents, copyrights)
- Innovation generally not patentable
- Therefore, the innovation output/capability is hard to measure, in Pakistan it is called "jugadh"



# **Measuring Capabilities**

Table 1. Measuring capabilities

Dimension	Measure
Science, research and innovation	Scientific publications, patents, R&D (total/business), innovation counts
Openness	Openness to trade, foreign direct investment, research cooperation/alliances with foreign partners, technology licensing, immigration
Production quality/standards	International (ISO) standards, total quality management (TQM), lean production, just-in-time
ICT infrastructure	Telecommunications, internet, computers
Finance	Access to bank credit, stock-market, venture capital
Skills	Primary, secondary and tertiary education, managerial, and technical skills
Quality of governance	Corruption, law and order, independence of courts, property rights, business friendly regulation
Social values	Civic activities, trust, tolerance, religious ethics, attitudes towards technology and science

Adapted from Fagerberg and Srholec (2008),

## **Funding Resources**

- Research and Innovation for Global Health Transformation (RIGHT) program funds interdisciplinary applied
  health research in low and middle-income countries (LMICs) on areas of unmet need where a strategic and
  targeted investment can result in a transformative impact.
- https://www.nihr.ac.uk/explore-nihr/funding-programmes/research-and-innovation-for-global-health-transformation.htm



# Using the Crowd as an Innovation Partner

### **Corporate or Academic Model**

- Well-coordinated environment
- Generating and organizing specialized knowledge

### **Crowd Model**

- Loose and decentralized
- Problem is exposed to:
- diverse individuals, w/
- varying skills
- experience
- perspectives
- Can operate at a scale much bigger than a complex corporate structure

## **Policy Impetus**

- Bayh-Dole Act 1980: Requiring univ to translate research to tech
- Each agency contributes ??% to SBIR/STTR
- Setup office s of Technology Management (OTM), IP, Trademarks
- Innovation Park
- Tech Campus
- Computing
- Local Needs/Strategy



# Benchmarking

Muslim Countries



# Eye Opener Statistic from IsDB

- The pandemic is estimated to have dropped 51 million additional people into extreme poverty in the IsDB MCs.
- While IsDB MCs constitute about 25
  percent of the world population, they
  account for approximately 40 percent
  of the people in extreme poverty
  around the world.
- Based on the available data, extreme poverty in IsDB MCs is highly concentrated in the rural areas where about 91 percent of the extremely poor reside.

#### Al-driven COVID-19 Research in Tajikistan



IsDB Transform Fund supported Tajrupt, a 2018 Transform Fund winner from Tajikistan focusing on computer science education and artificial intelligence (AI) research capacity, has recently partnered with Microsoft to build a machine-learning algorithm for healthcare amidst the COVID-19 pandemic. He has launched Tajrupt.ai (TAI) which is Central Asia's first artificial intelligence lab that trains machine learning (ML) education and entrepreneurship to high-school and engineering students through its supervised ML curriculum incorporating statistics, calculus, and programming.

TAI has also partnered locally to implement AI to minimize financial sector shocks: Use of machine learning can "better predict losses and defaults than traditional models in the presence of a negative shock to the aggregate credit supply," – a context indicated by Bank of International Settlements, that matches Tajikistan's current situation with economic effects of COVID-19. In this regard, TAI has partnered with two leading financial institutions in Tajikistan to deploy AI

# A Broad Perspective





# SUSTAINABLE GALS DEVELOPMENT GALS

17 GOALS TO TRANSFORM OUR WORLD





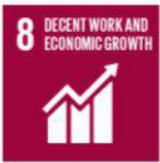


























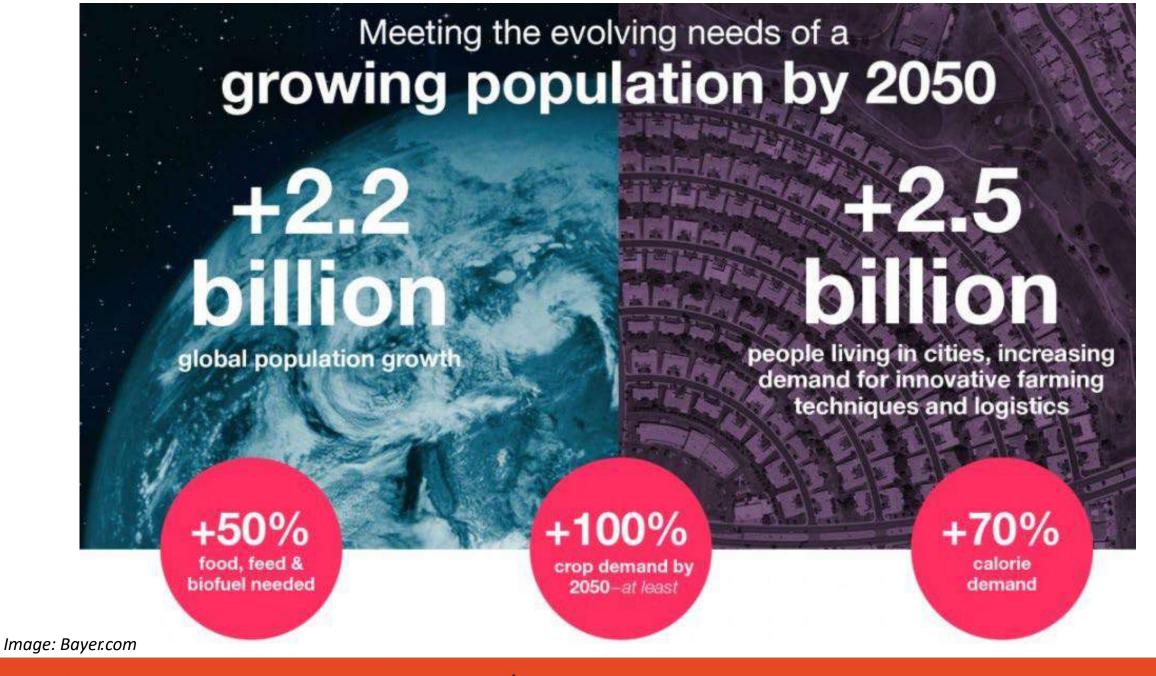




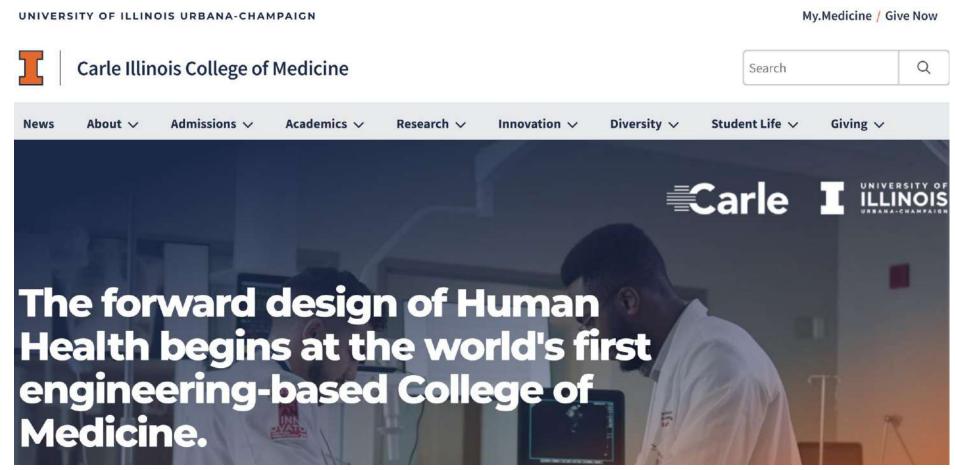


UN, 2015





## **Training of Physician Innovators**





# Health Innovation at the Intersection of Engineering and Medicine

Irfan S. Ahmad
Assistant Dean for Research
Executive Director, Health Maker Lab; and
Executive Director Interdisciplinary Initiatives,
Grainger College of Engineering

Carle Illinois
COLLEGE OF MEDICINE

February 19, 2021
Livingston Securities
Experts Webinar Series





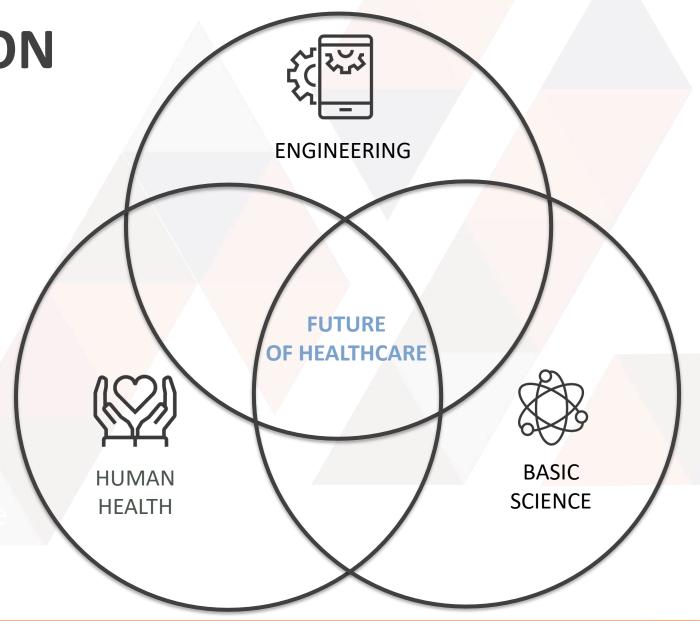


**OUR MISSION** 

Enable better healthcare for more people at lower cost by democratizing innovation at the intersection of engineering, basic science, and human health.

### **OUR CHARGE**

Find a problem, make an impact



### HEALTH Makerlab



# GOALS FOR CARLE ILLINOIS **COLLEGE OF MEDICINE RESEARCH**

- 1. CREATE a disruptive medical research culture
- 2. ESTABLISH a global presence from the start
- **3. BUILD** *Health Disparities* and *Data Analytics* into pervasive research threads
- **4. PIONEER** the field of *Progenerative Medicine*
- **5. PIONEER** the *Health Maker Lab: dream it, make it*
- **6. CATALYZE** transformative research in *Brain,*Cancer, Microbes, and First 1000 Days

Carle Illinois
COLLEGE OF MEDICINE



### HEALTH MAKERLAB



Compassion

**COMPETENCE** 

**CURIOSITY** 

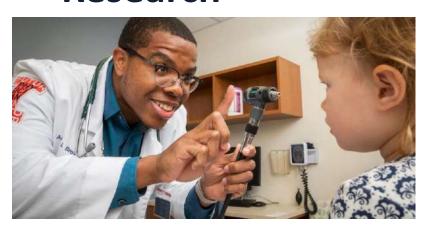
☐ CREATIVITY

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# MAKERLAB

**Building Competencies in** Engineering, Innovation, and Research



Carle Illinois **COLLEGE OF MEDICINE** 

### **CI MED**

### **FINDING YOUR WAY**

Phase 1

Pre-clinical courses, meet faculty, tour labs, Discovery – learn a technique, write a case report, outline a plan with a global site, do a literature search

### **ACQUIRING SKILLS** Phase 2

IDEA Projects course, Core Clerkships, Electives

# Phase 3

### **APPLYING SKILLS**

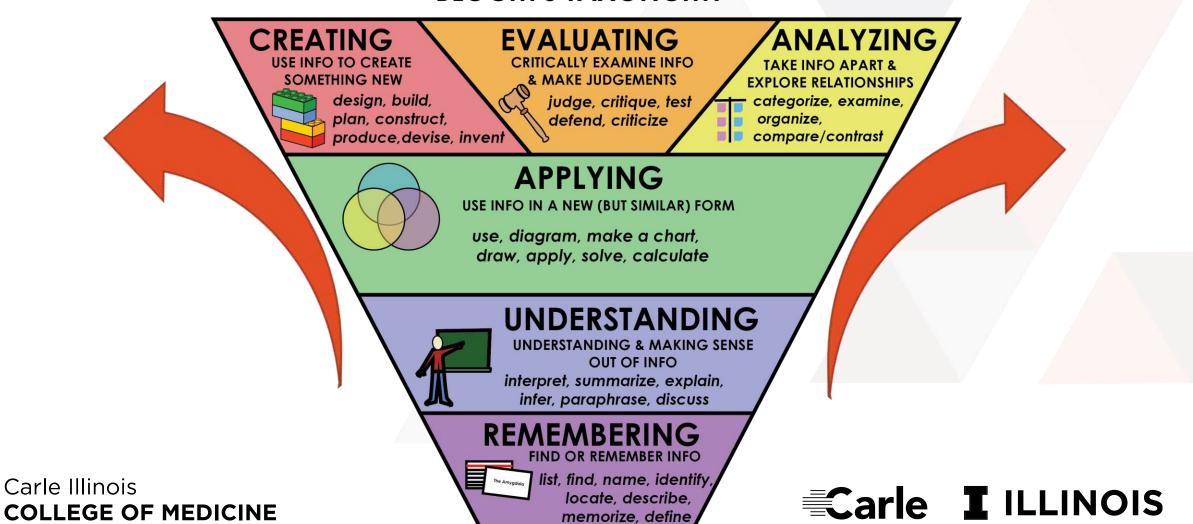
Capstone Project, Data Science Project, Electives





## Medical and Engineering Competencies

**BLOOM'S TAXONOMY** 





# Creating a culture of innovation



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### Health Maker Lab





# Recent Innovations

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### HEALTH MAKERLAB

**VR Cultural Competency Training** 

Victoria Fields vi Mardia Bishop vii Charee Thompson vii Sarah Bencivenga vi



### A Wire-Free EKG

Kenny Leung i



KordoFan Tayyaba Ali **v** 





**ECG** Shirt Hanna Erickson i Manisha Reddy v Meghna Basavaraju v



Sneha Subramanian vii Avani Patel iii





Music to my Ears Malik Ali Muhammad iv Ray Muhammad iii Asalah Muhammad v

Nano-Hyperbaric **Oxygen Delivery System** Michael Tsipursky ii

Joseph Irudayaraj vii Jordan Marsh i Neelabh Sharma v



**Preventing Renal Failure** 

Nathaniel Brooke i



**ProteCKD** Ariana Barreau i Andrew Chang i Priya Kumar v Sana Kamdar ii

Nomas Chow v Phani Gaddipati i



**STEM Vocabulary App** 

Mona Jawad v Ethan Gaughan v Aditi Adyan v Ayesha Kazi v Amy Le v Elizabeth Troy v Sri Medisetti **v**≡ Sumayyah Hussair



### **LEGEND**

i CI Med/COM Student ii Carle Physician **Iii** Community Member iv K-12 v Undergraduate Student vi Graduate Student vii UIUC Faculty/Staff

2020 Cohort

### HEALTH MAKERLAB





Portable Positive Pressure Ventilator

Mobola Kukoyi <mark>ii</mark> Roy Zhou **v** Matthew De Venecia **iii** 



Joy Chen v Adam Dama v

PillSafe Smart Cap

Ariana Alam Mizan iv



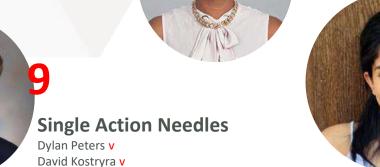
Project Escape
Sebastian Souyris vii
Aaron Brown i

Aaron Brown i Nekita Thomas vii





**Sepsig**Kavya Sudhir **v** 



I ILLIN

LEGEND
i CI Med/COM Student
ii Carle Physician
lii Community Member
iv K-12
v Undergraduate
Student
vi Graduate Student

vii UIUC Faculty/Staff



Carle Illinois
COLLEGE OF MEDICI



### 2019 Cohort

### HEALTH MAKERLAB

nouvo



V Amaury Saulsberry Akeem Kennedy V Trevor Sibby V Siyu Ai V Not pictured:

Kevin YuV

### ALICE SENSORS Mikaela Frechette vi

Thierry Guigma vi Widya Ramadhani vi



#### **LEGEND**

i CI Med/COM Student ii Carle Physician

III Community Member INOIS

iv K-12

v Undergraduate Student

vi Graduate Student vii UIUC Faculty/Staff **3E OF MEDICINE** 











PROGRAMMABLE PILL BOTTLE Dena StrongVII





MOBILE PHOTOTHERAPY SUIT

iiiSiddiqua Haswarey-Shari'at Yusef Shari'ati vi



4-IN-1 VITAL SIGN READER

Maaz Imam V Haajar Amin Mansour Kabir Fakoyay

Sarah Nixon iii

MINIATURE HORSE POWER



rle I ILLINOIS



# HEALTH MAKERLAB

## I-Personal Protective Equipment Menu

COVID-19 CDC **Guidelines** 

**FDA** Guidance **EUA** 



**Face Shield** 



Masks



Gowns



N95 Respirators



Sterilization













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COLLEGE OF MEDICINE



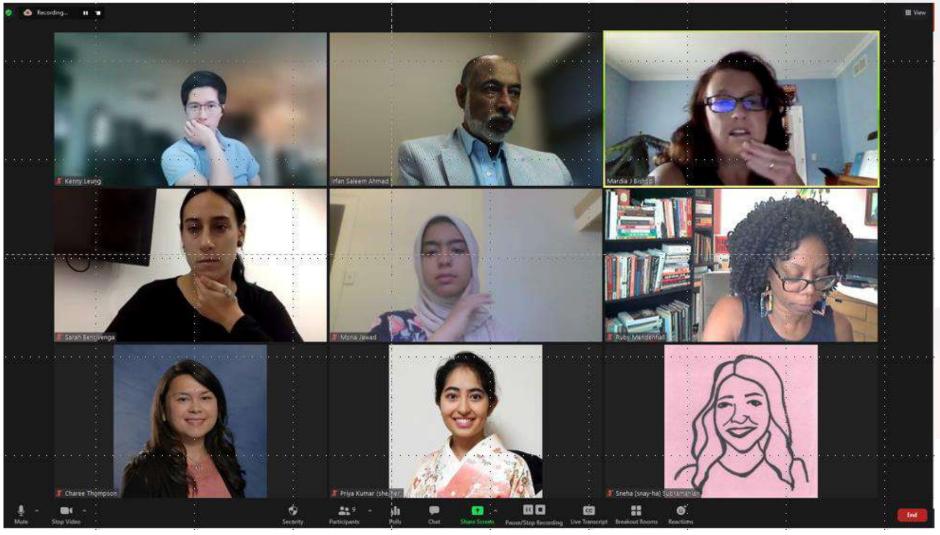
# ICCBS Role During the Pandemic-Commendable

 Providing COVID-19 testing facility (3000 tests/day), when the City of Karachi and the country as a whole were under a lot of stress to come up with meaningful but rapid innovative solutions





Sept 3 Monthly Mentoring Innovators Progress Zoom Meetings



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# Bionanotechnology



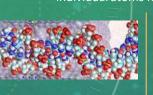
# Nanotechnology

through Time

1959 Richard Feynman gives a speech at annual meeting of American Physical Society which predicted physicists could manipulate matter at the molecular level



**1980** IBM scientists use a scanning tunneling microscope to directly image individual atoms for first time



### 1986

Word "nanotechnology" publicly used in Eric Drexler's

Binnig and Rohrer won Noble Prize in Physics for inventing scanning tunneling microscope



1998 US government organized Interagency Working Group on Nanotechnology

1996 Kroto, Smalley, and Curl's "buckyballs" earn them a Nobel Prize in Physics



### 2000

\$270 million for funding initiation of multi-agency NNI

NSF sponsored "Societa Implications of Nanoscience and Nanotechnology" workshop



#### 2004

**NSF** initiates competition for "Center for Nanotechnology in Society" funded at \$2.6 million

US Congress passes "21st Century Nanotechnology Research and Development Act"

**NCI** applies nanotechnology and research for early cancer detection



**2014** UI researchers study behavior of nanomembranes associated with transient electronics



2013 Stanford develops first carbon nanotube computer



1970

**1974** Japanese engineer Norio Taniguchi

used the word "nanotechnology"

nan.o.tech.nol.o.gy (1

technology of building elec

nan-o-sec-ond

1980

1990

2000

2010

2021

proposed National



Eric Drexler held first doctoral degree in molecular nanotechnology

1999 Mihail Roco Nanotechnology Initiative (NNI) to the White House

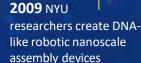


**2003** NSF supports 2 major projects at \$1.5 million over 5 years along with 600 grants including "nano"

implications

2004 Bulletin of Science,

Technology, and Society devote issue to societal





NPs for vaccination theranostics CoV

2010 Harvard demonstrates nanowire transistor that measures electrical activity in

heart cells



spherical molecules called "buckyballs"

**1985** Physicists Kroto, Smalley, and Curl

discover carbon exposed to high temp form



1990 Scientists at IBM manipulate individual Xenon atoms to write their company logo



In US, NSF funded \$6 million to begin first program devoted to NSE

1991

papers published that analyzed role of nanotechnology in science fiction

**2001** 2 academic

nano@illinois\* CNST University of Illinois Center for Nanoscale Science and Technology

Designed by Mariam Saadah



## Micro/Nano Solutions

- Engineered Nanomaterials
- Targeted delivery of Fertilizer, Herbicide, Pesticide, and Weedicide
- Water sustainability through nanopolymers hydrogels
- Enhancing seed germination through metal oxide nanoparticles
  - Higher yields and vitamin content
  - Drought resistant

Nanocarriers with smart delivery systems can enhance crop productivity and reduce operations costs



# Suggested Ideas



## **IT Exports**

- Freelancing
- Organized IT exports
  - AI ML Block Chain
    - Ag & Food Healthcare
- High School and College-level Mentoring Needed
- Upworks
- India currently has \$40-50B of IT exports

## **Lessons and Needs**

- Agricultural Mechanization: The level of mechanization has a significant positive impact on the cost, output value, income, and return rate of all types of crops.
- For every 1% increase in the level of mechanization, the yields of all crops, grain crops, and cash crops increase by 1.2151, 1.5941, and 0.4351%, respectively.



