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ABSTRACTS

of presentations

CONTENTS

INVITED LECTURE

SYMPOSIUM 11: FACING GLOBAL EPIDEMICS

TWAS 2016 MEDAL LECTURES

SYMPOSIUM III: SCIENCE AND TECHNOLOGY IN RWANDA

TWAS 2015 PRIZE LECTURES

SYMPOSIUM IV: EYES AND EARS ON THE UNIVERSE USING RADIO WAVE AND GRAVITATIONAL WAVE ASTRONOMY

PRESENTATIONS BY TWAS'S YOUNG AFFILIATES

INVITED LECTURE

EXCITING STORY OF CHEMICAL SCIENCE (GLORIOUS PAST AND CHALLENGING FUTURE)

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Chemistry as a subject made a beginning only by the end of the 18th century, thanks to Lavoisier. The 19th century saw great contributions from Dalton (who proposed the idea of the atom) and Faraday, the greatest scientist of all time. It is only in the 20th century, that chemistry as we understand today took shape.

This is because of the description of the atomic structure by Rutherford (1911) following the discovery of the electron (J.J. Thompson, 1897) and of the chemical bond in 1916 by (G.N. Lewis).

The latter marks the beginning of modern chemistry. Thanks to Linus Pauling and others the few decades after the discovery of the chemical bond saw an explosion in chemical research broadly dealing with synthesis, structure and dynamics.

20th century also saw the completion of the periodic table with nearly 114 elements. Since the 1970's, chemistry has changed in its scope, absorbing materials science and biology as major new directions. Chemical science has now gone beyond the molecular frontier. Chemistry worries about life processes, energy and environment, and other complex issues. Chemistry had a glorious past, and it is going to have a challenging future.

SYMPOSIUM 11: FACING GLOBAL EPIDEMICS

BATTLING AGAINST *LEISHMANIA*: AN OLD ENEMY

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Leishmaniasis is caused by over 20 species of unicellular protozoan parasite *Leishmania* and it is transmitted to humans by the female sandflies. Leishmaniasis is not a single entity, but comprises of a variety of syndromes (WHO, March 2016). There are four main forms of leishmaniases – visceral (known as kala azar and the most serious form of the disease), cutaneous (the most common), mucocutaneous and post kala azar dermal leishmaniasis (PKDL). According to the World Health Organisation there are 900000–1.3 million new cases with 20000–30000 deaths that occur annually.

The disease affects mainly the poor people and is associated with malnutrition, population displacement, poor housing, a weak immune system and lack of financial resources (WHO, March 2016).

High *Leishmania*-HIV coinfection rates are reported from Brazil, Ethiopia and the state of Bihar in India (WHO, March 2016). Chemotherapy is still the mainstay for control of leishmaniasis due the lack of proper vaccines. Although efforts have been made by WHO and other organisations, the problem of access to medicines for treatment of the leishmaniasis still exists in poor countries and emergence of new drug resistant strains have made the situation further complicated.

The goal of current biomedical research is to devise new intervention strategies to control public health impact of this parasitic disease. The biology of these organisms has many unusual facets that might be exploited for drug design and novel therapeutic intervention strategies.

The dramatic advances in molecular and cell biology in recent times, availability of parasite genome sequence data have provided opportunities for discovering and evaluating targets for drug designing.

Infectious diseases and Immunology Division of Indian Institute of Chemical Biology (CSIR-IICB) is conducting various research programmes on *Leishmania donovani*, the causative agent for visceral leishmaniasis. With the use of genomics and proteomics, the group at IICB has already undertaken intervention strategies for controlling leishmaniasis.

The strategies include:

1) prevention of host-parasite interaction,

2) identifying new target proteins, specific for the parasite that can be potential targets for drug development,

3) development of vaccines and diagnostics etc.

DNA topoisomerases of the protozoan parasite *Leishmania* is being studied in our laboratory for more than last two decades. Here the investigation are carried out in *Leishmania* parasites with the objective of understanding the DNA damage/repair process towards developing rational approaches to chemotherapy. Different types of DNA topoisomerases have been characterized in *Leishmania* which were shown to be potential targets for therapeutic agents.