# Building the Infrastructure of the Future: Requires a National Technology Strategy

- Smart High Speed Transportation System
- Dynamic Electric Grid with Renewables
- Broadband Internet Connectivity
  - Will improve social welfare across the spectrum
    - Agriculture and Food

Health

Energy

Communications

Fuchs, Erica R. 2022. The Next 75 Years of Science Policy



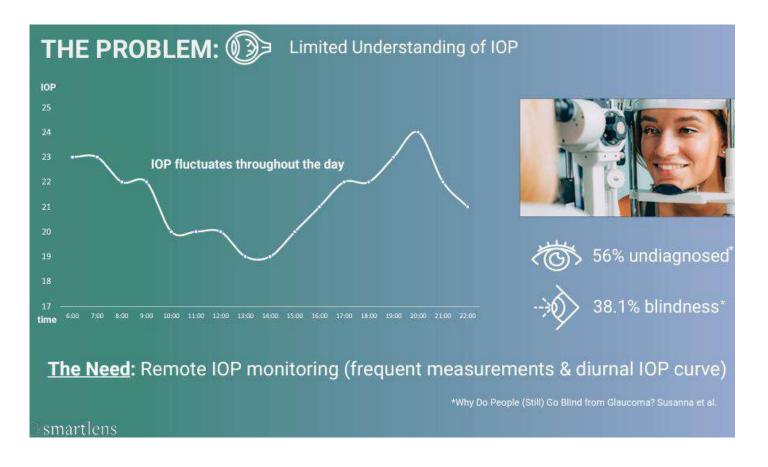
**Research and Innovation** 

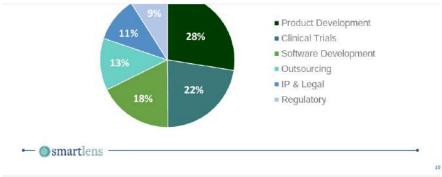


# Mimicking the Silicon Valley Innovation Ecosystem

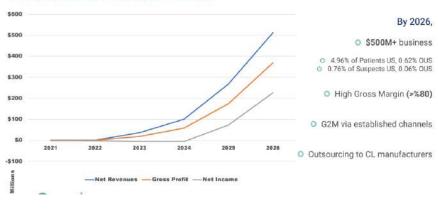
Start a Venture Investment Fund in Silicon Valley







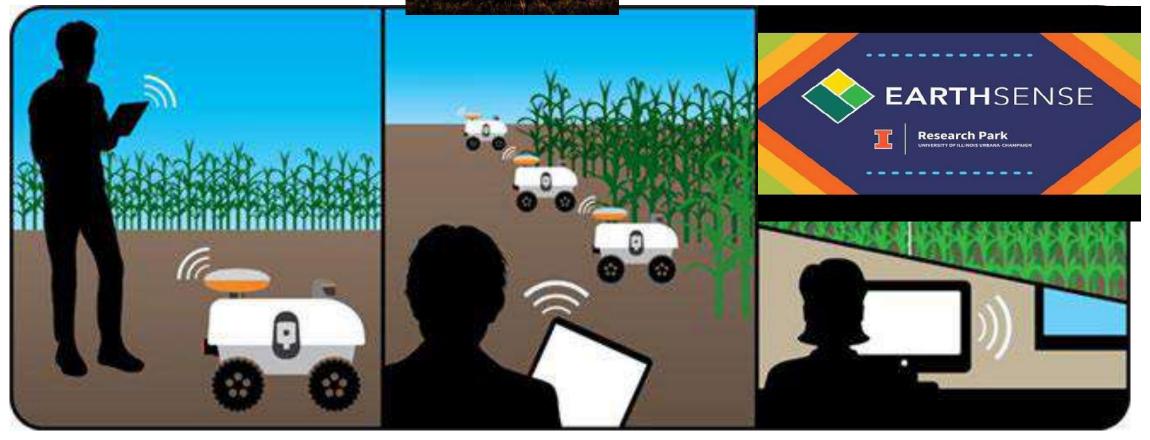




# **AgBots**

https://www.youtube.com/watch?v=GK5ncp82je4

https://www.youtube.com/watch?v=9LbbMWzfabQ



The Grainger Engineering researchers are focused on the mechanisms to increase the levels of autonomy in agbots while enabling interaction with humans / stakeholders, are testing their robots in the Illinois Autonomous Farm testbed. Katherine Rose Driggs-Campbell and Girish Chowdhary. **Center for Digital Agriculture** 

# UI Bionanotechnology Research Facilities

The Center for Nanoscale Science and Technology (CNST)- a campus-wide collaboratory for facilitating research, education, and entrepreneurship in nanotechnology, and the College of Applied Health Sciences, University of Illinois





### **Bionano Lab**

- Part of the CNST Collaboratory
- 8000 sq. ft Class 100 clean room
- BioNanotechnology labs
- Research Areas include:
- -Nanophotonics and Optoelectronics
- Micro and Nanoelectronics
- -Bionanotechnology and Nanomedicine
- MEMS and Integrated Systems





Egypt

Saudi Arabia

**United States** 

Pakistan

Kuwait

China

Morocco

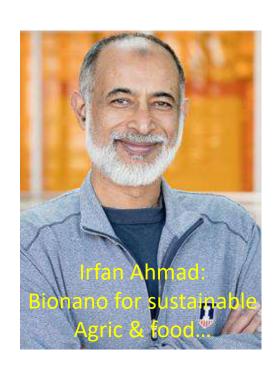
Turkiye

NanoPower Group\*

Palestine

Japan

Jordan UAE







<sup>\*</sup> Formed in 2004 to promote nanotechnology research, innovation-based entrepreneurship, education/training, and outreach

# Recommendations



# Recommendations 1/2

Establish a Research and Innovation Fund to seed projects across OIC

Establish Digital Health and Digital Agriculture for digital solutions

Community Engagement for the Advancement of Science and Engineering

Engagement of Expats

# Recommendations 2/2

Create Awareness

Innovation-based Entrepreneurship

Failure is an Option

Engage OIC and IsDB

Invite Industry and Policy Makers to the Meetings

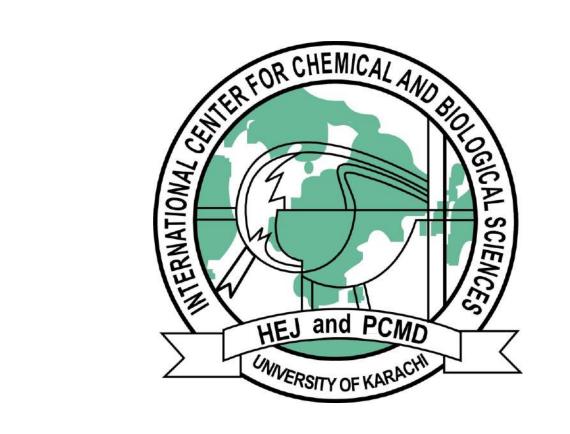
# Acknowledgements

- SmartSensing Research Group- Research scientists, graduate and undergraduate students
- National Academy of Sciences (NAS)
- Nano Sensors Group, UIUC
- Holonyak Micro and Nanotechnology Lab (HMNTL), UIUC
- Beckman Institute for Advanced Science and Technology, UIUC
- Center for Nanoscale Science and Technology, UIUC
- Profs. Munir Nayfeh, Bulent Aydogan, Taher Saif, Rashid Bashir, (UIUC); Rashid Ahmed (MUST); Anwarul Hassan (QU); Ilesanmi Adesida, (NU)
- ICCS/HEJ Chemistry Institute, University of Karachi- Prof. Atiya Abbasi
- Prof. Tehmina Anjum, Dr. Hina Ashraf, and collaborators, University of the Punjab

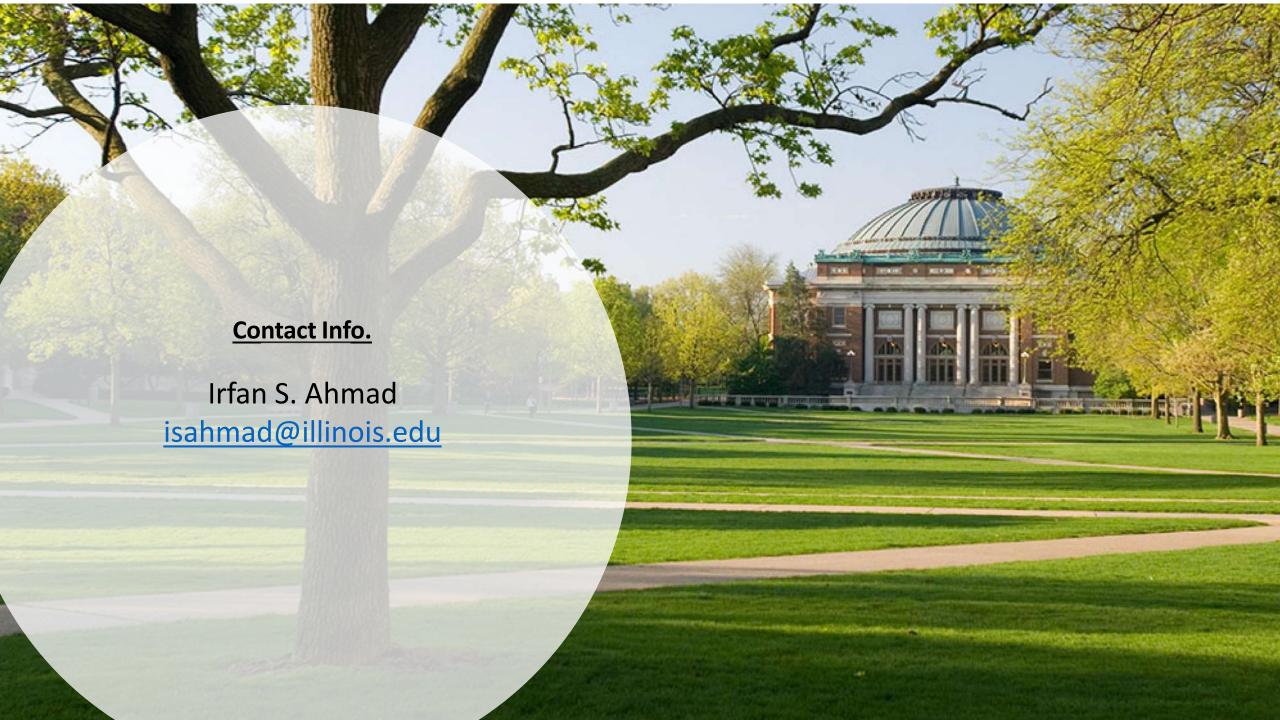


### **THANK YOU**









### References

- IMF Blog. 2023. Accessed Online on Feb. 12, 2023. https://www.imf.org/en/Blogs/Articles/2021/10/06/blog-ch3-weo-why-basic-science-matters-for-economic-growth
- SAS. 2022. The speed of digital disruption: Sustaining transformation in health care and life sciences. Accessed online on Feb 19, 2023.
- file:///Z:/CIMED/Articles/Digital-transformation-in-hls-112983.pdf

# Backup Slides



# **HEJ Research Institute of Chemistry**



International Center for Chemical and Biological Sciences





US-side PI: Kenneth Watkin, Irfan S. Ahmad; PK-side PI: Prof. Attiya Abbasi

### University of Karachi

- •Houses the single largest doctoral program in Pakistan with over 250 PhD students
- •Member of the International Center for Chemical and Biological Sciences system (ICCS)
- Research Areas include:
- natural product chemistry
- protein chemistry
- computational medicinal chemistry
- plant biotechnology

Center for Nanoscale Science and Technology and College of Applied Health Sciences, University of Illinois



### Nobel Laureates from Muslim Countries

Two Muslims have been awarded the Nobel Prize in Chemistry.

Year	image	Laureate	Country and profession	Rationale	comment	
1999		Ahmed Zewail (1946– 2016) <sup>[2]</sup>	Egyptian- American scientist	The 1999 Nobel Prize in Chemistry was awarded to Ahmed Zewail "for his studies of the transition states of chemical reactions using femtosecond spectroscopy". [3]	He is the first Muslim chemist to be awarded the Nobel Prize and the second Muslim scientist. [4][5][6][7][8]	
2015			Turkish- American	The 2015 Nobel Prize in Chemistry was awarded to Aziz Sancar "for mechanistic studies of DNA repair" <sup>[9]</sup>	He is the first Turkish chemist, and the second Turkish to date to be awarded the Nobel Prize and the third Muslim scientist.  [dubious – discuss][10]	

One Muslim has been awarded the Nobel Prize in Physics.

Year	image	Laureate	Country and profession	Rationale
1979		Mohammad Abdus Salam (1926–1996)	Pakistani physicist	The 1979 Nobel Prize in Physics was awarded jointly to Sheldon Glashow, Salam, and Steven Weinberg "for their contributions to the theory of the unified weak and electromagnetic interaction between elementary particles, including, inter alia, the prediction of the weak neutral current". <sup>[63]</sup>

# **Leading Research Universities**

- Khalifa University, UAE
- King Abdullah University of Science and Technology, Saudi Arabia
- University of Karachi
- Qatar University
- University of Science, Malaysia
- Cairo University, Egypt
- COMSATS, Pakistan
- Sharif University of Technology, Iran
- Quaid-e-Azam University, Pakistan
- Middle East Technical University (METU), Turkiye

Scimago Institutions Rankings, 2022. https://www.scimagoir.com/rankings.php?sector=Higher%20educ



### **UAE**

UAE government's Science, Technology and Innovation Policy and UAE's National Agenda 2021 to reduce dependence on oil revenues and transform into a knowledge-based economy by enhancing its research and development activities have been effective (<u>Vision 2021, 2018</u>).



# List of Nominated Engineering-Funded Centers

- Berkeley Sensor and Actuators Center (BSAC)
- Center for Innovative Instrumentation Technology (CiiT)
- Center for Advanced Design and Man of Integrated Microfluidics (CADMIM)
- Center for Advanced Forestry Systems (CAFS)
- Advanced Processing and Packaging Studies (CAPPS)
- Center for Advanced Vehicle and Extreme Environment Electronics (CAVE3)
- Center for Child Injury Prevention Studies (CChIPS)
- Center for the Design of Analog-Digital Integrated Circuits (CDADIC)
- Center for Dielectrics and Piezoelectrics (CDP)
- Center for Electromagnetic Compatibility (CEMC)
- Center for Tire Research (CenTiRe)
- Center for Electrochemical Processes and Technology (CEProTECH)
- Center for Health Organization Transformation (CHOT)

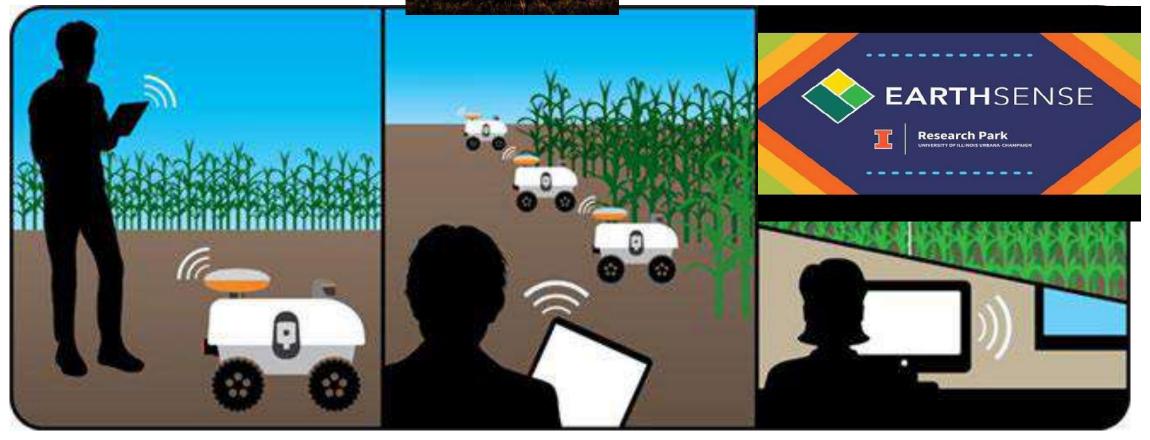
- Laser and Plasma for Advanced Manufacturing (LPAM)
- Center for Particulate and Surfactant Systems (CPaSS)
- Center for Pharmaceutical Development (CPD)
- Ceramics Composites and Optical Materials Center (CCOMC)
- Cooling Technologies Research Center (CTRC)
- Center for Energy-Smart Electronic Systems (ES2)
- GRid-Connected Advanced Power Electronic Systems (GRAPES)
- Science Center for Marine Fisheries Science (SCeMFiS)
- Smart Vehicle Concepts (SVC) Center
- Wind-Energy Science, Technology and Research (WINDStar)



# **AgBots**

https://www.youtube.com/watch?v=GK5ncp82je4

https://www.youtube.com/watch?v=9LbbMWzfabQ



The Grainger Engineering researchers are focused on the mechanisms to increase the levels of autonomy in agbots while enabling interaction with humans / stakeholders, are testing their robots in the Illinois Autonomous Farm testbed. Katherine Rose Driggs-Campbell and Girish Chowdhary. **Center for Digital Agriculture** 

# Coordinated Science Laboratory, UI

### AI-FARMS

- The Artificial Intelligence for Future Agricultural Resilience, Management, and Sustainability Institute serves as a nexus for multidisciplinary research teams that advance foundational Al and use these advances to address important challenges facing world agriculture.
- It focuses on technologies that impact production practices, on developing a diverse technically skilled workforce in digital agriculture, and on supporting women and minority farmers.

# Smart Sensing Technologies for AgBioFood Research Group



### Plant Extracts for Cancer Nanomedicine

Type of data produced -Standardized data format? -Specific to any particle class of nanoparticle? -Data archived anywhere?	-Plant extracts for medicinal use (cancer and infectious diseases) -Current Qty: 100, with 3000 more to study -Being explored with NanoHub at Illinois
Importance and frequency of this type of nanocharacterization -Importance=(1-5 scale, 5 highest) -Frequency of use=(1-5 scale, 5 highest)	Importance: 4 Frequency: 4
Type of equipment/ instrumentation needed	Biophotonic crystal sensor and card reader
Reference materials available (if at all) -Interlaboratory studies performed?	-Beckman Institute for Advanced Science and Technology -Micro and Nanotechnology Laboratory -ICCS/HEJ Chemistry Institute, Karachi; USDA, ARS, National -Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]

## Illinois Medicinal Plant Database: Typical Plant Extract Entry

### Brassica juncea

Scientific name(s): Brassica juncea (L.) Czern. (1), Brassica integrifloia (Vahl) O.E. Schulz, non Rupr. (1) Brassica integrifolia Rupr. (1). Brassica japonica Thunb. (1). Brassica juncea (L.) Czern. Var. crispifolia L.H. Bailey (1), Brassica juncea Czern. Var. japonica (Thunb). L.H. Bailey (1), Brassica willdenowii Boiss. (1) Sinapis juncea L. (1), Brassica integrifolia (West), O.E. Schulz (2), Brassica juncea (L.) Hook. F. & Thomson (3), Brassica juncea (L.) Coss. (3), Brassica juncea (Linn.) Czern. Et. Coss (4)

Family name(s): Brassicaceae (1)

Cruciferae (2)

English name(s): India mustard (1), curled mustard (4), brown mustard, leaf

mustard, mustard greens.

chinese mustard (8) Urdu name: Sarson (5)

خردل Arabic name: Khardal

### Scientific classification

Kingdom: Plantae Division: Angiosperms Order: Brassicales Family: Brassicaceae Genus: Brassica Species: B. juncea



### Introduction

Brassicaceae is a large family which include 350 genera and about 3000 species (5). It is a distributed nearly worldwide, especially in the temperate areas, with the highest diversity in the Irano-Turanian region, Mediterranean area, and Western North America (6). The genus Brassica includes plants that are annual, biennial, or perennial herbs. There are about 40 species in this genus distributed mainly in the Mediterranean region; only seven of them are found in Pakistan, among them is Brassica juncea (L.) Czern (5).

Brassica juncea (L.) Czern is native to Asia temperate, widely naturalized and widely cultivated (7).

### Distribution

### Notes

Disclaimer: Everything mentioned in this database is for educational purposes. The University of Illinois cannot take responsibility for any adverse affect from the use of plants mentioned in this database. Always seek advice from a professional before using a plant medically.





### Description

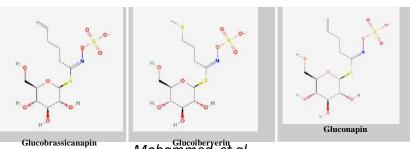
Brassica juncea (L.) Czern is an erect, reddish-brown (5). There is tremendous variation in the basal leaf morphology of Brassica juncea (L.) Czern., and minor variants have been recognized at specific, subspecifical, and varietal ranks (10).

### Constituents and Uses

Brassica juncea (L.) Czern. is high in vitamin A, vitamin C, and iron. Seeds contain sterols, sinigrin, myrosin, sinapic acid, sinapine, and fixed oils. Hydrolysis of sinigrin by the enzyme myrosin yields allyl isothiocynate, glucose, and potassium bisulfate. Allyl isothiocynate is volatile. Allyl isothiocynate is an irritant. It is also lachrymatory and has counterirritant properties when greatly diluted. It should not be tasted or inhaled when undiluted. It is one of the most toxic essential oils Volatile mustard oil has strong antimicrobial (bacteria and fungi) properties (11).

Brassica juncea (L.) Czern is reported to be anodyne, aperitif, diuretic, emetic, rubefacient, and a stimulant. It is a folk remedy for arthritis, footache, lumbago, and rheumatism. Seeds used for tumor in China. Roots used as a galactagouge in Africa. Believed to be aperient and tonic, the volatile oil is used as a counterirritant and stimulant. In Java the plant is used as an antisyphilitic emmenagogue. Leaves applied to the forehead are said to relieve headache. In Korea, the seeds are used for abscesses, colds, lumbago, rheumatism, and stomach disorders. Chinese eat the leaves in soups for bladder inflammation and hemorrahe. Mustard oil is used for skin eruptions and ulcers (11).

### Phytochemicals







### **Overall Conclusions**

- Bionanotechnology research provides avenues for transitioning to environment-friendly agriculture and for enhanced food security
  - more research is needed
- **Digital Agriculture** in sync with Machine Learning/Artificial Intelligence and Bionanotechnology could revolutionize communities and improve livelihoods by alleviating poverty

• The **next generation agricultural engineering workforce** has to be prepared to work at the intersection of bionano in agricultural sciences, big data, and sensing technologies.



### Irfan S. Ahmad

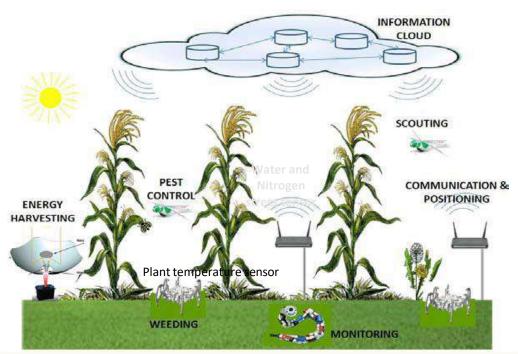
Research Faculty, Agricultural & Biological Engineering;

Holonyak Micro and Nanotechnology Lab.; and Biomedical and **Translational Sciences** 

### **Research Interests**

- **Biological Engineering**
- Off-Road Equipment Engineering
- Nanomedicine





isahmad@illinois.edu August 8, 2018, rev. 10/18/22

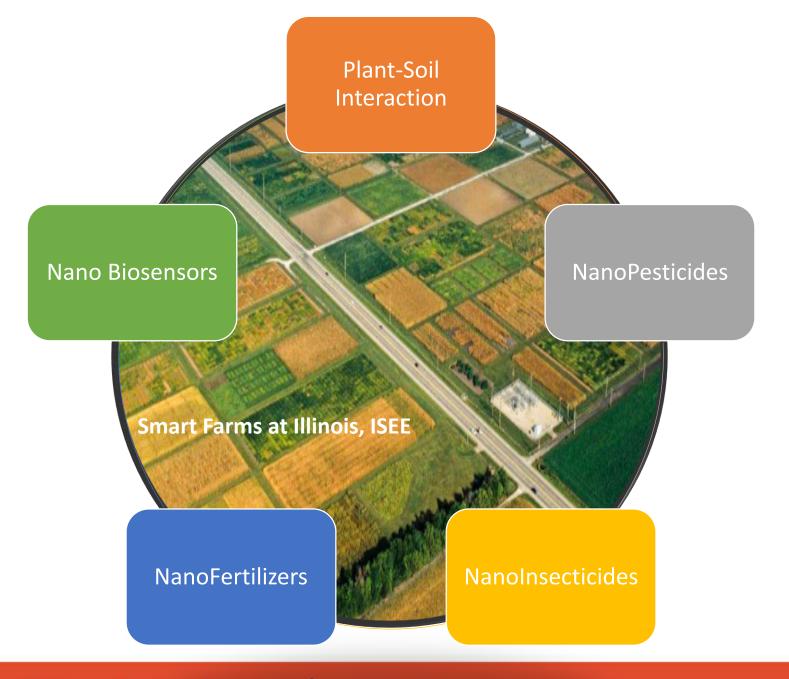
### **Current Projects**

- QNRF: A Novel Microchip based Spatial Gene Expression Analysis Assay for Breast & Prostate Cancer
- USDA: Innovative Food Dehydration Technologies for Improving Product Quality, Energy Efficiency, Sustainability
- NSF NCN: Hierarchical nanoManufacturing Node (https://nanohub.org/groups/nanoMFG)
- NSF I/UCRC: Center for Advanced Research in Drying (CARD) (Dryingresearch.org)
- DOD: Mechanism of Fungal Degradation in Military Aircraft Coatings - completed
- Dudley Smith Initiative: Reducing Insecticide Resistance: Development of Unique Liposomes Pest Control System (LPCS)completed

### Interest areas for collaboration/future work

Advanced manufacturing, Digital agriculture, Food safety, Smart sensing technologies

**Keywords:** Bionanotechnology, Crop, Imaging, Sensors, Nanomedicine, Pathogenesis, Soil



# Key Motivations: Bionanotechnology toward Environment-friendly Agriculture

- The global challenge is to feed 9 billion people by 2050 with a 60% increase in food availability.
- The agricultural and food sectors are confronted with such large issues as climate change, urbanization, sustainable use of resources, and environmental issues like run-off and accumulation of pesticides and fertilizers.
- Bionanotechnology can address such impacts as damage to the ecosystem with toxin release due to the overapplication of fungicides, insecticides, pesticides, and fertilizers.
- Bionanotechnology can contribute to the potential increase in crop production, food security, and sustainability. Fundamental and innovative research is needed to address these challenges for improved biodiversity, productivity, nutrition, and quality.
- Understanding the mechanisms of host-parasite interactions at the molecular level, developing a new generation of pesticides and their transport mechanisms, preservation, and packaging of food.
- Focus on research efforts toward environment-friendly agriculture through the development of liposomes as a novel carrier for designing slow-release formulations of commercially available nematicides, the use of CuO nanoparticles for disease management and plant health improvement, and the sensing of soil nitrates.



# Barriers to Overcome: Bionano in Agriculture

Determination and minimization of toxicity levels- risk assessment

Bionano Regulatory Framework

- Global adoption of new Agricultural Protocols
- (through the UN FAO, the USDA, FDA, WFP)



### 1<sup>st</sup> International Symposium and Workshop on



Nanomedicine: Past, Present & Future Prospects December 20-23, 2010









### nano@illinois





Dec. 20-23, 2010 University of Karachi







# Acknowledgements

- SmartSensing Research Group- Research scientists, graduate and undergraduate students
- National Academy of Sciences
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- Center for Nanoscale Science and Technology, UIUC
- Profs. Munir Nayfeh, Taher Saif, Rashid Bashir
- ICCS/HEJ Chemistry Institute, University of Karachi- Prof. Atiya Abbasi
- Prof. Tehmina Anjum and collaborators, University of the Punjab



### FUNCTIONAL NANOMATERIALS FOR BIOMEDICAL AND PHARMACEUTICAL APPLICATIONS

### IRSHAD HUSSAIN

Professor, Department of Chemistry & Chemical Engineering, SBA School of Science & Engineering (SSE), Lahore University of Management Sciences (LUMS), Pakistan

### **ABSTRACT**



Metal/metal oxide nanoparticles have been recognized as an important class of materials whose properties can be tuned by controlling their nanoscale features. A control over their size, shape and surface chemistry is extremely important for any potential applications in biomedical and environmental sciences. In this regard, we have demonstrated several reproducible protocols to prepare metal nanoparticles from subnanometer to over 100 nm in aqueous/organic media with a fair control over their size, shape, and surface chemistry. These metal

nanoparticles have been used as building blocks to design/ synthesize new nanostructured materials using template-based and template-less approaches. The functionalized metal/ metal oxide nanoparticles/ nanoclusters possess interesting optical, recognition and catalytic properties and we are now focusing more on their applications in biological sciences especially those in bio-sensing (bacterial detection), bio-imaging, drug delivery, improved bioavailability, targeted delivery of drugs, multidrug resistance and environmental remediation. This talk will, therefore, be an overview of our interdisciplinary research activities to synthesize functionalized metal nanoparticles possessing unique chemical and physical properties, and their diverse applications in biomedical and pharmaceutical sciences.

## **Functional Nanomaterials for Biomedical Application**

### **Irshad Hussain**

Department of Chemistry & Chemical Engineering, SBA School of Science & Engineering, Lahore University of Management Sciences (LUMS), Pakistan

ihussain@lums.edu.pk



### **OUTLINE**



Synthesis of metal nanoparticles/nanoclusters

Metal NPs/NCs applications in biosensing

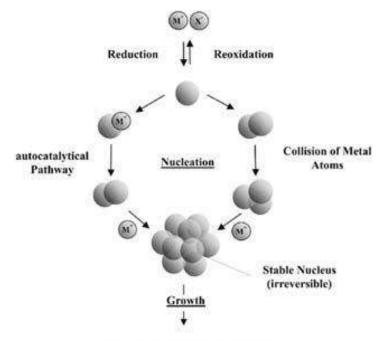
Metal NPs/NCs applications in drug/gene delivery

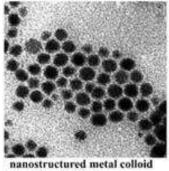
\* Nanomaterials to improve bioavailability and pharmacokinetics of drugs

Metal NPs/NCs applications to address multidrug resistance (MDR)

### Metal Nanoparticles Synthesis – A Chemical Reduction Approach

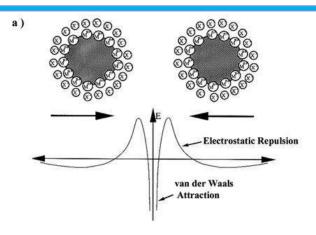




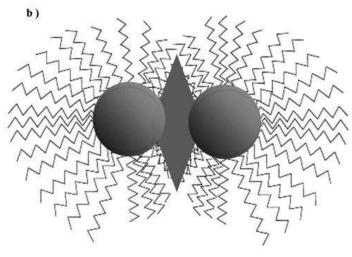


Chemical reduction of metal precursors

(TEM Micrograph)



**Electrostatic/charge stabilization** 



Steric stabilization

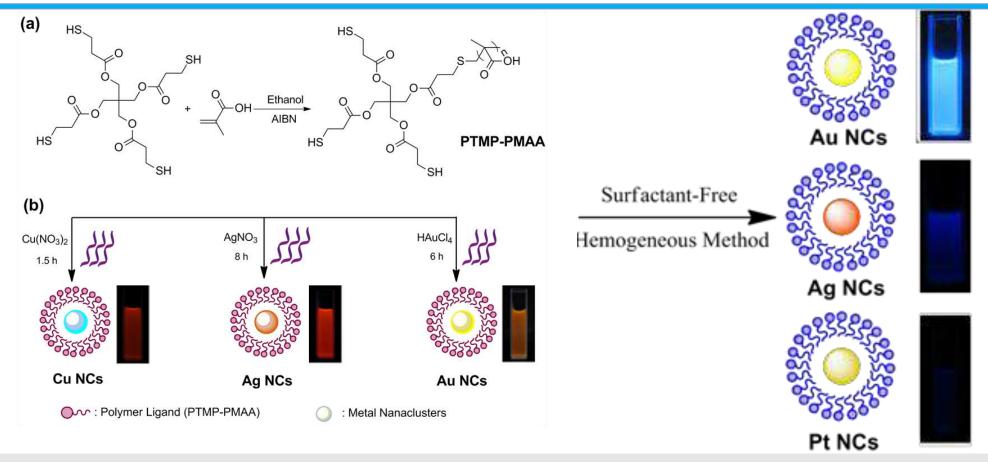
What factors control the rate of formation of metal nuclei, growth of metal nuclei, and ultimately size, shape and surface chemistry of metal NPs?

Nature of reducing agents, stabilizers, solvent, pH and temperature etc.

Thiol (-SH) and amine (-NH $_2$ ) containing organic molecules are generally better stabilizers for MNPs.

### **Subnanometer Fluorescent Metal Nanoclusters**



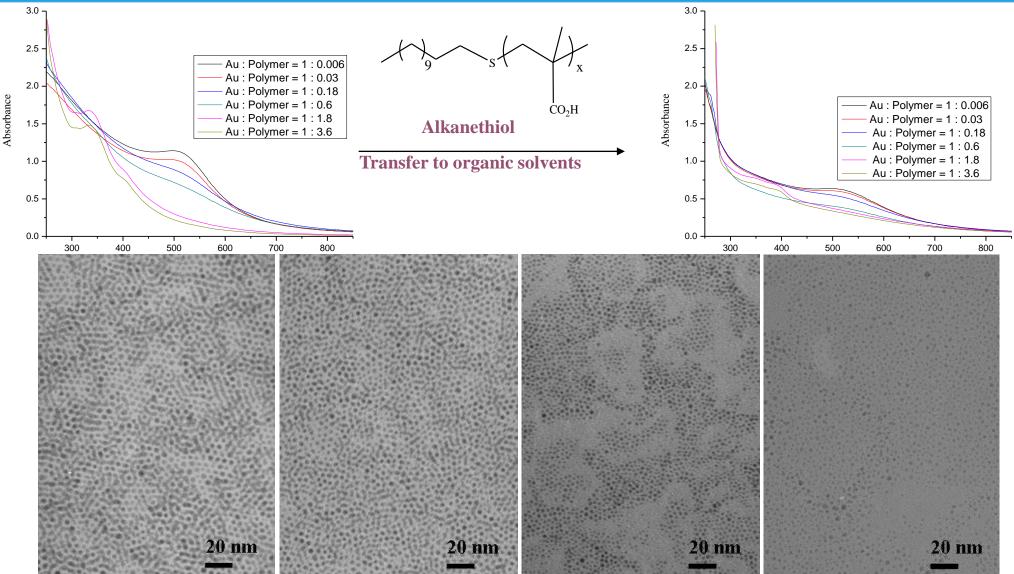


Water-soluble fluorescent metal nanoclusters were prepared by photo-reduction/chemical reduction of their inorganic precursors in the presence of polymer i.e., PMMA functionalized with pentaerythritol tetrakis 3-mercaptopropionate (PTMP).

Zhang et al. Hussain and Tan. Chemical Communications, 2012, 48, 567; Huang et al. Hussain and Tan. J. Phys Chem C, 2012, 116, 448; Rotello and Hussain et al. Langmuir, 2012, 28, 2023; Zhang & Shumaila et al., JMCB, 2017, 5, 5608; Yulian et al., Nanoscale, 2019, 1, 1287

## Controlling the Size of Metal Nanoclusters & Nanoparticles

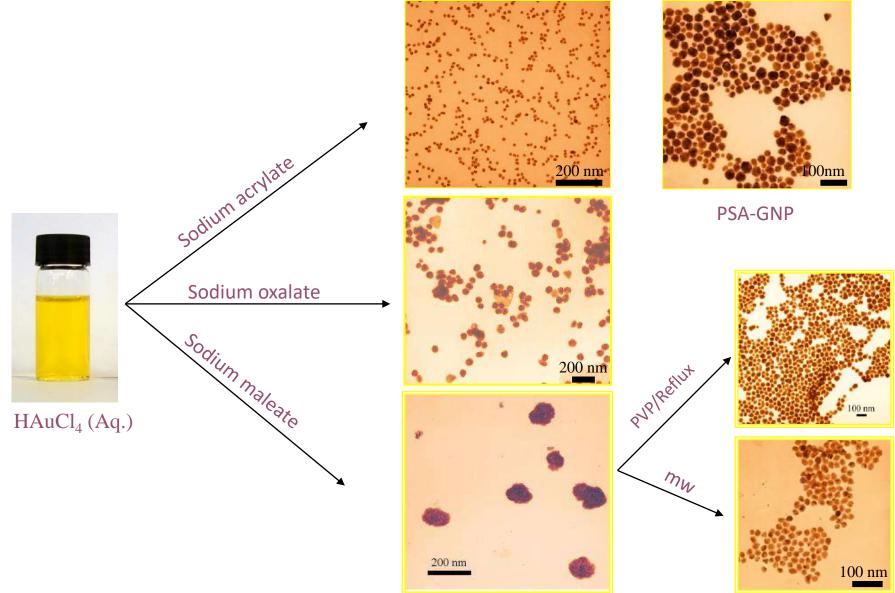




Hussain et. al., J. AM. CHEM. SOC. 2005, 127, 16398; Wang et al., Langmuir 2006, 23, 885; Tan et al., Nanoscale, 2011, 3, 1600.

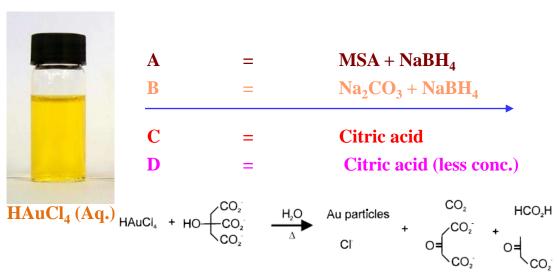
## Controlling the Size of Metal NPs

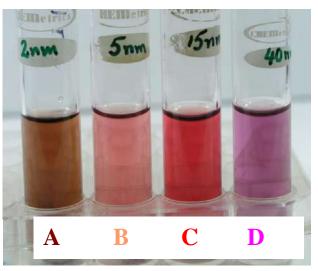


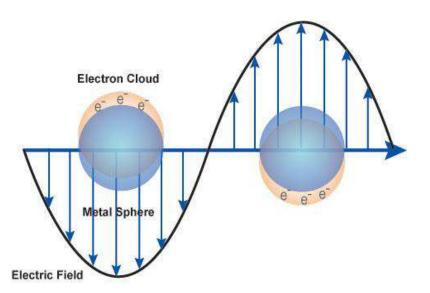


Hussain et al., Langmuir, 2003, 19, 4831

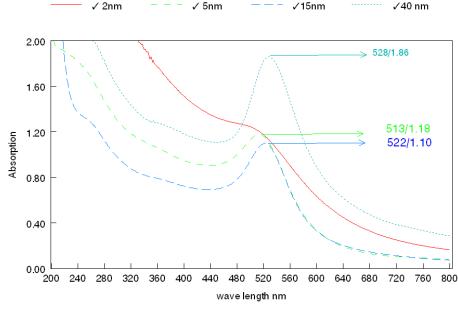
### **Optical Properties of Metal Nanoparticles**







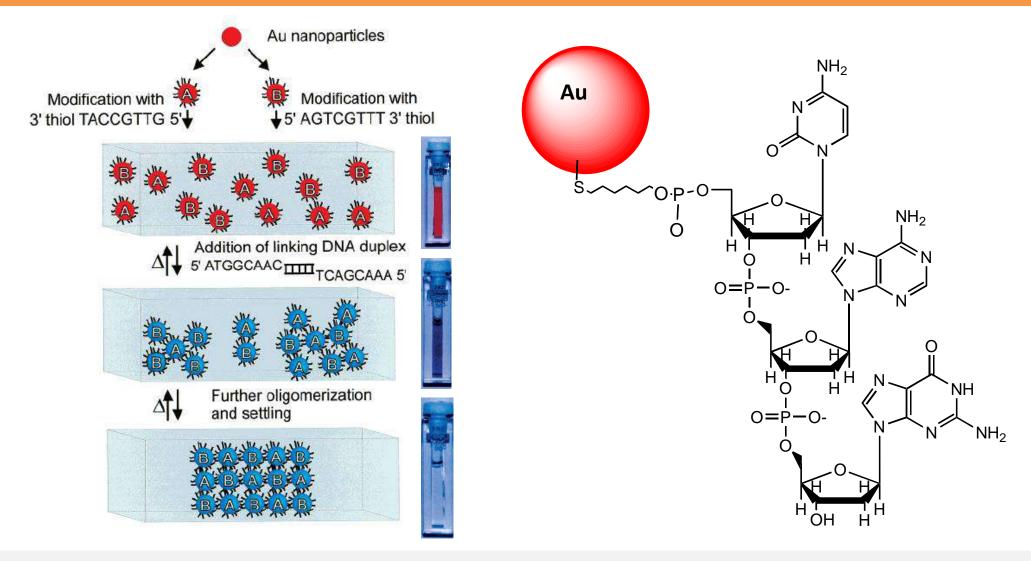
Surface Plasmon resonance of Au, Ag and Cu nanoparticles is in the visible region and, therefore, they are of different colors



The origin of surface Plasmon resonance and color of metal NPs

UV-visible spectra of GNPs of different sizes

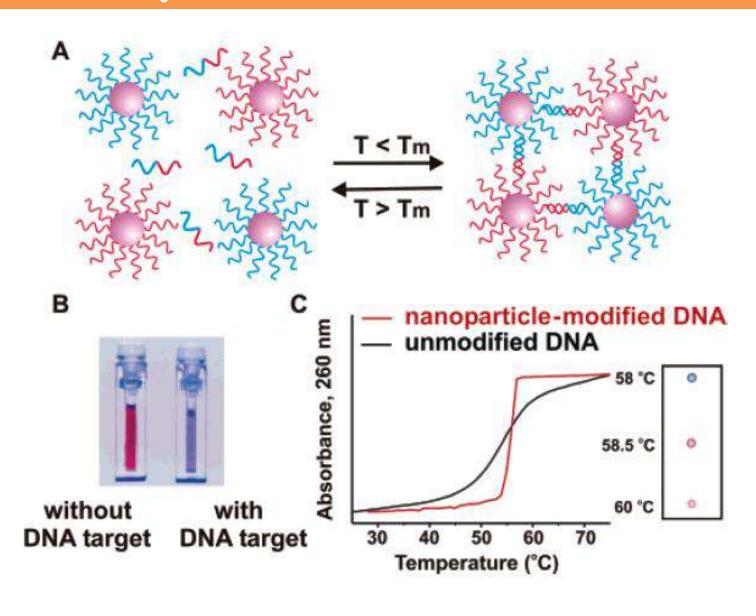
## **DNA-Gold Nanoparticles Conjugates for DNA Detection**



A simple colorimetric assay can be developed to detect complementary strands of DNA bound on gold nanoparticles surface based on the change in color.

### **GNPs** -Based Colorimetric Assay for the Detection of DNA

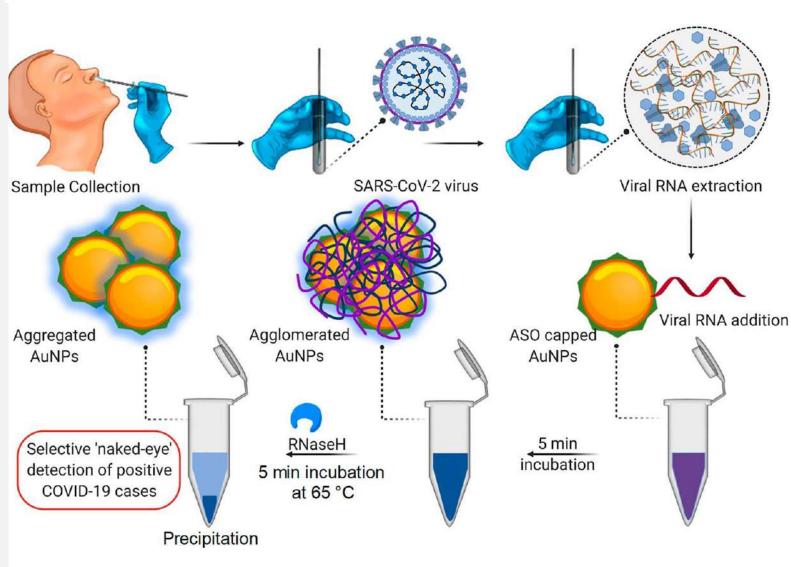
**GNPs** are conjugated with double stranded DNA with sticky ends. In this case, two types of GNPs are conjugated with dsDNAs whose sticky ends are non-complementary to each other. In the presence of a target DNA, one half of which is complementary to DNA on one type of GNPs and other half complementary to DNA on other type of GNPs, the particles will join resulting in their aggregation that can be monitored visually as well as by UV-visible absorption spectroscopy. These GNPs have specific melting temperature (Tm), which depends on the extent of binding of target DNA with probe DNA.