SCALING UP GROUP SUPPORT PSYCHOTHERAPY IN PRIMARY CARE FOR DEPRESSION TREATMENT IN PERSONS LIVING WITH HIV: IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT GOALS

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The gap between availability and need for mental health services, known as the "treatment gap", can be as high as 90% in low income countries. To bridge this gap, researchers have proposed task shifting of mental health services from specialist mental health professionals to non-specialist health workers in primary care settings.

This study examines the impact of brief structured group support psychotherapy (GSP) training intervention on knowledge acquisition and perceptions of trained primary health workers towards depression in persons living with HIV (PLWH) as well as the emotional and functional outcomes of treated PLWH. Eligible primary care health centers (PHCs) in three districts (Gulu, Kitgum and Pader) in northern Uganda were randomly allocated to receive either training in the delivery of GSP to PLWH presenting with depression (intervention arm), or training in the delivery of group HIV education (GHE) and treatment as usual to PLWH presenting with depression. The GSP and GHE training interventions were administered to three groups of primary care health workers during three separate 5-day and 2-day workshops respectively. Thereafter, trainees were required to conduct pilot GSP and GHE sessions as their practical training for a period of 8 weeks. Trainees completed pre- and post-tests that measured knowledge and attitudes about depression, basic counseling skills, the relationship between HIV/AIDS and depression.

Treated PLWH were evaluated at baseline, and at the end of the pilot group sessions. These activities are part of a preparatory phase of a cluster randomized trial evaluating the effectiveness of group support psychotherapy delivered by trained lay health workers to persons with HIV and depression in primary care registered with The Pan African Clinical Trials Registry, CTR201608001738234.

Forty-five health workers from 15 health centers allocated to GSP training and 33 health workers allocated to GHE training participated in the study. Both training interventions resulted in an increase of test scores at the end of the training. However, the increase was greater among those who received GSP training. A total of 342 PLWH with depression were treated with GSP while 369 were treated with GHE. PLWH treated with GSP had significantly greater reductions in depression symptoms than those treated with GHE.

Trained primary care health workers can effectively treat depression in PLWH using group support psychotherapy. Further, study findings provide evidence that it is possible to disseminate a first line depression treatment such as GSP to low resource rural areas by training non-mental

health professionals, where it may not be possible to employ sufficient numbers of mental health providers.

FACING GLOBAL EPIDEMICS & ENDEMIC DISEASES: THE VIEW FROM AN INFORMATION SOLUTIONS PROVIDER

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When the UN launched their new Sustainable Development Goals in September 2015, Elsevier and SciDev.net responded with *Sustainability Science in a Global Landscape*, a report mapping the research behind these ambitious goals. One of the key findings was that the participation of scientists from developing countries in sustainability science is less than 2%, clearly a number that needs to be boosted through increased collaboration, research opportunities and funding.

2016 can be characterized as the year we battled the Zika virus and 2015 that of the EBOLA epidemic. Long after the first responders have left the scene and survivors are rebuilding their communities, scientists are still hard at work distilling the results of their research. This presentation looks at how research into global epidemics and diseases endemic to developing countries has fared over the last 5 years. In this meta-analysis, Elsevier's Africa regional director, Mohamed Kamel provides a bibliometric review of research conducted on epidemics as well as a deep dive into the state of research over the last 5 years on Zika, Ebola, Leshmaniasis, Dengue, TB, Malaria and Leprosy.

Who is doing the research? What is the scope and output? Where are the collaborations happening? Are we seeing a growth in authors from low and middle income countries? And how quickly is the research in a specific disease area growing, especially in relation to each other? These are some of the questions addressed, as well as how both Elsevier and the Elsevier Foundation aim to support the global academic and health community when epidemics hit.

FOUR DECADES IN RESEARCH AND DEVELOPMENT, A LEARNING EXPERIENCE IN MANAGEMENT AND LEADERSHIP: KUWAIT

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Research and Development (R&D) in the Arab world is challenged by population increase, and low level of innovation and new technologies to accommodate the increasing unemployment in the region (estimated to be more than 100 million in the next decade). In addition, lack of alignment in science, technology and innovation with national development plans; low investment in R&D of less than 0.5%; poor investment in R&D by the public and private sector as well as brain drain and poor foreign investment, have also contributed.