## Naked Eye Detection of COVID-19 Using DNA Functionalized Au NPs



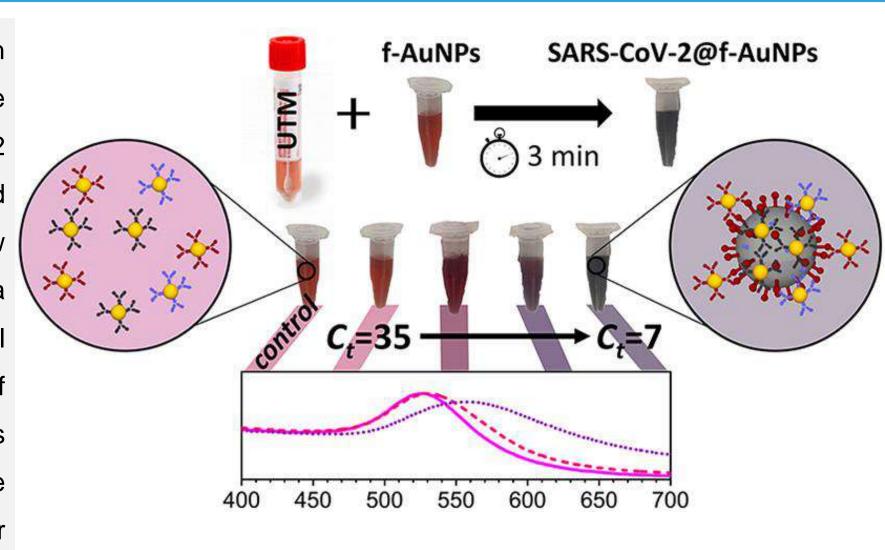
Gold nanoparticles capped with suitably thiol-modified designed antisense oligonucleotides (ASOs) specific for N-gene (nucleocapsid phosphoprotein) of SARS-CoV-2, agglomerate selectively in the presence of its target RNA sequence of SARS-CoV-2 and demonstrate a change in its surface plasmon resonance and thus the colour. The addition of RNaseH cleaves the RNA strand from the RNA-DNA hybrid leading to a visually detectable precipitate from the solution mediated. The selectivity of the assay has been monitored in the presence of MERS-CoV viral RNA with a limit of detection of 0.18 ng/µL of RNA having SARS-CoV-2 viral load.



### Colorimetric Detection of COVID-19 Using Au NPs

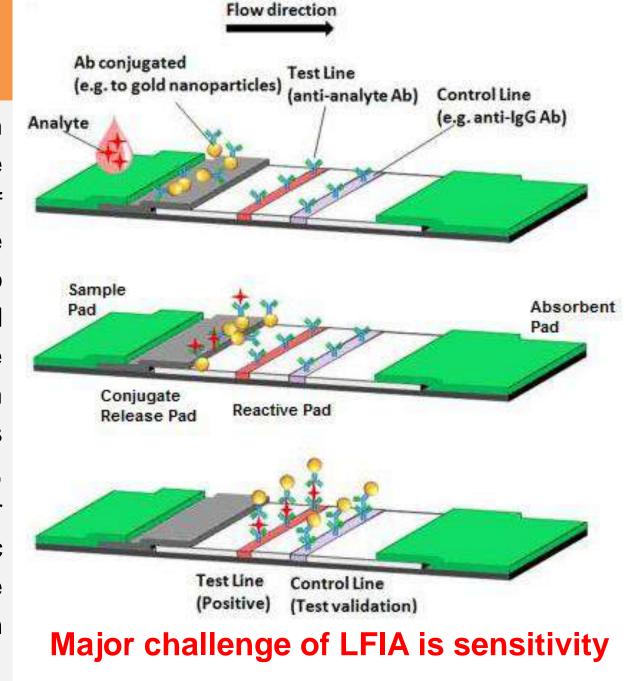


AuNPs functionalized with targeting antibodies three surface proteins of SARS-CoV-2 envelope, and (spike, membrane) is red-shifted in few minutes when mixed with a containing the solution particles. The detection limit of this colorimetric method approaching that of the real-time PCR and has great potential for mass testing.



## **AuNPs Based Lateral Flow Immunoassay for PoC devices**

Antibody conjugated gold nanoparticles are used in conjugate release pad that bind with the analyte (human chorionic gonadotropin (hCG) in case of pregnancy test) that binds further with the analyte specific antibody immobilised on the test line to produce a colour. Analyte-free Ab-conjugated AuNPs bind with IgG antibodies on the control line to ensure the proper diffusion of AuNPs. Such assays have potenial for other diagnostic purposes e.g., to ascertain failure of internal organs (e.g., heart attack, renal failure or diabetes), COVID or infections, contamination with specific other pathogens including biowarfare agents, presence of toxic compounds in food, environment and even the abuse of (illicit) drugs.



Trends in Analytical Chemistry 2021, 137, 116205; ACS Nano 2020, 14, 7783; ACS Appl. Nano Mater. 2019, 2, 8, 5020

# Functionalized Gold NPs Based Chemical Nose to Sniff Various Diseases

GNPs are functionalized with cationic/anionic ligands.

Fluorescent proteins/polymers are electrostatically conjugated to these nanoprobes.

Fluorescence of released proteins is measured after diseased proteins compete with the conjugated proteins.

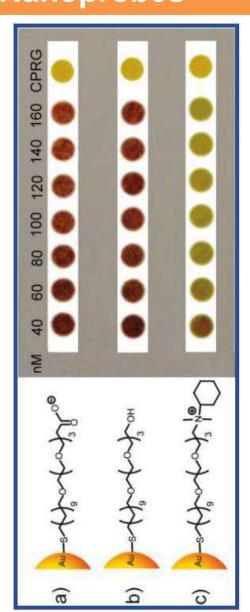
Great potential to detect various diseases at early stages.

Fluorescence 'off' Protein 1 Protein 2 Protein 3 High displacement Fluorescence response Low displacement Aggregation Protein 3 Protein 1 Protein 2

Rotello et al., Nat. Nanotech. 2011, 6, 573-579

## Bacteria β-gal Enzymatic reaction Bacteria ß-galactosidase (Mw = 465 kDa, pl = 4.6) Activity "ON" Activity "OFF" red CPRG = chlorophenol red $\beta$ -D-galactopyranoside b) Biocompatibility/Solubility Interacting Stability NP3: R = --CHo-

## Bacterial Detection Using Cationic Gold Nanoprobes

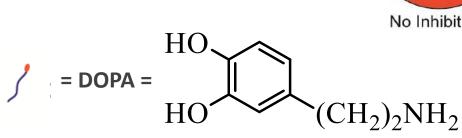


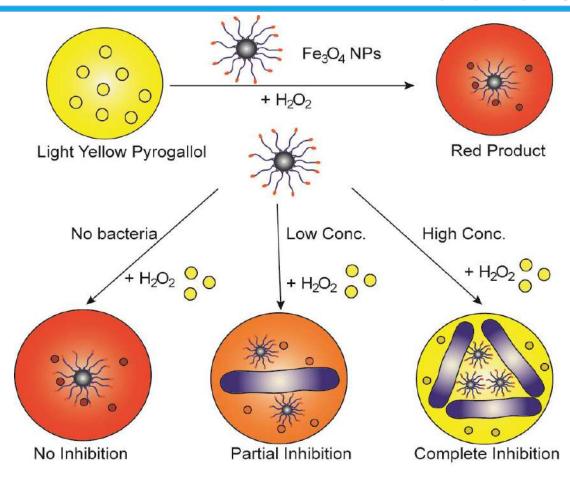
Rotello et al., J. Am. Chem. Soc. 2010, 132, 5285

## MIONs for Bacterial Detection – Turn-off Sensing



- ➤ Positively charged NPs
- > Interaction with bacteria
- > Catalytic activity inhibited
- ➤ No color production
- ➤ In absence of bacteria, color is produced

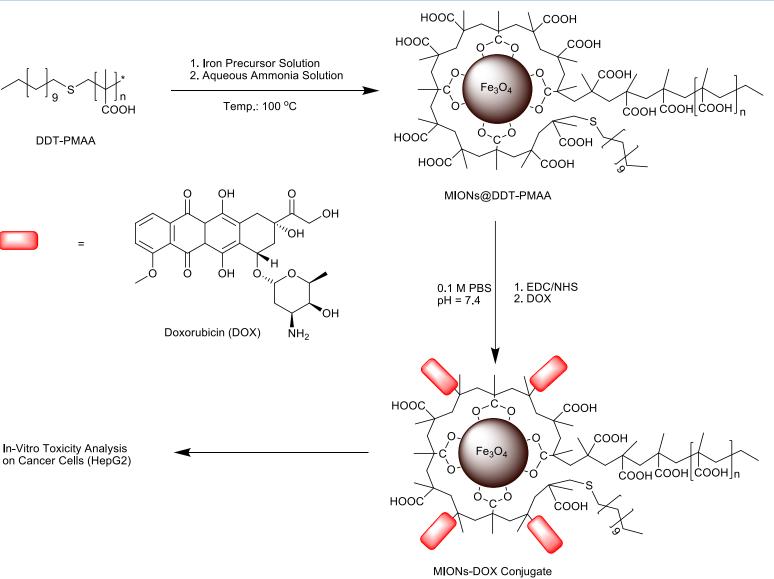




## Design & Synthesis of Highly Stable MIONs for Drug Delivery and MRI



Biocompatible non-toxic and uniform magnetic oxide iron nanoparticles (MIONs) coated with multifunctional polymer were further functionalized with an anticancer drug i.e. doxorubicin (DOX) and its efficacy, as a model drug delivery system, was determined using HepG2 cells. The efficiency of the drug-NP conjugates was found to be significantly higher than that of the free drug.

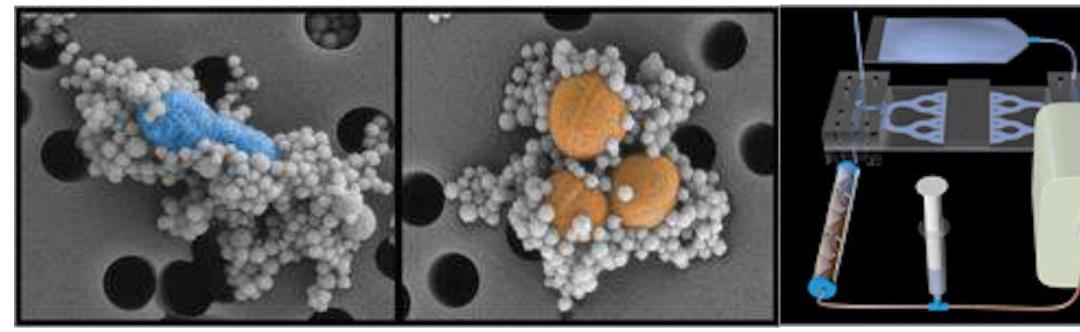


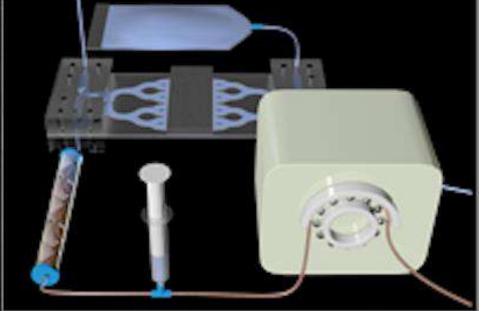
Irfan, Bien and Hussain et al. J. Mater. Chem. B, 2013, 1, 2874

## **Magnetic Nanoparticles Based Biospleen to Treat** Sepsis by Removing Blood Pathogens



Novel dialysis-like therapeutic device inspired by the spleen comprises of tiny nanometer-sized magnetic beads that are coated with a genetically engineered version of a natural immune system protein called mannose binding lectin (MBL). quickly filters bacteria, fungi and toxins



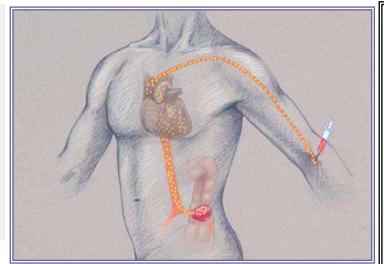


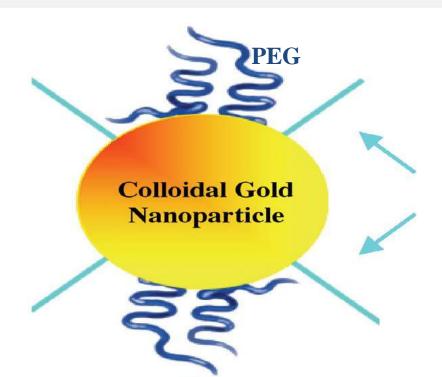
### **Gold NPs for Cancer Detection & Treatment**

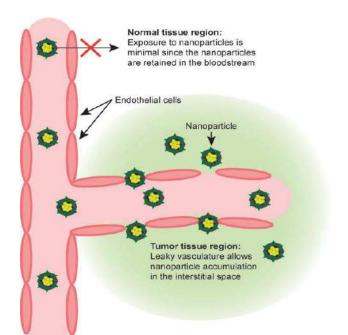


A Not-for-Profit University

Au NPs have the potential to deliver cancer drugs only to the target tumors by conjugating with tumor specific proteins thus minimizing side effects and increasing efficiency. Au NPs are now being evaluated not only as drug delivery systems but also as cancer monitoring and treatment system.







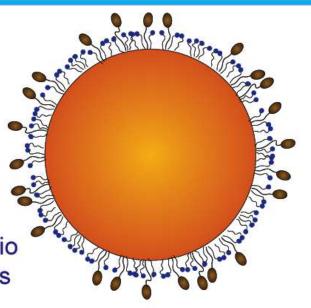


## **Porous Gold NPs for Targeted Drug Delivery**

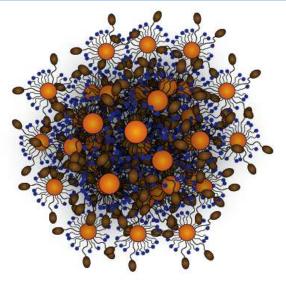




small nanoparticles:
high payload to carrier ratio
scalable efficient synthesis
increased cytotoxicity
inefficient uptake



large nanoparticles:
low toxicity
efficient uptake
challenges in scalability
low payload to carrier ratio

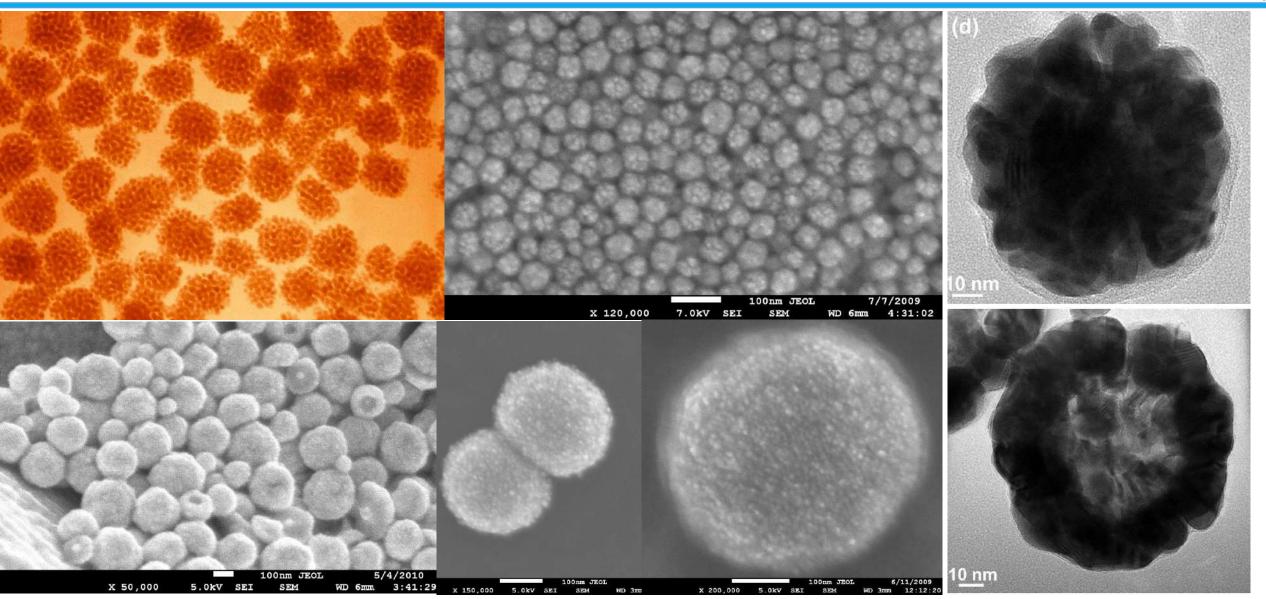


nanoparticle emulsions: low toxicity efficient uptake high payload to carrier ratio scalable efficient synthesis controlled release

Hussain and Wang et. al., Langmuir, 2006, 2941; Hussain et. al., J. Colloid & Interface Science, 2010, 350, 368; Ayesha and Hussain et al., Material Letters, 2013, 95, 78; Ayesha and Hussain et al. Journal of Colloid & Interface Science, 2015, 446, 59.. Irfan, Bien and Hussain et al., J. Mater. Chem. B, 2013, 1, 2874; Ayesha et al., Material Letters, 2013, 95, 78; and Journal of Colloid & Interface Science, 2015, 446, 59; Ibrahim Javed et. al., Journal of Materials Chemistry B, 2015, 3, 8359; Ibrahim Javed et. al., Colloids & Surfaces – B, 2016, 141, 1-9; Farhan Sohail et. al., Journal of Materials Chemistry B, 2016, 4, 6240; Faisal Usman et. al., RSC Advances, 2016, 4, 94896; Shumaila Razzaque et. al., Polymers, 2016, 8, 156;

## **Porous Gold Nanoparticles for Drug Delivery**





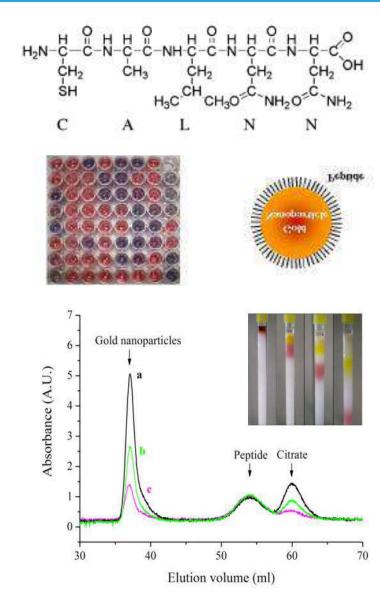
Hussain and Wang et. al., Langmuir, 2006, 2941; Hussain et. al., J. Colloid & Interface Science, 2010, 350, 368; Ayesha and Hussain et al., Material Letters, 2013, 95, 78; Ayesha and Hussain et al. Journal of Colloid & Interface Science, 2015, 446, 59.

## Peptide Coated Highly Stable Gold Nanoparticles



#### These peptide coated gold nanoparticles

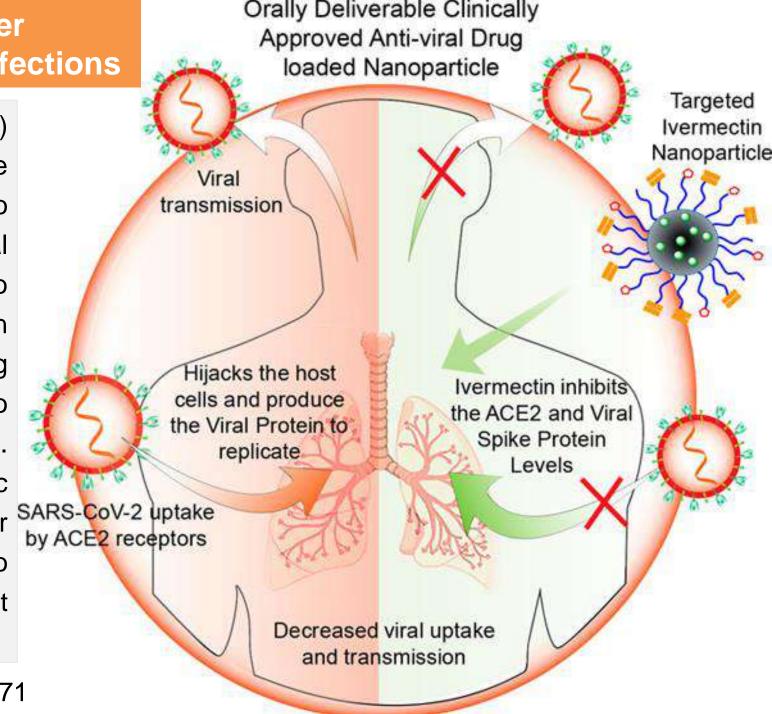
- Can be freeze-dried to store as re-dispersible powders
- Purification and size separation by size-exclusion chromatography
- Highly stable under extreme biological conditions
- Protein chemistry unchanged, so very useful for bioconjugation and recognition purposes



Levy and Hussain et. al., J. AM. CHEM. SOC., 2004, 126, 10076

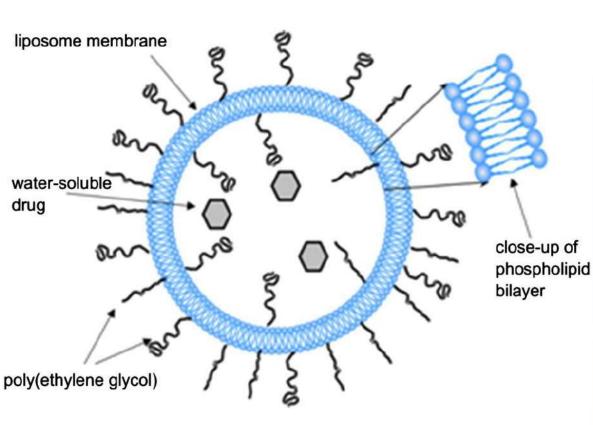
Ivermectin Loaded Polymer Nanoparticles to Treat COVID Infections

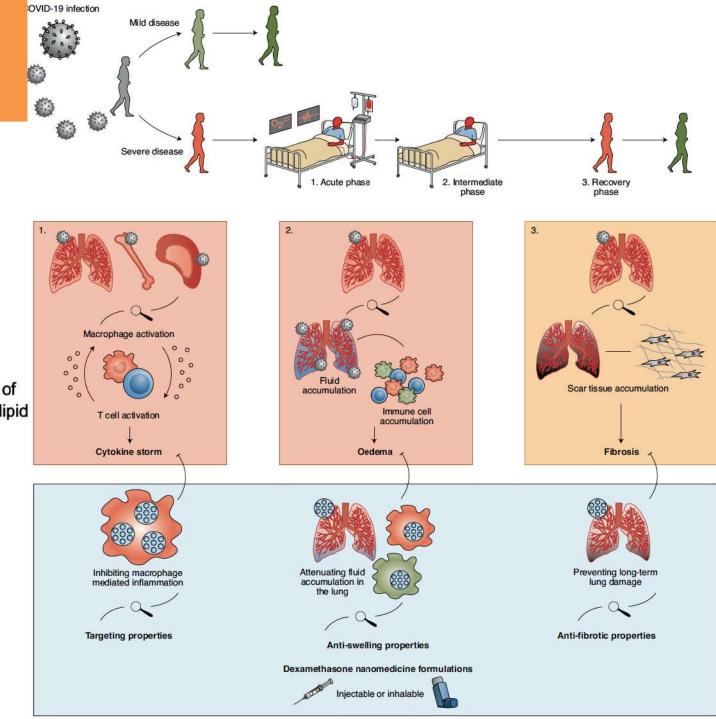
Ivermectin (FDA approved antiviral drug) packaged in orally administrable nanoparticles can serve as a vehicle to deliver a more potent therapeutic antiviral dose & demonstrate its efficacy to decrease expression of viral spike protein & its receptor angiotensin-converting enzyme-2 (ACE2) that are keys to lowering disease transmission rates. Polymer nanoparticles tagged with an Fc immunoglobulin fragment, to facilitate their transport from gut epithelial barrier to reach the bloodstream, have great potential in this regard.



ACS Pharmacol. Transl. Sci. 2020, 3, 1371

## Liposomal Dexamethazone as Anti-COVID-19 Drug

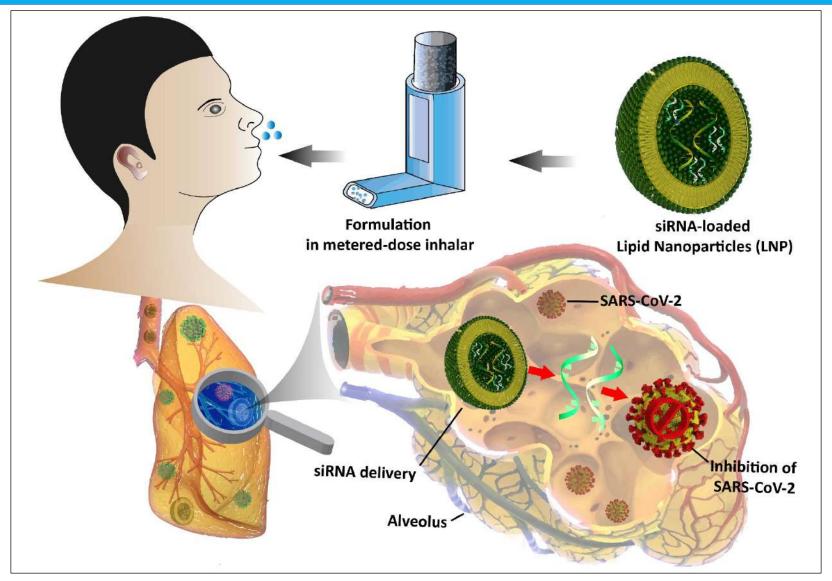




Journal of Controlled Release 2014, 190, 624; Nature Nanotechnology 2020, 15, 618

## NPs-Assisted Delivery of Antiviral-siRNA as Inhalable Treatment for Human Respiratory Viruses: A Candidate Approach against SARS-COV-2

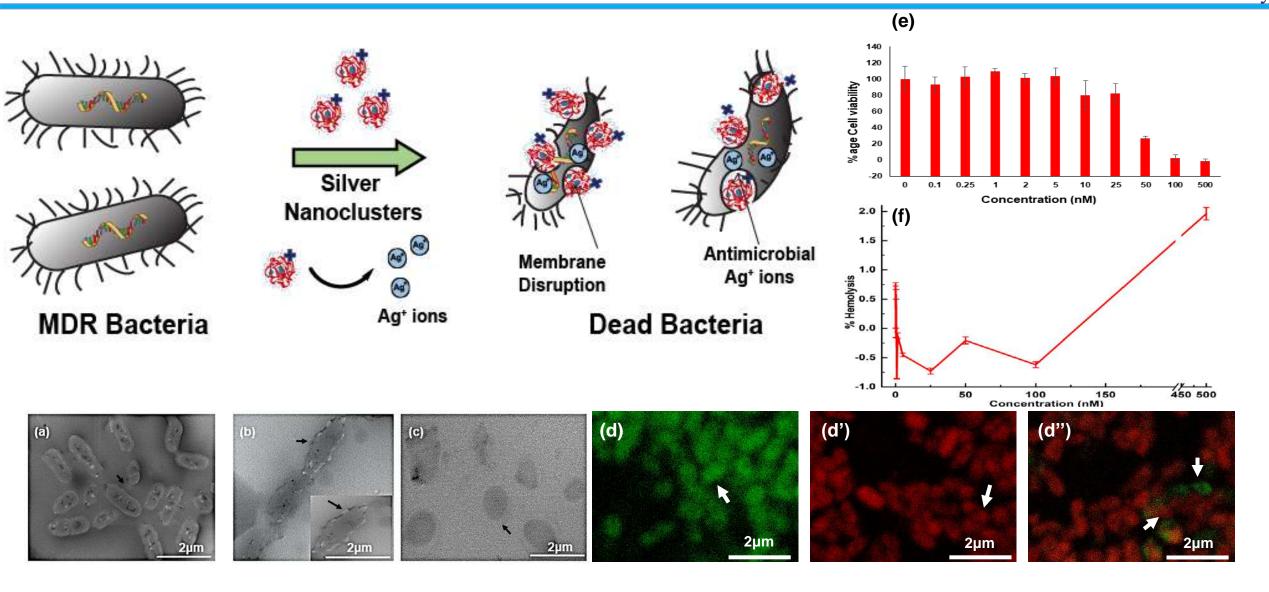




Ata Ullah and Asma Rehman et. al., Nano Select, 2020, 1, 612

## Cationic Ag NCs to Combat MDR in Bacteria

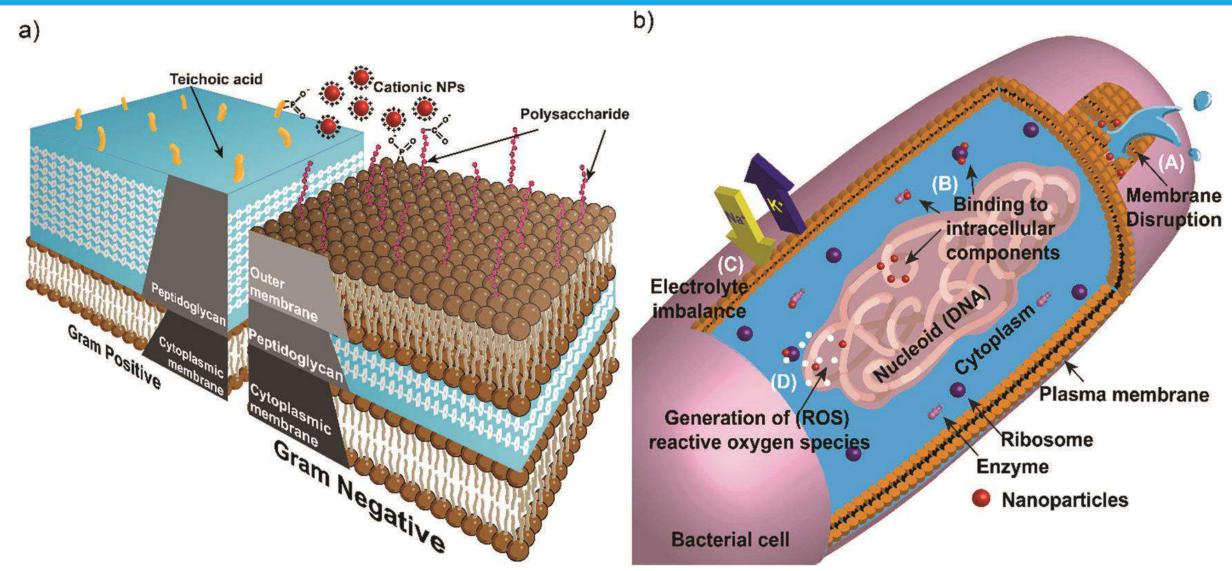




Huma et al., ACS Omega 2018, 3, 16721

## **Nanomaterials to Address MDR - related Issues**



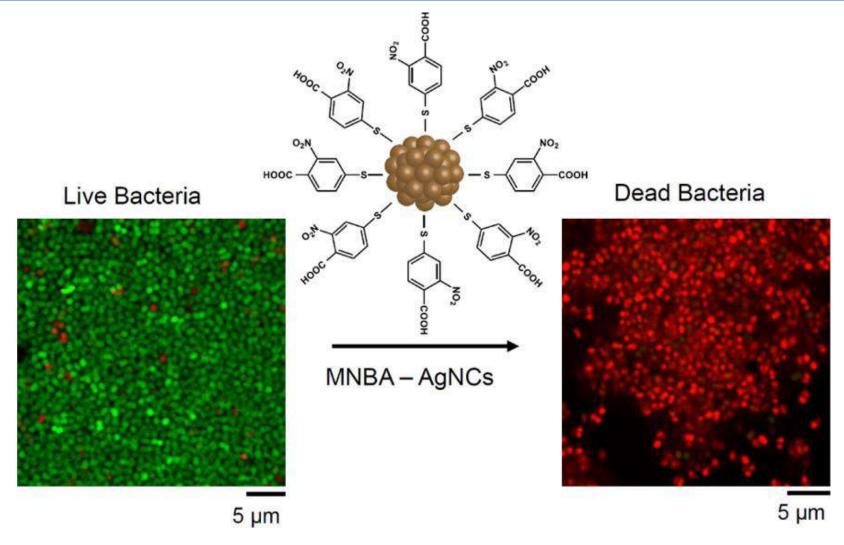


Akash & Shazia, et. al., Chem Soc Rev., 2019, 48, 415

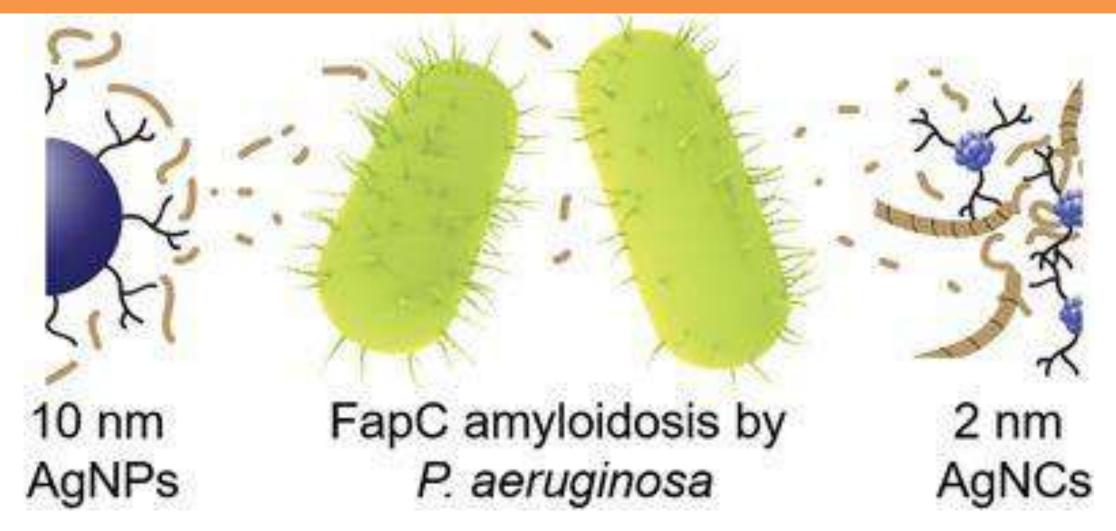
## Ag<sub>44</sub> NCs - Antimicrobial to Address MDR



MNB coated Ag<sub>44</sub> NCs are found very effective sexually to treat transmitted infections Multidrug by causes resistant bacteria i.e., Neisseria gonorrhoeae at doses non-toxic to mammalian cells (in vitro studies.



## Nanosilver Mitigates Biofilm Formation via FapC Amyloidosis Inhibition

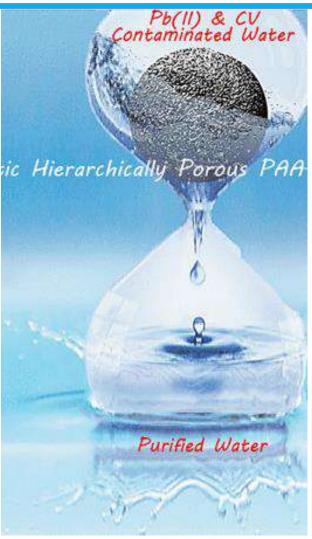


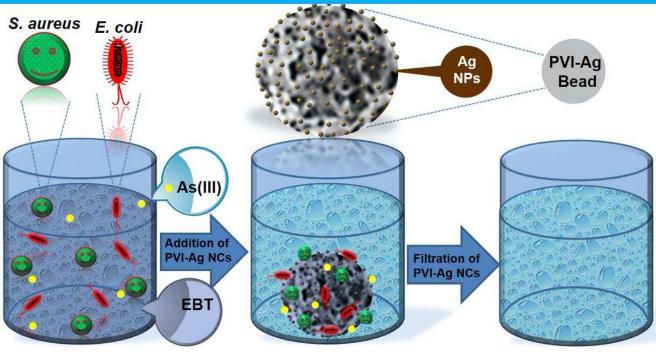
Antibiofilm potency of Ag NPs correlates with their capacity of FapC fibrillization inhibition

Huma et. al., **Small** 2020, 16, 1906674

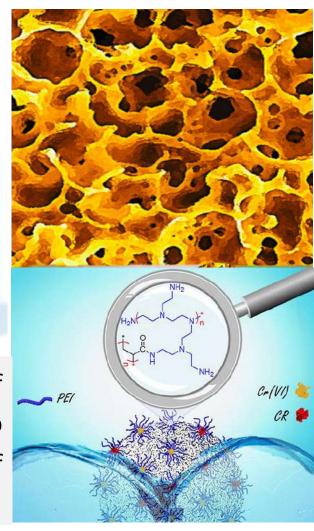
## Emulsion-Templated Porous Materials for Environmental Remediation







The control over the surface chemistry and porosity of hirerarchically porous polymer/composite helps to develop customised adsorbents for the effficcieent removal of organic and inorganic pollutants



Mudassir et al. *ADVANCED SCIENCE* 2021 (in press); Mudassir et al. *ACS Applied Materials & Interfaces* 2021, 13, 27400; Mudassir et al. *ACS Applied Materials & Interfaces* 2017, 9, 24190; Mudassir et al. *Langmuir* 2019, 35, 13165; Mudassir et al. *Langmuir* 2019, 35, 8996; *RSC Advances* 2018, 8, 29636.

## Acknowledgement



University of Liverpool, UK: Prof. Cooper, Brust, Zhang & Levy groups

HUST, Wuhan, China: Prof. Bien Tan's group

NIBGE, Faisalabad: Nanobiotech group and other collaborators ...

Functional nanomaterials group and other colleagues .....

Prof. Vincent Rotello's group

Prof. Francesco Stellacci's group

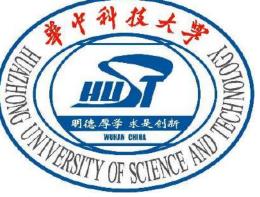
Prof. Wolfgang Parak's group

Prof. Osman Bakr's group



















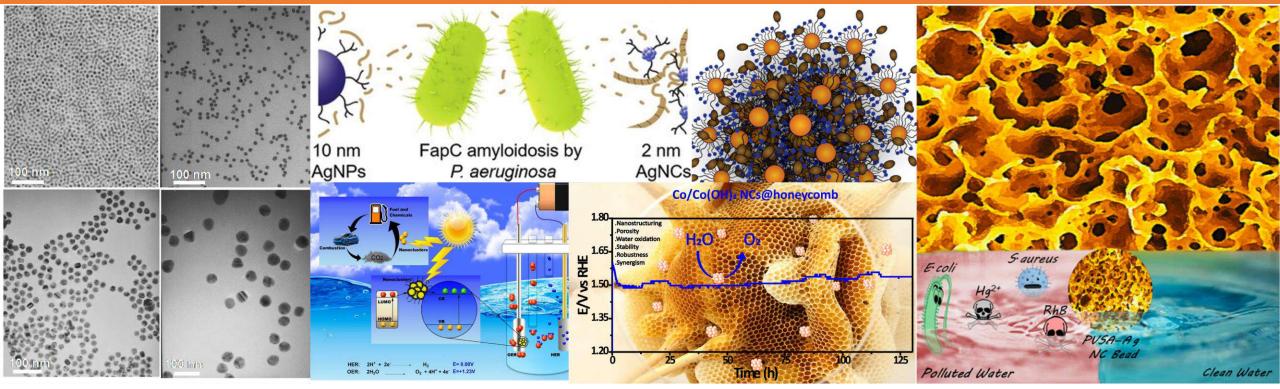


**SBASSE, LUMS:** 

**UMass, Amherst:** 

**EPFL, Lausanne:** 

## FUNCTIONAL NANOMATERIALS GROUP - IRSHAD HUSSAIN



Hussain et al., Langmuir 2003, 19, 4831; Levy & Hussain et. al., J. AM. CHEM. SOC. 2004, 126, 10076; Zhang & Hussain et al., Nature Materials 2005, 4, 787; Hussain & Tan et. al., J. AM. CHEM. SOC. 2005, 127, 16398; Wang & Hussain et al., Langmuir 2006, 23, 885; Zhang & Hussain et al., Angew. Chem. Int. Ed. 2008, 47, 4573; Zhang & Hussain et al., Adv. Mater. 2004, 1, 27; Zhang & Hussain et al., Chem. Commun. 2006, 2539; Roth & Hussain et al., Angew. Chem. Int. Ed. 2008, 47, 4573; Zhang & Hussain et al., Angew. Chem. Int. Ed. al., Chem. Commun. 2004, 1532; Roth & Hussain et. al., J. Electroanal. Chem. 2005, 581, 79; Hussain & Wang et. al., Langmuir 2006, 2941; Kanaras & Hussain et. al., Small 2007, 1, 67; Hussain et al Langmuir 2009, 25, 1934; Hussain et. al., Nanoscale 2010, 2, 2575; Asma & Hussain et. al., JCIS, 2010, 350, 368; Rotello & Hussain et al., Langmuir 2012, 28, 2023; Tan & Hussain et al. Chem Commun. 2012, 48, 567; Tan & Hussain et al., J. Phys Chem C, 2012, 116, 448-455. Khan & Hussain et al., IJHE 2013, 38, 2332; Lina & Hussain et al., J. Mater. Chem. A 2013, 1, 10148. Bien & Hussain et al. J. Mater. Chem. B 2013, 1, 2874; Sumaira & Hussain et al., Cellulose 2014, 21, 395; Yang & Hussain et al., J. Mater. Chem. A 2014, 2 11930; Maria & Hussain et al., Biosens. & Bioelect. 2014, 52, 242; Yan & Hussain et al., Mol. Chem. Phys. 2014. 215, 1257; Carolina et al., 2014, CoChE 2014, 4, 88; J. Mater. Chem. A 2015, 3, 6542; Javed et al., J. Mater. Chem. B 2015, 3, 8356; Rehman et al., Analyst 2015, 140, 7366; Wei et al., PSC Advances 2015, 5, 92017; Song et al., Dalton Transactions 2015, 44, 13906; Javed et al., Ayesha et al., J. Colloid Interfac Sci 2015, 446, 59; Wang et al., Asmer et. al., Espinosa et al., RSC Advances 2016, 6, 23310; Colloids & Surfaces B 2016, 141, 1-9; Nanoscale 2016, 8, 9695; RSC Advances 2016, 6, 81569; CHEMCATCHEM 2016, 8, 1671; JMCB 2016, 4, 6240; Colloids and Surfaces A 2016, 508, 301; RSC Advances 2016, 6, 94896; JMCB 2017, 5, 742, Int. J. Biol. Macromol 2017, 95, 138; Materials Letters 2017, 192, 56; Chem Select 2017, 2, 7497; RSC Advances 2017, 7, 42900; JMCB 2017, 5, 5608, ACS AMI 2017, 9, 24190; Journal of Physics D 2017 (In press); Int. J. Biol. Macromolec. 2017, 95, 138; Int. J. Biol. Macromolec. 2017, 102, 170; Science Advances 2017, 3, e1602610; Chem. Commun. 2017, 53, 12306; Nanomedicine, 2018, 13, 25; Colloid and Surfaces A 2018, 539, 391; Scientific Reports 2018, 8, 13304; Int. J. Nanomedicine 2018, 13, 3145; Journal of Hazardous Materials 2019, 364, 441; ACS Omega 2018, 3, 16721; ACS Applied Energy Materials 2018, 2, 363; Microchimica Acta 2019, 2019, 186, 127; ChemSusChem 2019, 12, 1517; Nanoscale 2019, 11, 1286; Chemistry - A European Journal 2019, 25, 548; ACS Applied Nanomaterials 2018, 2, 546; Microchimica Acta 2019, 186, 127; Chem. Soc. Rev. 2019, 48, 415; Nature Communications 2019, 10, 676; Langmuir 2019, 35, 13165; Nanoscale Adv. 2019, 1, 2924; Cell Cycle 2019, 18, 2281; ChemSusChem 2019, 12, 5117; Langmuir 2019, 35, 13165, Chemistry - A European Journal 2020, 26, 11209; Small 2020, 16, 1906674; Electrochimica Acta 2020, 341, 136032; JMCB 2020, 8, 8444; ACS-AMI 2020, 12, 27994; ACS-AMI 2021, 13, 468; Nanophotonics 2021, 10, 1595; Nanomedicine 2021, 16, 819; J. Mol. Liquids 2021, 333, 115972; RSC Advances 2021, 11, 19755; Mater. Sci & Eng. B 2021, 271, 115257; Macromolecules 2021, 54, 5848; ACS AMI 2021, 13, 27400; Nanoscale 2021, 12, 14207; ACS Applied Energy Materials 2021, 8685; Advanced Science 2021, 2102540; Nature Communications 2021, 1; Energy Conversion and Management 2022, 254, 115262; Journal of Electroanalytical Chemistry 2022, 905, 115977; IJHE 2022, 47, 36118; NanoImpact 2022, 28, 100419; ChemistrySelect 2022, 7, e202202774; JALCOM 2022, 932, 167647; IJHE 202248, 4719; J. Env. Chem. Eng. 2022, 11, 109185; ACS Applied Nanomaterials 2023. 6 (3), 1631; J. Mol. Liq. 2023, 376, 121438; RSC Advances 2023, 13, 4932; Advanced Therapeutics 2023 (in press); Nature Communications 2023 (under revision).