All these together created constraints on local scientists in the Arab Region to prosper and limited their productivity despite their credibility and potential. For more than four decades the author faced many of these challenges during her career at Kuwait Institute for Scientific Research (KISR).

She joined KISR in 1973 as a young professional scientist and advanced in her career to the academic rank of principal research scientist, as well as senior administrative posts of division director, program director of the Kuwait Environmental Remediation Program (KERP), and more recently she was appointed as director general of KISR. During her scientific career at KISR she led and successfully completed several contractual research projects that had great impact on the society and environment of Kuwait.

Her scientific achievements and contributions resulted in establishing protected areas in Kuwait, classification of soils and identification of arable lands and land use of Kuwait according to USDA soil classification system, developing innovative know-how and methodology for restoration of damaged desert ecosystems; preparing sustainable development plans for Boubyan Island and supervising the implementation of a large scale national program of the Kuwait environmental remediation program to rehabilitate damaged areas in the terrestrial environment of Kuwait, to name a few.

In her effort to achieve the goals and objectives of KISR, the author provided strategic input to ensure research excellence and resource mobilization with emphasis on promoting Science and Technology and Innovation (STI) in the institute.

She fostered interdisciplinary teamwork, highlighted the relevance of research on achieving impact; promoted a strong commitment to partnerships with public, non-governmental and private sector organizations; and ensured effective administrative support to research within the context of a multi-cultural organization. As a result the author was the recipient of many national and regional awards and is a regular keynote speaker in many regional and international conferences and symposia.

Having realized the gender gaps in R&D, she joined many non-governmental organizations participating in voluntary work relating to environment, agriculture and women leadership.

The author focused on strengthening KISR relationship with global organizations. She played a pivotal role in establishing partnership and collaborations with research organizations to foster R&D and innovation in the region. She played important roles in international organizations such as regional councillor for West Asia Region, board member in the Society for Ecological Restoration

(SER), treasurer in TWAS, executive board member and vice president for the Arab Region in the Organization for Women in Science for Developing World (OWSD) and member of the board of trustees in ICARDA.

Her involvement includes developing policies and strategies, reviewing finances and auditing, marketing, fundraising and programming. With her local and international experiences and leadership in R&D, the author represents a successful story for women scientists in developing countries and a strong voice for women equality and advancement in the region.

The author believes that success in R&D can only be achieved through collective efforts of multidisciplinary teams and effective partnerships. She views challenges as opportunities for creativity and solutions and that is exactly what the author is intending to do as a leader of KISR in the coming years.

THE PUZZLE OF SELF-ASSEMBLY AND THE SELF-ASSEMBLY OF PUZZLES

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A holy grail of nano-technology is the creation of truly complex structures by self-assembly. Most self-assembly has focused on the creation of 'structural complexity', the assembly of complex structures, using only a small number of distinct building blocks.

In my talk I will discuss 'Addressable Complexity': the creation of structures that contain hundreds or thousands of distinct building blocks that all have to find their place in a 3D structure, like pieces in a jig-saw puzzle. Simple model calculations allow us to understand the factors that control successful self-assembly. I will devote special attention to the counter-intuitive role of entropy in self-assembly.

HEMOGLOBIN CONCENTRATION: PROBLEMS AND SOLUTIONS

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Iron-deficiency anemia affects more than 1.5 billion people worldwide, particularly pregnant women and children under five years. Considering the important role of beans in daily meals in developing countries, bean biofortification through cross-breeding can be a solution to iron-deficiency anemia.

Iron absorption and efficacy studies were carried out to evaluate the benefits of biofortification for iron status improvement. Parasitic diseases, particularly malaria and soil-transmitted helminths, increase the severity of anemia. We carried out different studies to evaluate the risk factors for parasitic diseases and the preventive measures.

To evaluate the bioavailability of iron from normal beans and biofortified beans, multiple meal absorption studies were carried out between 2008 and 2014 among female university students, Huye campus. We measured iron absorption based on the erythrocyte incorporation of stable iron isotopes. An efficacy study was carried out during 128 days in 2013 in the same population. Parasitological studies were carried out between 2008 and 2015 among schoolchildren in Huye district, Southern Province of Rwanda, to evaluate the prevalence and risk factors for malaria and soil-transmitted helminths and the efficacy of preventive chemotherapy with mebendazole.

Iron absorption studies using multiple meals with normal and biofortified beans showed that the inhibitory role of polyphenols is negligible when composite meals are consumed. However, inhibition by phytic acid is evident and may limit the benefits of biofortification. The efficacy study demonstrated the advantage of biofortified beans for the improvement of iron status, VO2 max and cognitive performance.

Parasitological studies among schoolchildren showed high prevalence of *Plasmodium falciparum* (one out of six children) and *Ascaris lumbricoides* (one out of three children in rural areas), including submicroscopic infection detected by PCR tests. Soil-transmitted helminth preventive chemotherapy with mebendazole is efficient (cure rate 92%), however 7% re-infection occurs within three months.

Biofortification promises to be an efficient way to prevent iron-deficiency anemia. There is need for sustainability of interventions to control malaria and soil-transmitted helminths.

SYMPOSIUM III: SCIENCE AND TECHNOLOGY IN RWANDA

INITIATIVES TO PROMOTE RESEARCH AND INNOVATION IN THE ICT SECTOR

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Despite the remarkable growth of GDP (6%) of the low-income countries of the African continent during the last decade, they still remain challenged to become globally competitive. One of the major contributing factors is lagging behind in terms of the level of scientific, technological and innovation (STI) capacity, in comparison with developed economies. Thus, to become globally competitive developing nations should leap frog the stages through higher education and training in STI by building capacity in African researchers.

The region's development challenges cannot be addressed at a fast pace without adopting the latest technologies to improve capabilities for innovation and higher productivity. Therefore, it is very important to focus on revitalizing STI to address continental challenges and to promote global competitiveness in Africa.

Moreover, there is a positive correlation between ICT competitiveness and national competitiveness: a higher ICT competitiveness leads to a stronger national competitiveness according to the World Economic Forum (2011). The latest ICT technologies such as Internet of Things (IoT) have the potential to revolutionize science and influence social, environmental and health issues and will greatly improve service delivery in all sectors.

This will create more jobs and reflect into socio-economic development. The presentation will focus on sharing the initiatives taken in ICT sector to support in addressing the major challenges in Africa and to promote research and innovation. Also some of the best practices like Creating Job Creators (CJC) program at university level for promoting research and innovation would be discussed.

Among the various initiatives, one is the African centre of excellence in Internet of Things (ACEIoT), which is a World Bank funded project that aims to educate and train African researchers in the field of IoT, and would prepare them to carry out applied research, to address the developmental challenges related to high-priority domains such as the energy sector, agricultural sector, health sector; and many more. There is another African centre of excellence in data science promoting research in the field of big data analytics and the related technologies.

The presentation will give detailed information about the objectives of the above centres and about other university level initiatives that are in place to revitalize research and innovation for global competiveness.

THE IMPORTANCE OF THE SCHOOL OF SCIENCE FOR RWANDA

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The School of Science is one of the core schools at the University of Rwanda as it serves all Colleges within the University. The School of Science is split between two campuses, Huye and Nyarugenge. It has five departments (biology, chemistry, mathematics, geography and physics).

The school is delivering programmes at BSc and MSc levels and will soon do for PhD level. Apart from covering all modules of basic science in the college of science of technology, the school provides lecturers of mathematics and physics for the college of agriculture, animal sciences and veterinary medicine, mathematics for the college of business and economics, chemistry to the college of education, the same to the college of medicine and heath sciences.

You will find and also these lecturers in different public institutions like National Policy Academy under College of Art and Social Sciences and National Military Academy.

RWANDA NATURAL CAPITAL ACCOUNTING: APPLICATION FOR SECTORS AND POLICY USES

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Rwanda signed the Gaborone declaration in 2012 and committed then that Natural Capital Accounting (NCA) shall be used as one of the tools to boost the country's sustainable development. Following the System of Environmental Economic Accounting (SEEA), published by the UN Statistical Division in 2012 as a global standard, NCA might enable to go beyond measuring the annual economic output and incorporate natural resource wealth and assets into the national account.