## DESIGN AND SYNTHESIS OF NANOMATERIALS FOR BIOMEDICAL AND ENERGY APPLICATIONS

#### JACKIE Y. YING FIAS\*\*

Founding Executive Director, NanoBio Lab, Institute of Materials Research and Engineering, USA

#### **ABSTRACT**



Nanostructured materials can be designed with sophisticated features to fulfill the complex requirements of advanced material applications. Our laboratory has developed organic and inorganic nanoparticles and nanocomposites for advanced drug delivery, antimicrobial, stem cell culture, and tissue engineering applications. In addition, we have nanofabricated microfluidic systems for drug screening, *in vitro* toxicology, and diagnostic applications. The nanosystems allow for the rapid and automated processing of drug candidates and clinical samples in tiny volumes, greatly facilitating drug testing, genotyping assays, infectious disease detection, point-of-care monitoring, as well as cancer diagnosis and prognosis.

We have also synthesized metallic, metal oxide and semiconducting nanoclusters, nanocrystals and nanosheets of controlled dimensions and morphology. The nano-sized building blocks are used to create multifunctional systems with excellent dispersion and unique properties. Nanoporous materials of a variety of metal oxide and organic backbone have also been created with high surface areas and well-defined porosities. These nanostructured materials are successfully tailored towards energy and sustainability applications.

E-mail: jyying@imre.a-star.edu.sg

<sup>\*\*</sup> Institute of Materials Research and Engineering 31 Biopolis Way, The Nanos, Singapore 138669 https://jyyinglab.net

## THE MULTIDISCIPLINARY BS DEGREE IN NANOSCIENCE AND NANOTECHNOLOGY: ITS GROWING ACADEMIC AND SOCIO-ECONOMIC IMPORTANCE

#### N. M. BUTT FIAS

Professor & Chairman, Preston Institute of Nano Science & Technology (PINSAT),
Preston University Kohat, Islamabad Campus, Pakistan

#### **ABSTRACT**



Nanotechnology is the new and fast growing technology of great socioeconomic and strategic importance. It is applied to almost all kinds of industries; may be Energy, Defense, Space, Oil and Gas Exploration, Mineral Development, Clean drinking water, Pharmaceuticals, Healthcare and Medicine, Electronics, IT, Environment, Climate Change Mitigation, Consumer goods industry or whatever.

It is the technology where materials of very small sizes, the sizes of atoms and molecules or the sizes at nanoscale(10<sup>-9</sup>m) are used in the

industrial products and that greatly adds value to the relevant industrial products both in terms of quality and the efficacy of the production. The nanoscale of materials used for nanotechnology is normally considered involving material sizes of up to 100 nanometers. One nanometer(nm) being one billionth of a meter(10<sup>-9</sup>m).

Nanotechnology is seen with such a high industrial potential that it is regarded as an INDUSTRIAL REVOLUTION of 21st Century. This aspect is reflected in the fact that advanced countries like USA, Japan, EU, China etc. are investing billions of dollars annually in a global race of socio-economic power dominance.

USA for example from 2001 to 2021, has invested over 38 billion dollars on nanotechnology, including **1.98** billion dollars for the year 2022. The political leaders of advanced countries have supported Nanotechnology programs on **NATIONAL LEVEL** to give it serious considerations.

Regarded as an **Industrial Revolution** the applications of nanotechnology to various industries is expected to last for several decades in future, some business experts estimating the global marketing potential of 2-3 trillion dollars of nano-based products.

Keeping this importance in view it is pertinent that a Nano-specific qualified and trained HUMAN RESOURCE must be produced to best utilize their training and experience. Such specific human resource is needed in all spheres of employment, not only in Industries and in Academia but also in allied areas of employment like Legal and IPR fraternity who need to be familiar with nano based products during the litigation or patenting process.

To produce such human resource, the educational institutions need to adopt the curriculum in education and training of nanotechnology at all levels of education, not only at the University teaching or R&D levels but also at the college level down to the school level.

One of the important level of teaching is the undergraduate level after which the entry doors are available to higher studies in various subject specialties and the needs of Industries or R&D institutions.

In the present presentation we therefore emphasize the importance of BS level teaching at the international level as well as the national level by describing the successes achieved over the past few years of execution of such undergraduate and post graduate degree programs in Nanotechnology.

Currently several countries have designed appropriate curricula for formal degrees in Nanotechnology in natural sciences as well as engineering sciences. Such curricula, of necessity, have a multidisciplinary mixer, particularly of natural and social sciences at BS level and possibly in some countries the mixer of engineering and natural sciences is also in the offing.

### It is re-emphasized that the BS level (16 years education) is a very important level as it is a feed to higher degrees and research and also directly required to the industry.

A survey showed that BS in Nanoscience and Nanotechnology degree awarding institutions in 2010 were about 30 which increased by 2017 to over 100, a threefold increase showing fast growth for proper degree qualifications in Nanotechnology area.

We have found excellent results during the last 10 years as the <u>FIRST HAND</u> experience of launching in Fall-2010 the 4 year BS (Nanoscience and Nanotechnology) degree at the Preston Institute of Nanoscience and Technology (PINSAT) at the Preston University Kohat, Islamabad Campus, Islamabad.

Our 65 BS (Nanoscience and Nanotechnology) graduates produced with this Multidisciplinary degree with teaching of theory and practical of 4 nano-based subjects of **Physics**, **Chemistry**, **Biology** and **Materials Science** won 59 MS/PhD fully-funded scholarships (0ver 90 %) in 12 countries, which is rare percentage globally of winning fully -funded MS/PhD scholarships by the BS graduates of a University.

In this paper, some of the successful examples of the multidisciplinary BS/MS degrees in Nanoscience and Nanotechnology in Pakistan and abroad will be discussed with available facts.





"The Multidisciplinary BS degree in Nanoscience and Nanotechnology:

Its growing Academic and Socio-Economic Importance"

Prof. Dr. N. M. Butt, S.I.

M.Sc(Punjab), Ph.D(Birmingham), D.Sc(Birmingham)

Preston Institute of Nano Science and Technology (PINSAT).

**Preston University Kohat,** 

Islamabad Campus. Islamabad.

( e-mail: nmbutt36@gmail.com )

#### **Presentation at:**

The joint IAS and COMSTECH ,"24th International Scientific Conference on Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries", ICCBS, KARACHI, PAKISTAN.

March 7 – 8, 2023

#### Presentation Scheme on Nanotechnology in Pakistan.

1.First Ever Initiation: 1995 (Lecture on New Materials at PINSTECH-N.M.Butt)

Important <u>Support by Professor Atta Ur Raman</u> as Federal Minister & Chairman HEC.

2. Second Initiative: Formal NanoEducation - 2010:
Multidisciplinary BS (Nanoscience & Nanotechnology) Degree.
Excellent Successful Outcome-10 Years Experience.
(All Times Support: Dr.Abdul Basit - Chancellor Preston University)

#### 3.Important Financial Support:

- International Development Research Centre-IDRC (Canada)[2011-2013]
- Pakistan Academy of Sciences (PAS): 3 Research Grants-:(2011-13), (2014-16),(2018-20)

\*\*\*\*\*\*

### Nanotechnology in Pakistan.

- (i). 1995: First time in Pakistan referred the word "Nanotechnology" used by Tani Guchi's paper of 1974 on "Transistor fabrication".
  - (Ref: Invited Lecture on Biomaterials, PINSTECH, Islamabad 1995) N.M.Butt .
- (ii). 2001: Conference on Nanotechnology, COMSATS Institute of Information Technology (CIIT), Islamabad, 2001. <a href="Invited Lecture-N.M.Butt">Invited Lecture-N.M.Butt</a>
- (iii) 2002: Nanotechnology: An Overview ,The 12th IAS Conference , Islamabad , October 14-17, 2002. Invited Lecture IAS Conference Islamabad.
- (iv) 2003:Nanotechnology:The Key Technology:, Islamabad, July 31, 2003:

Pakistan Academy of Sciences PAS – Invited Lecture = N.M.Butt

\*\*\*\*\*

### **Important National level Support**

by

Professor Atta-ur-Rahman, Minister of S&T, Govt of Pakistan

Approval of (i)Rs 36 Million for administration and (ii) Rs 945 million for Research Projects of 5 Universities/Institutes

to

"National Commission on Nano-Science and Nano-Technology" (Chairman :Dr.N.M.Butt 2003-2008)

\*\*\*\*\*\*

Now (2023) nanotechnology Research is in almost all Science Universities of Pakistan.

#### First PC-1 Draft of Nanotechnology corrected by Professor

Atta-ur-Rahman in his own hand writing during our Air-travel

from Islamabad to Karachi - Sept 20

PLANNING COMMISSION GOVERNMENT OF PAKISTAN

Formulation of National Nano-science and Nano-technology Policies/Action Plan and its Implementation in Pakistan

Pakistan Council of Scientific and Industrial Research
(PCSIR)

(Ministry of Science & Technology)

(September 2003)

2003	Javaid Bashir
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Approved by	Dr. Anwar-ul-Haq Chairman PCSIR, Islamabad, Ph:- 9258336 Fax:- 9258167 E-mail:- anwar@comsats.net.pk

#### Annex-I

Sr.	al phasing and financial requirements of the	Financial Distributions				
No.		First Year	Second Year	Third Year	Total	
L.	Post-doctoral Fellowships, Lab. Equipment, Research Grants etc.	5.000	5.500	5.500	16.000	
2	Conferences, Workshops, Scientific Visits	2.000	2.000	1.500	5,500	
3.	Books and Journals	0.000	0.500	0,500	1.000	
4.	Establishment charges (Annex. IV)	1.864	1.864	1.864	5.592	
5.	Office Equipment and accessories (Annex-V)	2.000	0.500	0.500	3,000	
6.	Vehicles, POL, maintenance etc (Annex- VI)	1,000	0.500	0.500	5,000	
7.	Contingencies (unforeseen/ miscellaneous etc.)	0.600	0.600	0,600	1.800	
	Total	14.964	10.964	11.964	34.89	

Corrections of budget figures of PC-1 by Professor Atta-ur-Rahman as Federal Minister of Science & Technology, Govt of Pakistan



#### HIGHER EDUCATION COMMISSION

Prof. Dr. Atta-ur-Rahman

Nation-Institute Marie Annies. Service Annies. Torrighe Annies
UNBSOG Science Loureafte
Chairman
Federal Minister)

No. 1-1 /CHR/HEC/03/ 2760 September 30, 2003

My dear doctor sahib,

اسدم عندم

I shall be grateful if the PC-L revised and sent back to me urgently.

It should cost Rs. 36 million after the following changes have been incorporated:

1.	12 Post-doctoral Fellowships @ US\$ 25,000/year = US\$ 300,000/-	Rs. 18 million approx.
2.	Lab. Equipment = US\$ 200,000/- =	Rs. 12 million
3.	Others (as in your PC-I) =	Rs. 6 million
3.	TOTAL:	Rs. 36 million

With kind regards.

Yours sincerely,

Prof. Dr. Atta-ur-Rahman

Dr. N. M. Butt House No.155 Street-15, Sector E-7

### Research Projects-Pakistan-2004

First Time Funds for Research Projects in Nanoscience and Nanotechnology approved by Prof. Atta-ur-Rahman as Federal Minister of S&T /Chairman HEC.

No.	Project	Institution	Rs million	Funded by
i.	Synthesis and Characterization	PIEAS	60	HEC
ii.	Nano-magnetism	QAU	137	HEC
iii.	Micro/Nano electronic devices	CIIT	189	HEC
iv.	Nano-Composites	GIK Private Inst.	195( not released)	HEC
v.	Nano-biotechnology	NIBGE	155	MoST
Vi	Nano-devices, L.E.D. etc	PINSTECH	196	MoST
vii.	Nano Coating	PCSIR Lhr	13	MoST
	Total: US\$ 15million		945	5

### Scientific & Socioeconomic Importance

### Scientific & Socioeconomic Importance

### Scientific:

- **Surface** to **Volume** Ratio of Particles
- Quantum Science at nano scale.
- **Properties** at Bulk scale very Different from Nanoscale.
- Multidisciplinary

### Socio Economic:

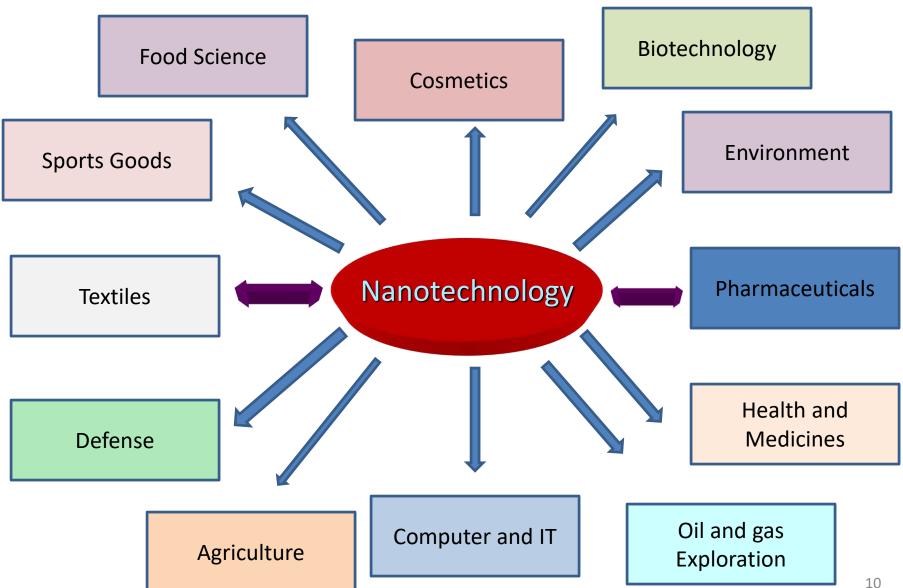
- Society— Public Acceptance
- **Economy-** Investment and Industry
- Safety, Standards and Regulations.
- ❖Intellectual Property Rights (IPRs).

#### GLOBAL IMPACT

- > Applications of nanotechnology have developed.
- Potential of 3.1 trillion dollar market by 2020. It was \$147 billion products in 2007 and 1 Trillion \$ in 2013.(<a href="www.luxresearchinc.com">www.luxresearchinc.com</a>).
- > 2586 nanoproducts already in the market by Nov 2009 (Ref: Helmut Kaiser Consultancy, Germany).
- ➤ Another "Industrial Revolution" in the making & Part of 4th Industrial Revolution: including (i)robotics,
- (ii) <u>artificial intelligence</u>, (iii) <u>nanotechnology</u>, (iv) <u>quantum computing</u>, (v) <u>biotechnology</u>, (vi) <u>The Internet of</u> (IoT), (vii) <u>decentralized</u> consensus, (viii) <u>3D printing</u> and (ix) <u>autonomous vehicles</u>. World Economic Forum (WEF):
- Profound <u>effect on the socio-economic scenario of the world for 40-50-years.</u>

### Nanotechnology and Industries:

### **Need of Nano-Qualified Graduates**



### Career in Nanotechnology Electronics/semiconductor industry

- **1**.
- Materials science including textiles, polymers, packaging. 2.
- **3**. Auto and aerospace industries
- 4. **Sports equipment**
- **5**. Pharmaceuticals including drug delivery, cosmetics.
- **Biotechnology** 6.
- **7**. Medical fields
- 8. **Optoelectronics**
- **Environmental monitoring and control** 9.
- Food science including quality control and packaging **10**.
- University lab research/R&D in govt and private research 11. Institutes
- **12. National security**
- **Military 13**.
- **Agriculture 14**.
- **Academic & Teaching 15.**
- Forensic science & many other new industries emerging as a result **16**. of advances in nanotechnology.

http://www.nnin.org/nnin\_careers.html

- NEED FOR Formal NANO EDUCATION:
  Why?
- Nanotechnology as INDUSTRIAL REVOLUTION to influence the Socioeconomic Structure of Society for next 40-50 years.
- 2. <u>To meet the needs of industry, R & D Institutions,</u>

  <u>Universities, IPRS. Patent offices, Legal offices, Society</u>

  <u>Awareness etc,</u>
- 3. There is a dire Need of <u>properly qualified and trained</u>

  <u>Human Resource</u> in nanotechnology for their best

  contributions: essential for all countries.

### Nano-Human Resource Development

**Nano Degree Programs Worldwide** 

### **Country wise Breakup: BS-MS-PhD**

Country	BS	MS	PhD	Country	BS	MS	PhD
Australia	<b>12</b>	05	2	Malaysia	02	01	01
Belgium	-	02	-	Mexico	09	<b>07</b>	06
Brazil	03	04	03	Netherlands	_	05	03
Canada	09	01	01	New	02	01	-
		ŭ <b>–</b>	<b>~</b> _	Zealand			
Czech republic	01	01	-	Norway	03	04	-
Denmark	05	05	05	Russia	05	<b>05</b>	-
Egypt	-	02	-	Singapore	01	-	-
France	-	10	09	Spain	01	03	-
Pakistan	01	04	01	Singapore	01	01	01
Germany	<b>07</b>	05	01	Poland	02	02	01

Greece		01	-	Switzerland	01	02	02
~ -							
Sweden	02	04	-	USA	<b>14</b>	<b>10</b>	09
Hong kong	-	01	01	Taiwan	-	02	01
Srilanka	-	-	01	Hongkong	-	-	01
India	03	28	06	Thailand	01	03	02
Ireland	02	-	-	Turkey	01	07	06
Israel	-	04	03	UK	04	15	07
Japan	-	01	01	Egypt	_	02	_
Italy	-	01	-				
Korea	08	06	02	<u>Total</u>	<u>100</u>	<u>155</u>	<u>76</u>

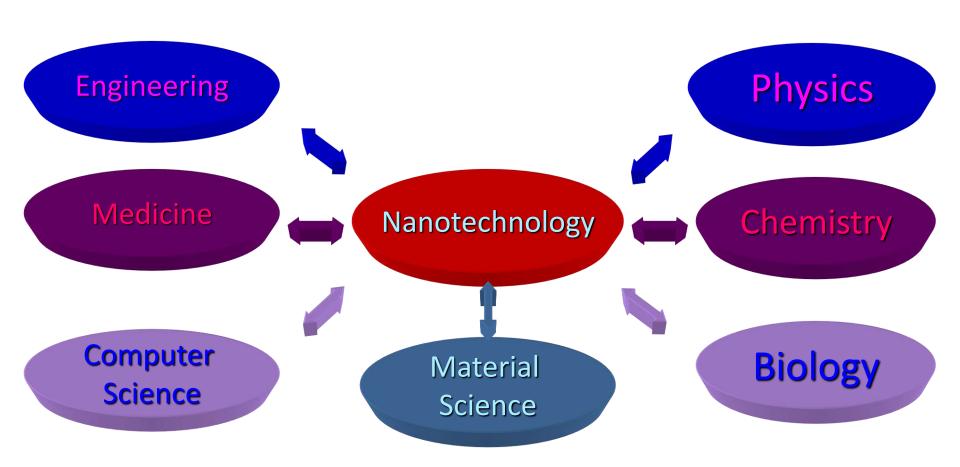
### Some International Nanotechnology Multidisciplinary BS Degree Programs: 2010=30, 2016=100

- 1. Universidade Federal do Rio de Janeiro Bachelor Program Nanoscience and Nanotechnology (Brazil)
- The Nanotechnology undergraduate course at the Federal University of Rio de Janeiro was created in 2010. After teaching the basic concepts of
- **chemistry**, **physics and biology**, students will learn concepts of nanotechnology applied to one of the three specific areas:
- 2. <u>University Hamburg Bachelor in Nanosciences (Germany)</u>
- Fächern Chemie, Biochemie und Molekularbiologie, Informatik, Mathematik und Physik.
- 3. University of Aarhus Bachelor's Program in Nanoscience (Denmark)
- During the first three years, students receive basic interdisciplinary training in **physics**, **chemistry**, **biology**, **molecular biology**, **mathematics**, and computer science. In addition, a number of courses address issues specific to the nano-area.
- 4. University of Basel Bachelor of Science (BSc) in Nanosciences (Switzerland)
- The University of Basel is the first Swiss university to provide a programme in nanosciences. From the very beginning of studies, the
- interdisciplinary curriculum in nanosciences combines the three disciplines of biology, chemistry and physics nto the word of nano systems. After three years a BSc with a Major in Nanosciences can be awarded.
- 5. <u>University of Chicago B.Sc. in Molecular Engineering (USA)</u>
- The BS degree program in Molecular Engineering offers undergraduates a cutting-edge engineering curriculum built on a strong foundation in

#### mathematics, physics, chemistry, and biology

- 6. University of Leeds BSc Nanotechnology (UK)
- You will study key topics from all the core sciences chemistry, biology, physics, material science and
- **electronics** alongside specialist modules in nanoscience and nanotechnology.
- 7. University of Toronto BASc in Engineering Science (Nanoengineering Option) (Canada)
- This option transcends the traditional boundaries between physics, chemistry, and biology. Starting with a foundation in materials engineering and augmented by research from the leading-edge of nanoengineering,
- 8. <u>University of Western Australia Bachelor of Science (Nanotechnology) (Australia)</u>
- This program investigates the basic theory and applications of nanotechnology in the biological, chemical sciences, physics and engineering science.

### Nanotechnology is Multidisciplinary



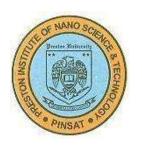
# Nanotechnology Education in Pakistan

### Nanotechnology Education in Pakistan

B.S(Nanoscience & Nanotechnology)
4 year Multidisciplinary BS-Degree: Only one in Pakistan
(majors: Phys, Chem, Bio & Mat. Sci)
at
Preston Institute of Nano Science and Technology (PINSAT).
Preston University Kohat,
Islamabad Campus. Islamabad.

First initiative in Pakistan Admissions: Fall-2010





Summary:-BS (Nanoscience and Nanotechnology)-Multidisciplinary Degree(Nano-based):Phys,Chem,Bio,Mat Sci,Math.