In Rwanda, land, water and mineral sectors were selected based on criteria such as data availability, institutional engagement, policy relevance, and contribution to Growth Domestic Product (GDP), employment creation and in response to some key policy oriented question that resonates with the Second Economic Development and Poverty Reduction Strategy (EDPRS2).

Land accounts would help Rwanda to account for trends in economic values of land in different uses and to assess potential trade-offs more systematically. Water accounts can help to clarify and compare the economic values of water in competing uses and how it is changing over time (trends). The mineral accounts can assist in the efficient allocation of resources. The natural accounts can also be used to derive green indicators to monitor the EDPRS, as well as indicators for the Sustainable Development Goals (SDGs).

Considering the period of 2014-2016 and by using data extracted from the land administration system (LAIS), physical flow and physical asset accounts for land were compiled. Preliminary findings in land show that land fragmentation increased only slowly during 2014 and 2015 given ongoing policies aimed at combatting land fragmentation. For water, by compiling the physical water flow accounts and water asset accounts, and by using data from Rwanda National Water Resources Master Plan (NWRMP) for year 2012 and additional data collected from different economic sectors, initial results show that water demand for agriculture use is the highest at 51.3%, followed by the domestic water use at 45.0%.

Improving water access for agriculture as way of improving productivity would be considered an important use of investment funds for water infrastructure. For both land and water, physical information will serve to link land use and water consumed to value added and employment of each sector. Further analysis will discuss the policy uses of the accounts.

PHYTOTECHNOLOGIES AS A SUSTAINABLE TOOL FOR MANAGING ABANDONED MINING SITES: PREVENTING ENVIRONMENTAL AND HEALTH RISKS

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The mining sector contributes to the national Growth Domestic Product (GDP) of many countries worldwide. However, mining operations notably mineral extraction and on-site accumulation of tailings are important cause of physico-chemical degradation of the environment.

Indeed, valued metals are associated with potentially toxic trace metallic elements (ETM) that are persistent in the environment, and this constitutes environmental and health hazards. The wind and water erosion contribute to the spread of ETM from mine tailings to surrounding water bodies and agricultural land. Elevated soil concentrations of ETM may render lands unsuitable for crop production since ETM can be absorbed by plants and then contaminate food chain. Moreover, the unavailability of contaminated soils for food production constitutes an additional food security burden.

The solution would not call for farmers to stop using their lands, but replace food crops with economically valuable ones that can reduce the ETM-induced hazards.

Phytotechnologies are green, cost-effective and environment-friendly soil and water remediation options that are alternative to physico-chemical processes for pollutant removal and immobilization. Phytotechnologies mainly include phytoextraction, i.e., uptake and concentration of ETM from the soils or water into harvestable plants parts; and phytostabilization, i.e., the use of plants and associated microorganisms to enhance ETM immobilization in the rhizosphere and roots.

In contrast to physico-chemical remediation methods, phytotechnologies provide several economic and ecological benefits including carbon sequestration, increased inland and soil biodiversity, limited greenhouse gas emissions, limited soil erosion and groundwater contamination, landscape aesthetics, etc.

The lack of plants that can naturally produce high biomass and accumulate more than one type of contaminant in multiple ETM-contaminated sites is a major drawback for using phytoextraction. Moreover, handling contaminated biomass and avoiding further environmental and food chain contamination remain controversial.

Consequently, phytostabilization is suggested as a more relevant option for managing such sites. For this phytotechnology to be successful, the consideration of the site specificity, socio-economic context and availability of candidate plants is of crucial importance. The combination of both *in-situ* and *ex-situ* experiments for screening trees' and grasses' species and varieties allow the

selection of suitable candidates with ability to tolerate ETM contamination, produce high biomass, contain soil contamination, avoid health risks, and provide ecosystem services.

INCREASING ENERGY FROM WASTE THROUGH CO-DIGESTION OF ORGANIC SOLID WASTES IN RWANDA

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Anaerobic Digestion (AD) technology, commonly known as biogas technology, has been a proven and effective technology for organic waste management and consists of a breakdown of biodegradable waste by micro-organisms in the absence of oxygen, producing biogas (50-75% methane gas) and a digestate that can be used as a soil conditioner.

AD is suitable for the conversion of material such as biodegradable solid fraction of industrial wastewater, food wastes and organic fraction of municipal solid wastes, animal manure, agro-processing and agricultural biomass residues and sewage sludge into energy-rich biogas. Depending on the substrate, methane gas potential ranges from 200 m^3 to 900 m^3 per ton of volatile solids.

In developing countries including Rwanda, an uptake of AD technology has been observed in rural environments with the use of animal waste as feedstock to generate biogas for cooking and lighting and bio-fertiliser hence sustaining rural livelihoods. However, the technology has attracted little attention in the bioconversion of other organic solid wastes probably due to competition with other uses of organic wastes/residues such as composting and animal feeding or lack of relevant technical information on available feedstocks and their energy potential.

Co-digestion of two or more types of wastes is used to stabilise anaerobic waste digesters. Mitigation against variations in quantity and quality of waste, improved biogas yield and a better NPK ratio in the digestate, economically viable operation are some of many advantages of co-digestion. Large farms with various farming activities including establishments with closed livestock holdings benefit from such AD applications for local energy use or small grid projects. AD plants are used to sustain farm operations by processing biomass arising from various sources within a defined geographical area. Similar applications can also significantly benefit food and drink processing industries.

Critical factors include operational reliability including availability of quality feedstock, understanding of feedstock technical information including suitable design from the combination of various substrates, technology and scale, cost issues both in terms of capital costs and operational costs as well as operational framework for biogas and digestate reuse. The development of small to medium scale AD technology in Rwanda would need proper selection of suitable feedstock mix, appropriate strategic policy arrangements including substantial economic drivers for the reuse of biogas and digestate for stimulating best practices, private investment and collaboration in waste collection and treatment.

ECOSYSTEM FUNCTION, WILDLIFE BEHAVIOR, AND BUFFER ZONE INTERACTIONS FOR BIODIVERSITY CONSERVATION IN PROTECTED AREAS: NYUNGWE NATIONAL PARK, RWANDA

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Tropical forests are threatened globally with land cover change, wildlife population declines due to poaching and illegal wildlife trade, and climate change impacts. Protected areas are the main tool we have today to conserve our remaining tropical forests.

In Rwanda, protected areas cover nearly 10% of the country's land surface, and are essentially islands surrounded by human-dominated landscapes. Nyungwe National Park (NNP) in Rwanda is one of the most important remaining montane tropical forests in Eastern Africa, and is extremely rich biologically with many endemic species. It provides important ecosystem services to the country.

Fundamental biological research is important to effectively protect the biodiversity in our national parks. In this presentation I describe an overview of research in three areas: seed dispersal ecology, an ecosystem function and its role in maintaining forest regeneration dynamics in NNP; the importance of understanding animal behavioral ecology for effective conservation; and the role of buffer zones around the park in contributing to biodiversity conservation.

Chimpanzees have been a focus of this research due to their status as an endangered great ape, and their importance to Rwanda's tourism development goals. Our research has shown that chimpanzees are important seed dispersers of many large seeded fruit trees in NNP, and they disperse seeds into open habitats where germination rates are high, contributing to forest regeneration dynamics.

Chimpanzees use forest adjacent to certain buffer zone types more than others, influencing the probability of their contact with human activities, with implications for buffer zone management. Ecological data from NNP contributes to deeper understanding of how land use around the park affects park conservation efforts, the roles of wildlife in contributing to maintenance of ecosystem function within the park. The next steps are to translate the research findings into policy for effective biodiversity conservation in protected areas.

BIOMEDICAL LABORATORY SCIENCES IN RWANDA: THE BACKBONE OF QUALITY DIAGNOSTICS

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Today more than ever, biomedical sciences are growing rapidly as areas of research and knowledge, as educational programs, and as body of practice in health care and industry. Keeping pace with this field requires a new kind of scientist – a scientist who can rapidly accede and adapt to new information and recognize the potential for applying this knowledge to existing problems of human health and biology. However, in Rwanda and Africa in general, biomedical technology is not yet developed, due to the lack of qualified personnel and inadequate equipment required.