- 1. PINSAT Scheme of Studies as per HEC--- 43 Courses –132 Cr.Hr (Also Courses on Nano Economy, Ethics, Social Sci, IPR, Psychology)
- 2. PINSAT Faculty with 6 Full Professors with 25-30 years Experience. [Rtd, from PAEC & Q.A.Univ.:High Quality Institutions of Pakistan.]

**BS Students Annually: 10-15 Annually.** 

Imp: Very High Professor: Student Ratio.

	<u>Subjects</u>	<b>Science Subjects</b>	<u>CH</u>
1.	Mathematics		3+3
2.	Basic IT		2 +1
3.	Chemistry		3+3+3+1
4.	Physics		3+3+3
<b>5.</b>	Nanoscience and its In	dustrial Applications	3 +0
6.	Nanomaterials -I,II,III (	Materials Science)	3+3+3
<b>7.</b>	Cell Biology		2+1
8.	Synthesis and Characte	erization Techniques of Na	anomaterial's 3+1
9.	Biochemistry		2+1
<b>10.</b>	Electronics		3+1
11.	<b>General Microbiology</b>		3 +0
<b>12.</b>	<b>Environment &amp; Ethics</b>	in Nanotechnology	2 +0
<b>13.</b>	Nanocomposite Mater	rials	2 +0
14.	Nanochemistry		3 +0
<b>15.</b>	Nanobiotechnology		3 +0
16.	Nano Sensors and Dev	vices	3 +0
<b>17.</b>	<b>Research Methods</b>		3+0

18. Quantum Mechanics	3 +0			
19. Nanocatalysis	2 +0			
20. Social Impact of Nanotechnology	3 +0			
21. Nanoelectronics	3 +0			
22. Applied Mathematics	3 +0			
23. Laboratory-I,II,III	2+2+2			
25. Nanobiology	2+0			
26. Research Project (Last 8 <sup>th</sup> Semester)	6+0			
27. Internship	6+0( Not counted in CGPA)			
Total CH	107			
Social Subjects				
29. Introduction to Psychology	3+0			
	3+0 3 +3+3			
29. Introduction to Psychology				
29. Introduction to Psychology 30. English	3 +3+3			
<ul><li>29. Introduction to Psychology</li><li>30. English</li><li>31. Pakistan Studies</li></ul>	3 +3+3 3+0			
<ul> <li>29. Introduction to Psychology</li> <li>30. English</li> <li>31. Pakistan Studies</li> <li>32. Islamic Studies</li> </ul>	3 +3+3 3+0 3+0			
<ul> <li>29. Introduction to Psychology</li> <li>30. English</li> <li>31. Pakistan Studies</li> <li>32. Islamic Studies</li> <li>33. Statistics</li> </ul>	3 +3+3 3+0 3+0 3+0			
<ul> <li>29. Introduction to Psychology</li> <li>30. English</li> <li>31. Pakistan Studies</li> <li>32. Islamic Studies</li> <li>33. Statistics</li> <li>34. Technical Project Managemet</li> </ul>	3 +3+3 3+0 3+0 3+0 3 +0			

### eston University

### Preston University Islamabad PINSAT Faculty-2017





L to R: Mr Asad Ali, Lecturer, Prof.Dr.M.Fayyaz Ch (QAU-Dean Retd), Prof.Dr.M.Javed Iqbal (QAU Prof.Retd), Prof.Dr.K.Yaldram(Chief Scientist PAEC- Retd), Prof.Dr.N.M.Butt(Chairman PINSAT), Prof.Dr.J.I.Akhter(D.G Pinstech-Retd), Prof.Dr.Qamar Javed(QAU Prof-Retd), Visiting Prof.Dr.M.Afzal Sh(Chief Scientist PAEC-Retd), Assoc Prof.Dr.Shahid Bilal Butt(Chief Scientist PAEC-Retd).

### PINSAT Islamabad: Success Story- 10 years Experience Excellent Success

1. 65 BS Graduates won 59 Fully Funded MS/PhD (59/65=97%) Foreign Scholarships in 11 Countries [USA,China,Germany,Japan,Australia,Canada,Belgium,Norway, Hong Kong,South Africa, Saudi Arabia].

[Total Amount of Scholarships= RS430 million-Highest of all Univs in Pakistan].

- 2. Won Awards during MS and PhD abroad and Medals /First positions at home.
- 3. MS/PhD in variety of areas: Cancer, Solar Energy, Brain Materials Studies, Biology, BioChemistry, Composite Materials etc.,
- 4. Published high quality Papers in PhD, [3 students PhD with 19,16,16 Papers].
- 5. Preston Alumnus Addressed Graduates -2021 Ceremony UCAS Beijing students. [Great Honour for Pakistan]

### **Reasons of Success:**

- 1. High Quality Faculty: 6 Full Professors
- 2.Well Euipped Labs: Empasis on Practica
- 3. Professor: Students Ratio 1:15
- 4. Emphasis on Personality formation

### **Pakistan**

- \*\*\*\*\*
- (i): PINSAT Alumni Awards.
- 1. NUST-Islamabad (MS-Gold Medal).
- 2. Bahria Univrsity Islamabad (MBA Gold Medal).
- 3. CUST Islamabad (Chancellor's Roll of Honour)
  - \*\*\*\*\*

### (ii): PINSAT Alumni Cash Prizes:

- 1. MS(Nanotechnology): CSSP(P.U) Lahore, Director's Prize -2016.
- 2. NUST (SCME): MS-2017



### **Shazra** Shahzad(Preston BS graduate)

\*\*\*\*

- > **NUST-SCME** :**MS(**2018)
- > FIRST Position- Gold Medal.









President of Pakistan awarding **Gold Medal MBA** -Bahria University Islamabad to PINSAT Alumna, Ms Bakhtawar Mahmood

\*\*\*\*\*\*



Faiza Nadeem- Preston Alumna- ReceivingCUST Chancellor's Honor Roll— MS-2017-Engg Management.

### **International Wards**

### National & International Excellent Success of

Preston BS(Nanoscience and Nanotechnology) Graduates.

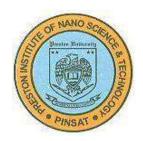
\*\*\*\*

1.Fully Funded MS/PhD Scholarships

&

2. Outstanding Research Awards





### PINSAT, Preston University 65 BS Graduates Passed [2014-2021]

**59** Scholarships & Fellowships;

(MS=27, Ph.D=23 & Fellowships=9)

Total Amount = Rs 430.23 million

\*\*\*\*\*\*\*

65 BS graduates passed & 59/65= 90.7% won Fully Funded Scholarships in 11 Countries

#### **HIGHEST of All Universities in Pakistan**

\*\*\*\*\*\*\*\*\*\*

### PINSAT, Preston University 65 BS Graduates passed and

#### 59 Fully funded MS/PhD Scholarships/UNESCO Fellowships won in 11 Countries

#### **Summary:**

S.No	Country	Scholarships/	Amount
		Fellowships	
1	Australia Chaudhry Muhammad	<b>Ph.D</b> = 1	Rs. 12.2 million
	Furqan (cmfurqan@connect.ust.hk)		
	(University of New South Wales, Dept. of Engineering)		
2	Canada Humza Javed ( <u>humza333@outlook.com</u> )	$\mathbf{Ph.D} = 1$	Rs. 17.82 million
	(University of Calgary, Dept. of Chemical & Petroleum Engineering)		
3	Saudi Arabia Nawal Mughal < nawalmughal88@gmail.com >	<b>Ph.D</b> = 1	Rs. 41.85 million
	(King Abdullah University of Science and Technology (KAUST),		
	Material Science & Engineering		
4	US Jabran Saleem (jabran55555@gmail.com)	$\mathbf{Ph.D} = 1$	Rs. 9.972 million
	(Raleigh, North Carolina, Dept. of Chemistry)		
	China / 30 students – List attached	MS = 22	Rs 230.376 million
	(NCNST)	$\mathbf{Ph.D} = 15$	
5	Hong Kong Humza Javed(humza333@outlook.com)	MS = 2	Rs 21.112 million
	Ch M. Furqan (cmfurqan@connect.ust.hk)		
	(The Hong Kong University of Science and Technology)		
6	Norway Muhammad Ibrahim ( <u>muhammad.ibrahim20@gmail.com</u> )	Ph.D = 1	Rs 23.04 million
	(Norwegian University of Science and Technology)		

Germany Mishal Khan ( <u>khanmishal798@gmail.com</u> ) (Institute for <u>Molecular Systems Engineering</u> (IMSE), Ruprecht Karl University of Heidelberg)	Ph.D = 1	Rs 19.8846 million
South Africa: UNESCO Fellowships (iThemba Labs Cape town)	9 students	Rs 6.46 million
Russia: Mr. Muhammad Owais (mohammadowais001@gmail.com) (Skoltech Institute of Science and Technology)	MS = 1 Ph.D = 1	Rs 10.08 million
Japan Ms.Arouba Iftikhar (aroobaiftikhar9@gmail.com) (Japan advance institute of science and technology JAIST), Advance Science & Technology	MS = 1	Rs 5.011 million
Belgium Momina Amir (momina.amir30@gmail.com) (KL Leuven), Engineering Science	MS = 1 Ph.D = 1	Rs32.522million
Total	59 Scholarships & <u>UNESCO</u> Fellowships	Amount = Rs 430.23 million
	(Institute for Molecular Systems Engineering (IMSE), Ruprecht Karl University of Heidelberg)  South Africa: UNESCO Fellowships (iThemba Labs Cape town)  Russia: Mr. Muhammad Owais (mohammadowais001@gmail.com) (Skoltech Institute of Science and Technology)  Japan Ms.Arouba Iftikhar (aroobaiftikhar9@gmail.com) (Japan advance institute of science and technology JAIST), Advance Science & Technology  Belgium Momina Amir (momina.amir30@gmail.com) (KL Leuven), Engineering Science	(Institute for Molecular Systems Engineering (IMSE), Ruprecht Karl University of Heidelberg)  South Africa: UNESCO Fellowships (iThemba Labs Cape town)  Russia: Mr. Muhammad Owais (mohammadowais001@gmail.com) (Skoltech Institute of Science and Technology)  Japan Ms. Arouba Iftikhar (aroobaiftikhar9@gmail.com) (Japan advance institute of science and technology JAIST), Advance Science & Technology  Belgium Momina Amir (momina.amir30@gmail.com) MS = 1 (KL Leuven), Engineering Science  Total  59 Scholarships & UNESCO

# Alumnus Kamran Amin – Prestom Alumnus Receiving Special Contribution Award NCNST Beijing, Chinese Academy of Sciences.







### Muhammad Abdullah Adil – Pinsat Alumnus-2015

[Wins NCNST Beijing Excellent International PhD Student "Achievement Certificate" for Excellent Performance-2019].

➢ He published 19 PhD papers(5-FIRST author) in high Impact Factor Journals, IF=27,15,12 .....etc.,

## 所精闡微為爲用用

向多禮な聞

NCNST Director Scholarship is awarded to:

#### Kamran Amin

On his outstanding research performance in

National Center for Nanoscience and Technology

(NCNST), China

2018

国家纳米科学中心

National Center for Nanoscience and Technology, China

### Kamran Amin-Pinsat Alumnus-2015

[Wins NCNST Beijing Director's Scholarship for Outstanding Research-2018].

He published 16 PhD papers(4-FIRST author) in high Impact Factor Journals, IF=27,15,12,7.....etc.,



向多禮な問

This certificate awarded to

Kamran Amin

"Special Contribution Award"

For Promoting the International Students Culture

In 2018-2019

Date 2019-8-28

By Graduate Education Office

国家纳米科学中心

National Center for Nanoscience and Technology, China

### Kamran Amin-Pinsat Alumnus-2015.

[Wins NCNST Beijing "Special Contribution Award" 2018-2019].



Dr Kamran Amin –Preston Alumnus
Addressing NCNST Graduation Ceremony-2021 NCNST
Representing International students at the University of Chinese
Academy of Sciences(UCAS).

# PINSAT Alumnus: Kamran Amin Excellent International Graduate 2021 UCAS(University of Chinese Academy of Sciences)

\*\*\*\*\*



#### KAMRAN AMIN

has been awarded as 2021 Excellent International Graduate



## Future BS Degrees: CONVERGENCE of Science, Engineering and Social Sciences

\*\*\*\*

- Different disciplines of science are converging as scientists have common and overlapping interests.
- Nanotechnology will promote the unification of most branches of <u>Science</u>, <u>Engineering</u>, <u>Technology</u>, based on unity of nature at the nanoscale and <u>Social</u> <u>Sciences</u>. <u>CURRICULA for INTEGRATED Degrees</u>.
- Social, Ethics, Safety, Standards, Regulations, IPRS

\*\*\*\*\*

#### **Conclusion**

Multidisclinary BS Degree (Nanoscience and Nanotechnology) has proved an important success at home and abroad.

\*\*\*\*\*\*

## BS(Nano) Degree

- 1. Most suitable for Nanotechnology Institutions worldover.
- 2.Imporatnt stage of Formal degree entry to:
- 3. Entry for Most Jobs, Private, Public Institutions
- 4.Entry to Higher degrees of MS /PhD
- 5. Entry to Industries, IPRS
- 6. Entry to other subjects for second under-graduation.

(Project Management-MBA – Media ,etc.,)

## The Future of Nanotechnology: Balancing Potential benefits and Risks.

\*\*\*\*\*

Nanotechnology has emerged as a game-changing field that has the potential to transform almost every aspect of our lives.

Nanotechnology has already demonstrated significant impacts in various industries, including healthcare, energy, electronics, Defence, Aeospace and materials science & Engg, etc.,

### **In Conclusion:**

Nanotechnology is shaping the next industrial revolution, which will have far-reaching consequences for society as a whole

\*\*\*\*\*\*\*

Ref: Nano Magazine: March 01, 2023

(Good 2p summary).

## Some Game Changing Emerging Technologies

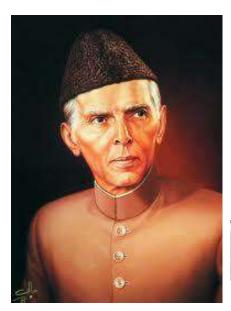
- 1.Picotechnology
- 2. Artificial Intelligence-A and Machine Learning
- 3. Robots
- 4.Gene Technology
- **5-D Printing**
- 6. Computer-Human Interface

## Acknowledegment

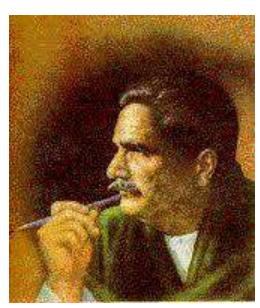
I am grateful to the Chancellor, Preston University Dr. Abdul Basit for his all time support.

I appreciate heartily the strong support of Professor Atta-ur-Rahman to my Nanotechnology initiative in Pakistan.

And to the excellent PINSAT Faculty for their dedication.







Thank you & God Bless you

#### APPENDIX A

#### CONFERENCE ORGANIZING COMMITTEE

#### ISLAMIC WORLD ACADEMY OF SCIENCES (IAS), JORDAN

Prof. Adnan Badran President. & Director General, IAS.

Ms. Taghreed Saqer Executive Secretary, IAS. Ms. Najwa F. Daghestani Programs Manager, IAS.

## INTERNATIONAL CENTER FOR CHEMICAL AND BIOLOGICAL SCIENCES (ICCBS), UNIVERSITY OF KARACHI, KARACHI, PAKISTAN

Prof. Atta-ur-Rahman FRS Patron-in-Chief, ICCBS.

Prof. M. Iqbal Choudhary Coordinator General, COMSTECH/

Director, ICCBS.

Dr. Humera Jahan Associate Professor, ICCBS.

Prof. Farzana Shaheen Professor, ICCBS. Prof. M. Raza Shah Professor, ICCBS.

#### COMSTECH, ISLAMABAD, PAKISTAN

Prof. Mohammed Ali Mahesar Consultant, COMSTECH.

Mr. Aftab Zaidi Director, HR & Administration,

COMSTECH.

Mr. Abdul Haleem Asghar Focal Person (Awards & Programs -

Africa), COMSTECH.

Mr. Muhammad Haris Akram Programme Manager, COMSTECH.

Ms. Khazima Muazim Programme Manager, COMSTECH.

Mr. Umer Ali Program Officer, COMSTECH.

#### 24<sup>th</sup> Islamic World Academy of Sciences Conference

#### Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries

## List of Participants 7-8 March 2023

	Name	Designation	Country
1.	Abdelhafid Lahlaidi	Vice President, Islamic World Academy of Sciences (IAS)	Morocco
2.	Abdul Haleem Asghar	Focal Person (Awards & Africa Program), COMSTECH	Pakistan
3.	Abdullah Al Musa	Secretary General, Higher Council for Science and Technology (HCST)	Jordan
4.	Adnan Badran	President & DG, Islamic World Academy of Sciences (IAS)	Jordan
5.	Aftab Hussain Zaidi	Senior Director HR & Administration, COMSTECH	Pakistan
6.	Ahmed Azad	Chief Research Scientist, CSIRO Division of Biomolecular Engineering	Australia
7.	Ali Moosavi-Movahedi	Professor of Biophysics, University of Tehran, Inst of Biochemistry Biophysics	Iran
8.	Atta-ur-Rahman	Patron-in Chief, UNESCO Science Laureate, International Centre for Chemical and Biological Sciences, University of Karachi, Pakistan	Pakistan
9.	Ayaz Ahmad	Assistant Professor, ICCBS	Pakistan
10.	Aziz Latif Jamal	Chairman, Husein Ebrahim Jamal Foundation (HEJ)	Pakistan

11.	Birgit van Munster	founder of 'Only One Earth Science'	UK
12.	Elias Baydoun	Treasurer, IAS American University of Beirut	Lebanon
13.	Fatimah Al Musa	Wife of Dr. Abduallah Al Musa	Jordan
14.	Hala El-Khozondar	Professor, Islamic University of Gaza	Palestine
15.	Hasan Mandal	President of TUBITAK	Turkey
16.	Hina Siddiqui	Associate Professor, ICCBS	Pakistan
17.	Humera Jahan	Associate Professor, ICCBS	Pakistan
18.	Ilkay Erdogan Orhan	Dean of Faculty of Pharmacy, Gazi University	Turkey
19.	Irfan Ahmad	Executive Director for Interdisciplinary Initiatives, the Grainger College of Engineering; and Executive Director for the Health Maker Lab, the Carle Illinois College of Medicine, University of Illinois at Urbana-Champaign	USA
20.	Irshad Hussain	Lahore University of Management Sciences Syed Babar Ali School of Science and Engineering	Pakistan
21.	Ishtiaq Baig	Honorary Consul General, Consulate of Morocco in Karachi	Pakistan
22.	Jackie Ying	Founding Executive Director, NanoBio Lab, Institute of Materials Research and Engineering	USA
23.	June Kuncoro Hadiningrat	Consul General, Consulate of the Republic of Indonesia in Karachi	Indonesia

24.	Khalid Mahmood Iraqi	Vice Chancellor, University of Karachi	Pakistan
25.	Khatijah Yusoff	Vice President, Islamic World Academy of Sciences (IAS)	Malaysia
26.	Liaquat Ali	Honorary Chief Scientist & Advisor Pothikrit Institute of Health Studies (PIHS)	Bangladesh
27.	M. Iqbal Choudhary	Coordinator General, COMSTECH / Director ICCBS	Pakistan
28.	Mahnaz Kaffash Tehrani	Wife of Prof. Moovahedi	
29.	Malik Maaza	Fellow, Islamic World Academy of Sciences (IAS)	South Africa
30.	Michael Wadleigh	Founder, The Homo Sapiens Foundation (UNESCO), Science Activist, Oscar-winning Director.	USA
31.	Mohammed Ali Mahesar	Assistant Coordinator General, COMSTECH	Pakistan
32.	Mohammed Besri	Institut Agronomique et Vétérinaire Hassan II	Morocco
33.	Muhammad Ameen Kalroo	Executive Secretary, COMSTECH	Pakistan
34.	Muhammad Raza Shah	International Center for Chemical and Biological Sciences (H.E.J. Research Institute of Chemistry), University of Karachi	Pakistan
35.	Muhammad Yusuf Farrukh	Honorary Consul General, Consulate of Jordan in Karachi	Pakistan
36.	Mukhtar Ahmed	Chairman, Higher Education Commission	Pakistan
37.	Nadira Panjwani	Chairperson, Dr. Panjwani Memorial Trust	Pakistan

38.	Najwa Daghestani	Programs Manager, Islamic World Academy of Sciences (IAS)	Jordan
39.	Noor M. Butt	Professor & Chairman, Preston Institute of Nano Science & Technology (PINSAT), Preston University Kohat.	Pakistan
40.	Rabia Hussain	Professor, The Aga Khan University	Pakistan
41.	Sammer Yousef	Professor, ICCBS	Pakistan
42.	Shabbir Hussain	Media Coordinator, COMSTECH	Pakistan
43.	ShahNor Basri	Professor, University Malaysia Kelantan	Malaysia
44.	Shazia Anjum	Fellow, Islamic World Academy of Sciences (IAS)	Pakistan
45.	Shovosil Ziyodov	Director, Imam Bukhari International Scientific-Research Center (IBISRC)	Uzbekistan
46.	Syed M. Qaim	Professor, Institute of Neuroscience and Medicine, Nuclear Chemistry, Forschungszentrum Jülich	Germany
47.	Syed Murad Ali Shah	Chief Minister, Government of Sindh	Pakistan
48.	Taghreed Saqer	Executive Secretary, Islamic World Academy of Sciences (IAS)	Jordan
49.	Tasawar Hayat	Secretary General, Islamic World Academy of Sciences (IAS)	Pakistan
50.	Zabta Shinwari	Vice President, Islamic World Academy of Sciences (IAS)	Pakistan
51.	Zakri Abdul Hamid	Founding Chair, IPBES; Ambassador/Science Advisor, Campaign for Nature	Malaysia

52.	Zulfiqar Ali	Director of the Programs and Projects Department, Islamic Organization for Food Security (IOFS)	Kazakhstan
53.	Zulfiqar Bhutta	Professor and Founding Director of the Institute for Global Health and Development and the Centre of Excellence in Women and Child Health	Canada

#### APPENDIX C

#### Patrons of the Islamic World Academy of Sciences

His Excellency the President of the Islamic Republic of Pakistan. His Royal Highness Prince El-Hassan bin Talal of the Hashemite Kingdom of Jordan, Founding Patron.

## Honorary Fellows of the Islamic World Academy of Sciences (in alphabetical order)

- 1. Dr. Mohammad **Abdolahad**, The 2019 Mustafa Prize Laureate, Iran.
- 2. Mr. Fouad **Alghanim**, President, Alghanim Group, Kuwait.
- 3. Prof. Hossein **Baharvand**, The 2019 Mustafa Prize Laureate, Iran.
- 4. Prof. Sami Erol **Gelenbe**, The 2017 Mustafa Prize Laureate, Turkey.
- 5. Prof. M. Zahid **Hasan**, The 2021 Mustafa Prize Laureate, Bangladesh.
- 6. Prof. Ekmeleddin **Ihsanoglu**, Former OIC Secretary General, Turkey.
- 7. Prof. Umran S. **Inan,** The 2019 Mustafa Prize Laureate, Turkey.
- 8. Prof. Ali **Khademhosseini**, The 2019 Mustafa Prize Laureate, Iran.
- 9. Tun Pehin Sri Haji Dr. Abdul Taib **Mahmud**, the Governor of Sarawak (Yang di-Pertua Negeri), Malaysia.
- 10. Dr. Adnan M. Mjalli, Chairman, MIG, USA.
- 11. His Excellency Dato' Seri Dr. Mahathir **Mohamad**, Former Prime Minister of Malaysia.
- 12. Prof. Ferid Murad, 1998 Nobel Laureate (Medicine), USA.
- 13. His Excellency Nursultan **Nazarbayev**, Former President of the Republic of Kazakhstan.
- 14. Prof. Ugur **Sahin,** The 2019 Mustafa Prize Laureate, Turkey.
- 15. Prof. Mohamed El-**Sayegh**, The 2021 Mustafa Prize Laureate, Lebanon.
- 16. His Excellency Mr. Mintimer **Shaimiev**, Former President of the Republic of Tatarstan/Russian Federation.
- 17. Prof. M. Amin **Shokrollahi**, The 2017 Mustafa Prize Laureate, Iran.
- 18. Prof. Yahya **Tayalati**, The 2021 Mustafa Prize Laureate, Morocco.
- 19. His Excellency Sheikh Hamad Bin Jassim Bin Jabr Al **Thani**, Former Prime Minister of Qatar, Qatar.
- 20. Prof. Cumrun Vafa, The 2021 Mustafa Prize Laureate, Iran.

#### List of Fellows of the Islamic World Academy of Sciences (February 2023)

		_	
1.	Prof. Mohammad <b>Abdollahi</b>	Iran	Toxicology/Pharmacology
2.	Prof. Zakri Abdul Hamid	Malaysia	Genetics
3.	Prof. Omar Abdul Rahman	Malaysia	Veterinary Medicine
4.	Prof. Farhan Jalees <b>Ahmad</b>	India	Pharmaceutics
5.	Prof. Bobomurat <b>Ahmedov</b>	Uzbekistan	Physics
6.	Prof. Askar <b>Akayev</b>	Kyrgyzstan	Computer Engineering
7.	Prof. Liaquat <b>Ali</b>	Bangladesh	Medicine
8.	Prof. M. Shamsher <b>Ali</b>	Bangladesh	Physics
	Prof. Qurashi Mohammed <b>Ali</b>	Sudan	Medicine/Anatomy
	Prof. Huda Saleh <b>Ammash</b>	Iraq	Biology
11.	Prof. Shazia <b>Anjum</b>	Pakistan	Chemistry
12.	Prof. Muhammad <b>Asghar</b>	France	Physics
13.	Prof. Muhammad <b>Ashraf</b>	Pakistan	Botany-Salt Tolerance
	Prof. Allaberen <b>Ashyralyev</b>	Turkmenistan	Mathematics
15.	Prof. Saleh A <b>Al-Athel</b>	Saudi Arabia	Mechanical Engineering
16.	Prof. Ahmad Abdullah <b>Azad</b>	Bangladesh/	Biochemistry
		Australia	
17.	Prof. Agadjan <b>Babaev</b>	Turkmenistan	Geography
18.	Prof. Adnan <b>Badran</b>	Jordan	Biology
19.	Prof. Shah Nor Bin <b>Basri</b>	Malaysia	Mechanical Engineering
20.	Prof. Elias <b>Baydoun</b>	Jordan	Biochemistry
21.	Prof. Farouk <b>El-Baz</b>	USA	Geology
22.	Prof. Kazem <b>Behbehani</b>	Kuwait	Immunology
23.	Prof. Azret <b>Bekkiev</b>	Balkar/Russia	Physics
24.	Prof. Rafik <b>Boukhris</b>	Tunisia	Medicine
25.	Prof. David (Mohamed Daud)	UK	Physics
	A. Bradley		
26.	Prof. Noor Mohammad Butt	Pakistan	Physics
27.	Prof. Mohamed Thameur	Tunisia	Agriculture/ Climate
	Chaibi		Technologies
28.	Prof. Muhammad Iqbal	Pakistan	Organic Chemistry
	Choudhary		
29.	Prof. Abdallah <b>Daar</b>	Oman/ Canada	Medicine
30.	Prof. Ali Al- <b>Daffa'</b>	Saudi Arabia	Mathematics
31.	Prof. Mamadou <b>Daffe</b>	Mali/France	Biochemistry
32.	Prof. Ramazan <b>Demir</b>	Turkey	Biology
33.	Prof. Oussaynou Fall <b>Dia</b>	Senegal	Geology
34.	Prof. Dilfuza <b>Egamberdieva</b>	Uzbekistan	Biology
35.	Prof. Mehmet <b>Ergin</b>	Turkey	Chemical Engineering
36.	Prof. Sehamuddin <b>Galadari</b>	UAE	Biochemistry

37. Prof. Nesreen <b>Ghaddar</b>	Lebanon	Metallurgical Engineering
38. Prof. Mehdi <b>Golshani</b>	Iran	Physics
39. Prof. Kadyr G <b>Gulamov</b>	Uzbekistan	Physics
40. Prof. Ameenah <b>Gurib-Fakim</b>	Mauritius	Chemistry
41. Prof. Hashim M <b>El-Hadi</b>	Sudan	Veterinary Medicine
42. Prof. Kemal <b>Hanjalic</b>	Bosnia-	Mechanical Engineering
72. 1 101. Kemai Hanjane	Herzegovina	Wicemanical Engineering
43. Prof. Mohamed H A <b>Hassan</b>	Sudan	Mathematics
44. Prof. Tasawar <b>Hayat</b>	Pakistan	Mathematics
45. Prof. Bambang <b>Hidayat</b>	Indonesia	
46. Prof. Rabia <b>Hussain</b>	Pakistan	Astronomy
47. Prof. Aini <b>Ideris</b>		Microbiology
	Malaysia	Veterinary Medicine
48. Prof. Asma Ismail	Malaysia	Biotechnology
49. Prof. Mohammad Shamim	India	Zoology
Jairajpuri	Dalaista a	C1
50. Prof. Mohammad Qasim <b>Jan</b>	Pakistan	Geology
51. Prof. Afaf Kamal-Edin	Sudan	Chemistry
52. Prof. Hamza <b>El-Kettani</b>	Morocco	Physics and Chemistry
53. Prof. Idriss <b>Khalil</b> 54. Prof. Hameed Ahmed <b>Khan</b>	Morocco Pakistan	Mathematics
55. Prof. Mostefa <b>Khiati</b>		Physics Medicine
56. Prof. Hala <b>El Khozondar</b>	Algeria Gaza/ Palestine	
57. Prof. Abdelhafid <b>Lahlaidi</b>	Morocco	Physics Medicine
58. Prof. Zohra Ben <b>Lakhdar</b>	Tunisia	
59. Prof. Malek <b>Maaza</b>		Physics Neutronics
60. Prof. Ahmed <b>Marrakchi</b>	Algeria Tunisia	
	Tatarstan/ Russia	Electronic Engineering
<ul><li>61. Prof. Akhmet Mazgarov</li><li>62. Prof. Amdoulla Mehrabov</li></ul>	•	Petrochemistry Materials Science
63. Prof. Shaher <b>Al-Momani</b>	Azerbaijan Lordan	Mathematics
64. Prof. Ali Moosavi- <b>Movahedi</b>	Jordan Iran	
65. Prof. Sami <b>Al- Mudhaffar</b>		Chemistry
66. Prof. Zaghloul <b>El-Naggar</b>	Iraq	Biochemistry Geology
67. Prof. Ibrahim Saleh <b>Al- Naimi</b>	Egypt	Chemistry
68. Prof. Anwar <b>Nasim</b>	Qatar Pakistan/ Canada	Genetics
<ul><li>69. Prof. Munir Nayfeh</li><li>70. Prof. Robert Nigmatulin</li></ul>	Jordan/ USA Tatarstan/ Russia	Physics / Mathematics
71. Prof. Shekoufeh <b>Nikfar</b>		Physics/ Mathematics
/1. Prof. Shekoulen Mikiar	Iran	Pharmacoeconomics/ Pharmaceutical
72 Deaf Culson Once	Tuelvor	Medicine
72. Prof. Gulsen <b>Oner</b>	Turkey	
73. Prof. Ilkay Erdogan <b>Orhan</b> 74. Prof. Ramdane <b>Ouahes</b>	Turkey	Pharmacognosy Chemistry
75. Prof. Munir <b>Ozturk</b>	Algeria Turkey	Chemistry
	Turkey South Africa	Biology
76. Prof. Iqbal <b>Parker</b>		Biochemistry Nuclear Chamistry
77. Prof. Syed Muhammad <b>Qaim</b>	Germany Pakistan	Nuclear Chemistry
78. Prof. Atta-ur- <b>Rahman</b>	rakistan	Chemistry

79. Prof. Hussein Samir <b>Salama</b> 80. Prof. Eldar Yunisoglu <b>Salayev</b>	Egypt Azerbaijan	Entomology Physics/ Mathematics
81. Prof. Jawad A. <b>Salehi</b>	Iran	Electronic Engineering
82. Prof. Boudjema <b>Samraoui</b>	Algeria	Biology
83. Prof. Lorenzo <b>Savioli</b>	Italy	Medicine
84. Prof. Mohammed Musa <b>Shabat</b>	Gaza/ Palestine	Biology
85. Prof. Muhammad Raza <b>Shah</b>	Pakistan	Nanotechnology
86. Prof. Misbah-Ud-Din <b>Shami</b>	Pakistan	Chemistry
87. Prof. Ali <b>Al-Shamlan</b>	Kuwait	Geology
88. Prof. Ahmad <b>Shamsul-Islam</b>	Bangladesh	Botany
89. Prof. Muthana <b>Shanshal</b>	Iraq	Chemistry
90. Prof. Zabta Khan <b>Shinwari</b>	Pakistan	Biology
91. Prof. Ahmedou M <b>Sow</b>	Senegal	Medicine
92. Prof. Mahmoud <b>Tebyani</b>	Iran	Electronic Engineering
93. Prof. Ahmet Hikmet Ucisik	Turkey	Materials Science
94. Prof. Gulnar Vagapova	Tatarstan/ Russia	Medicine
95. Prof. Omar M. <b>Yaghi</b>	Jordan/USA	Chemistry
96. Prof. Jackie <b>Ying</b>	Singapore/USA	Chemical Engineering
97. Prof. Bekhzad <b>Yuldashev</b>	Uzbekistan	Physics/ Mathematics
98. Prof. Khatijah Mohd <b>Yusoff</b>	Malaysia	Microbiology
99. Prof. Salim <b>Yusuf</b>	Canada	Medicine
100. Prof. Mikhael <b>Zalikhanov</b>	Balkar/Russia	Glaciology/Biology

#### APPENDIX D

#### LAUREATES OF THE IAS-COMSTECH IBRAHIM MEMORIAL AWARD

Prof. Ugur <b>Dilmen</b>	1996	Turkey.
Prof. Mohammad Abdollahi	2005	Iran.
Prof. Mohammed Manna Al-Qattan	2007	Saudi Arabia.
Dr Faris Gavrankapetanovic	2009	Bosnia.
Dr Saima <b>Riazuddin</b>	2011	Pakistan.
Prof. Liaquat <b>Ali</b>	2013	Bangladesh.
Prof. Jackie <b>Ying</b>	2015	Singapore.
Prof. Ameenah Gurib-Fakim	2017	Mauritius.

#### APPENDIX D

#### THE COUNCIL OF THE ISLAMIC WORLD ACADEMY OF SCIENCES (2023-2027)

President: **Adnan Badran** Jordan Khatijah Yusoff Vice-President: Malaysia **Abdelhafid Lahlaidi** Vice-President: Morocco Vice-President: Zabta Shinwari Pakistan Treasurer: Elias Baydoun Jordan Secretary General: **Tasawar Hayat** Pakistan Algeria Member: Malek Maaza **Farhan Jalees Ahmad** Member: India Member: Mohammad Abdollahi Iran Member: **Aini Ideris** Malaysia

Uzbekistan Member: Dilfuza Egamberdieva

#### IAS EXECUTIVE STAFF

Prof. Adnan Badran President & Director General.

Ms. Taghreed Sager Executive Secretary. Programs Manager. Ms. Najwa F. Daghestani Mr. Ahmad Nassar Finance Officer.

Mr. Hamdi Bader Ahmad Driver.

#### APPENDIX E

### PUBLICATIONS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

#### **CONFERENCE PROCEEDINGS**

- The Islamic Academy of Sciences. Proceedings of the Founding Conference (1986). Published by the Islamic Academy of Sciences, Editor: A. Kettani (Morocco).
- Food Security in the Muslim World. Proceedings of the first international conference, Amman (Jordan) (1987). Published by the Islamic World Academy of Sciences, Editor: S. Qasem (Jordan).
- Science and Technology Policy for Self-Reliance in the Muslim World. Proceedings of the second international conference, Islamabad (Pakistan) (1988). Published by the Islamic World Academy of Sciences, Editors: F. Daghestani (Jordan), H. El-Mulki (Jordan), and M. Al-Halaiqa (Jordan).
- New Technologies and Development of the Muslim World. Proceedings of the third international conference, (Kuwait) (1989). Published by the Islamic World Academy of Sciences, Editors: F. Daghestani (Jordan), and S. Qasem (Jordan).
- Technology Transfer for Development in the Muslim World.
   Proceedings of the fourth international conference, Antalya (Turkey) (1990). Published by the Islamic World Academy of Sciences, Editors:

   F. Daghestani (Jordan), A. Altamemi (Jordan), and M. Ergin (Turkey).
- Science and Technology Manpower Development in the Islamic World.
   Proceedings of the fifth international conference, Amman (Jordan) (1991). Published by the Islamic World Academy of Sciences, Editors:

   F. Daghestani (Jordan), A. Altamemi (Jordan), and H. El-Mulki (Jordan).
- Environment and Development in the Islamic World. Proceedings of the sixth international conference, Kuala Lumpur (Malaysia) (1992). Published by the Islamic World Academy of Sciences, Editors: S. Al-Athel (Saudi Arabia), and F. Daghestani (Jordan).
- Health, Nutrition and Development in the Islamic World. Proceedings of the seventh international conference, Dakar (Senegal) (1993). Published by the Islamic World Academy of Sciences, Editors: N. Bor (Turkey), A. Kettani (Morocco), and Moneef R. Zou'bi (Jordan).

- Water in the Islamic World: An Imminent Crisis. Proceedings of the eighth international conference, Khartoum (Sudan) (1994). Published by the Islamic World Academy of Sciences, Editors: M. Ergin (Turkey), H. Dogan Altinbilek (Turkey), and Moneef R. Zou'bi (Jordan).
- Science and Technology Education for Development in the Islamic World. Proceedings of the ninth international conference, Tehran (Iran) (1999). Published by the Islamic World Academy of Sciences, Editors: M. Ergin (Turkey), M. Doruk (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-7).
- Information Technology for Development in the Islamic World.
   Proceedings of the tenth international conference, Tunis (Tunisia) (2000). Published by the Islamic World Academy of Sciences, Editors:
   M. Ergin (Turkey), M. Doruk (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-03-5). Online.
- Biotechnology and Genetic Engineering for Development in the Islamic World. Proceedings of the eleventh international conference, Rabat (Morocco) (2001). Published by the Islamic World Academy of Sciences, Editors: A. S. Majali (Jordan), M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-07-8). Online.
- Materials Science and Technology and Culture of Science. Proceedings of the twelfth international conference, Islamabad (Pakistan), (2002). Published by the Islamic World Academy of Sciences, Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-06-x). Online.
- Energy for Sustainable Development and Science for the Future of the Islamic World and Humanity. Proceedings of the thirteenth international conference, Kuching, Sarawak (Malaysia), (2003). Published by the Islamic World Academy of Sciences, Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-08-6). Online.
- Science Technology and Innovation for Socioeconomic Development of OIC-Member Countries Towards Vision 1441. Proceedings of the fourteenth international conference, Kuala Lumpur (Malaysia), (2005).
   Published by the Islamic World Academy of Sciences, Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-11-6). Online.
- Higher Education Excellence for Development in the Islamic World. Proceedings of the fifteenth international conference, Ankara (Turkey), (2006). Published by the Islamic World Academy of Sciences, Editors:

- M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-18-0). Online.
- Science, Technology and Innovation for Sustainable Development in the Islamic World: The Policies and Politics Rapprochement. Proceedings of the Sixteenth international conference, Kazan (Tatarstan), (2008). Published by the Islamic World Academy of Sciences, Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-19-7). Online.
- Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination, Proceedings of the seventeenth international conference, Shah Alam (Malaysia), (2009).
   Published by the Islamic World Academy of Sciences, Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-22-7). Online.
- The Islamic World and the West: Rebuilding Bridges through Science and Technology, Proceedings of the eighteenth international conference, Doha (Qatar), (2011). Published by the Islamic World Academy of Sciences, Editor: Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-24-1). Online.
- Science and Technology in Muslim World: Achievements and Prospects, Proceedings of the IAS Symposium, Astana (Kazakhstan), (2012). Published by the Islamic World Academy of Sciences, Editor: Moneef R. Zou'bi (Jordan). Online.
- Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation, Proceedings of the nineteenth international conference, Dhaka (Bangladesh), (2013). Published by the Islamic World Academy of Sciences, Editors: Moneef R. Zou'bi (Jordan), and Najwa F. Daghestani (Jordan) (ISBN 978-9957-412-25-8). Online.
- Science, Technology and Innovation: Building Humanity's Common Future, Proceedings of the twentieth international conference, Tehran (Iran), (2015). Published by the Islamic World Academy of Sciences, Editors: Moneef R. Zou'bi (Jordan), and Najwa F. Daghestani (Jordan) (ISBN 978-9957-412-26-5). Online.
- Science, Technology and Innovation for Global Peace and Prosperity, Proceedings of the twenty-first international conference, Konya (Turkey), (2017). Published by the Islamic World Academy of Sciences, Editors: Moneef R. Zou'bi (Jordan), and Najwa F. Daghestani (Jordan) (ISBN 978-9957-412-27-2). Online.
- Landscape of Science, Technology and Innovation in the Islamic Countries, Proceedings of the twenty-second international conference,

- Amman (Jordan), (2020) *Virtual Conference*. Published by the Islamic World Academy of Sciences, **Editors: Abdullah Al Musa (Jordan), and Najwa F. Daghestani (Jordan). Online.**
- Biodiversity Conference, Proceedings of the IAS conference on Biodiversity, Amman (Jordan), (2021) Virtual Conference. Published by the Islamic World Academy of Sciences, Editors: Abdullah Al Musa (Jordan), and Najwa F. Daghestani (Jordan). Online.
- Science, Technology and Innovation Under Ever Changing Global Events, Proceedings of the twenty-third international conference, Rabat (Morocco), (2022). Published by the Islamic World Academy of Sciences, Editors: Abdullah Al Musa (Jordan), and Najwa F. Daghestani (Jordan). Online.
- Challenges to Promote Science and Technology for Socio-Economic Development in OIC Countries, Proceedings of the twenty-fourth international conference, Karachi (Pakistan), (2023). Published by the Islamic World Academy of Sciences, Editors: Adnan Badran (Jordan), and Najwa F. Daghestani (Jordan). Online.

#### **BOOKS**

- 1) Islamic Thought and Modern Science Published by the Islamic World Academy of Sciences (1997) Author: Mumtaz A. Kazi.
- 2) Qur'anic Concepts and Scientific Theories Published by the Islamic World Academy of Sciences (1999) Author: Mumtaz A. Kazi.
- 2) Personalities Noble Editor: Hakim Mohammed Said, Second Revised Edition, Published by the Islamic World Academy of Sciences (2000), Editor: Moneef R. Zou'bi (Arabic-English). (ISBN: 9957-412-01-6).
- 3) Declarations of the Islamic World Academy of Sciences Published by the Islamic World Academy of Sciences (2005), Editor: Moneef. R. Zou'bi (ISBN: 9957-412-09-4).
- 4) Islamic World Academy of Sciences Outreach, Published by the Islamic World Academy of Sciences (2005), Editor: Moneef R. Zou'bi (ISBN: 9957-412-10-8).
- 5) Intellectual Property Rights: An Introduction for Scientists and Technologists Published by the Islamic World Academy of Sciences (2006), Author: Mohamed B. E. Fayez (ISBN: 978-9957-412-18-0).
- 6) Reverse Engineering: The Permissible but not Well-Recognized Published by the Islamic World Academy of Sciences (2010), Author: Mohamed B. E. Fayez (ISBN: 978-9957-412-20-3).

- 7) The Discoveries in the Islamic Countries Arabic Edition Published by the Islamic World Academy of Sciences (2012), Author: Ahmed Djebbar (ISBN: 978-9957-412-23-4).
- 8) The Essentials of Science, Technology and Innovation Policy Published by the Islamic World Academy of Sciences (2013), Author: Tan Sri Dr Omar Abdel Rahman (ISBN: 978-983-9445-95-4).
- 9) Overview. Published by the Islamic World Academy of Sciences (2021).

#### **PERIODICALS**

- 1) Medical Journal of the Islamic World Academy of Sciences (ISSN 1016-3360) quarterly. Responsible Editor: **Dr. Nedim Aytekin**.
- 2) Newsletter of the Islamic World Academy of Sciences quarterly. Responsible Editor: Najwa Daghestani.
- 3) Islamic Thought and Scientific Creativity (in Arabic) quarterly Journal of the Organisation of the Islamic Conference (OIC) Standing Committee on Scientific and Technological Co-operation (COMSTECH). Arabic version published by the IAS with the support of the Royal Academy for Islamic Civilisation Research (Al-Albait Foundation) (publication ceased in 1996).