Based on these facts, the Government of Rwanda in collaboration with its partners is bridging this gap through:

Positioning of biomedical technology within the political, social and economic spaces.

Building and expanding institutions that support biomedical programs: expanding educational infrastructures (CMHS-UR, INES-Ruhengeri, etc.) and expanding research and development infrastructure (MRC-RBC, NIRDA, etc.).

The aim of those programs is to prepare the candidates to become a valuable part of a medical team of pathologists, technologists and technicians who will be proficient in the procurement and analyses of biological specimens and who are capable of interpreting the results obtained by such analyses.

On the other hand, research centres are encouraged to promote, support and conduct high quality applied medical research to contribute to the knowledge used to improve health and well-being, through better policy, advice and health & social care services for individuals as well as the general Rwandan population. These will also improve the diagnostic methodology and implement new finer tools for the control of endemic diseases in the region.

Each year in sub-Saharan Africa, around 12 million people die and, for the majority of individuals, the causes of death are largely uninvestigated. These uninvestigated deaths are generally attributed to infectious diseases, most commonly HIV infection, malaria, and tuberculosis, but, in the absence of laboratory confirmation, the accuracy of these estimates remains uncertain. Quality laboratory testing is crucial to confirm clinical diagnoses, conduct accurate infectious disease surveillance, and direct public health care policy.

agricultural sciences

NEW PARADIGMS OF GROWING RICE TO ADDRESS SHORTAGES OF WATER AND LABOR, AND GLOBAL WARMING POTENTIAL

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Asia is home to about 4.3 billion people, with 920 millions living on less than $1.25 per day. An intensive cereal system is the lifeline of vast majority of Asians facing dual challenges – shortages and untimely availability of water and labor. Among the cereals, rice is the most important food crop, which heavily depends on large amounts of water and labor because of the way it is grown.

Globally rice is grown by transplanting on puddled (wet tilled) soil in more than 100 million hectares annually. Rice consumes about 50% of total irrigation water in Asia and accounts for about 24-30% of the withdrawal of world total freshwater.

To grow a kg of rough rice, on average 2500 l of water are used. The higher water application in rice is also due to water requirements for puddling and losses associated with continuous flooding such as seepage and deep percolation losses to groundwater. Rice transplanting largely done manually is highly labor intensive requiring 25-50 person-days ha^{-1}. Rapid economic growth in Asia has increased the demand for labor in non-agricultural sectors, resulting in reduced labor availability for agriculture. For example, labor forces in agriculture are declining at 0.1% to 0.4%, with an average of 0.2% per year in Asia leading to sharp increases in the labor wages. Rice cultivation is also a major source of CH_4, currently accounting for 10-15% of all global greenhouse gases (GHG) emissions from agriculture and 10-12% of the world's total anthropogenic CH_4 emissions.

Although this practice of growing rice is highly capital and energy-intensive, it has survived for centuries since it provides certain advantages, in particular weed control. It is argued that this has been a most sustainable crop production system on earth but whether it would maintain sustainability in future under the emerging scenarios of acute shortages of water and labor is highly uncertain.

Our research has shown that the traditional practice of puddling (wet tillage) and transplanting of rice can be avoided by growing rice without soil tillage followed by direct seeding – referred as dry direct seeding or aerobic culture. Much progress has been made in perfecting this technology and in developing a package of practices. Not only aerobic rice culture saves water and labor, it also allows crop residue recycling (which is otherwise burnt), reduces much of methane emissions, lowers energy use and increases farmers profit. Avoiding puddling also improves soil structure which is an essential soil health requirement for the succeeding aerobic crops such as wheat, maize and vegetables.

MULCHED FURROW-RIDGE TECHNOLOGY PROMOTES DRYLAND FARMING SUSTAINABLE DEVELOPMENT IN NORTHWEST CHINA

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Dryland farming area of Northwest China generally refers to the regions with average annual rainfall of 250-550 mm to the Northeast of the Tibetan Plateau. The dryland farming area accounts for 33% of total arable lands, and feeds 32% of total population of the country. In this region, the major landscape is dominated by low hilly and scattered small plains.

Locally, the winter is cold and dry and the summer is warm and rainy. As a general trend, local inter-annual precipitation fluctuates greatly, leading to low and unsteady field productivity. Terrace building practice has a history of nearly 2000 years. With the increased use of agricultural machinery, the size and quality of terraces significantly increased over the past 20 years. And meanwhile, increasing crop yield per unit area proves to be the critical pathway to overcome poverty and achieve prosperity for local people, as well as the fundamental condition to increase land vegetation cover and biodiversity in the dryland farming areas of NW China.

As a result of decades of exploration, various farming patterns of furrow-ridge with plastic film mulching in terms of maize, potato, wheat and other field crops have been developed, which play important roles in local development.

Particularly, summer crops such as maize and potato, whose growth rhythms match with the dynamics of rain and thermal distribution, have been grown on large areas due to their great yield potentials and fine market value.

These two crops have been chosen to meet the demand of local socio-economic and natural conditions. With the extension and application of furrow-ridge with plastic mulching technologies, yield potential of crops has been continuously improved. Since the beginning of 21st century food shortage, which has lasted for several centuries, has been largely solved in most of dryland farming area. With the increase in areas suitable to maize cultivation and in maize productivity, there has been a large amount of additional maize straw resources available to be used for silage fermentation.

This turned out to become one of major sources of livestock forage, which has been the major restriction for local livestock development in the past. Artificial seeded grasslands, such as alfalfa pasture, not only act as supplemental sources of local livestock forage, but in the meantime, they could exert important effects on local ecological vegetation restoration, and the control of serious soil erosion. According to efficiently use of natural rainfall, vegetation coverage and biodiversity has gradually increased in dryland agricultural area of NW China, while there have been synergistic development in coupled natural and human system through incorporating food crops and cash crops into artificial grassland and livestock husbandry system. This sort of integrated management paradigm is thus developed on the basis of sustainable development in dryland agricultural area of NW China.

biology

INTRACELLULAR PATHOGENS AND AUTOPHAGY: FRIENDS OR FOES?

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Several microorganisms use the invasion of host cells as strategy to shelter from the host immune system but cells have developed powerful means to destroy invading pathogens. Therefore, intracellular pathogens use sophisticated mechanisms to overcome host cell defenses and replicate successfully.

One of the mechanisms employed by bacteria to evade the host innate defenses is escaping into the cytoplasm to avoid lysosomal killing. Other intracellular microorganisms stay inside the vacuolar phagosome, but hamper their maturation into phagolysosomes, thus guaranteeing the progression of the infectious process. Others intersect the autophagy pathway. Autophagy involves the sequestration of cytosolic components including organelles or microorganisms, in a vacuole called autophagosome. By fusion with lysosomes, the sequestered material is degraded and the molecules reused.

Several lines of evidence indicate that certain bacteria, viruses and parasites avoid or in contrast, actively subvert autophagy to promote their own replication.

We have studied intracellular bacteria characterized by surviving and replicating into the host cell with different intracellular life styles such as *Mycobacterium tuberculosis* and *marinum, Staphylococcus aureus* and *Coxiella burnetii*. Certain microbes manipulate the autophagic pathway at the molecular level as a strategy to establish persistent infection. However, transit through the autophagy pathway is not beneficial for most pathogens and autophagic events are critical cell defense mechanisms against infecting microorganisms. Our results offer a novel perspective for understanding the importance of autophagy as a modulator of intracellular pathogens fate.

earth sciences

THE CARBON BALANCE OF TERRESTRIAL ECOSYSTEMS IN CHINA

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The carbon balance of China is of large scientific and political concern because China is the world's most populous country and the largest fossil fuel CO_2 emitter.

Here, we use three independent approaches, biomass and soil carbon inventories, biogeochemical models, and atmospheric inversions, to quantify the terrestrial carbon balance of China and its mechanisms.

The three approaches produce robustly similar estimates of a net carbon sink in a range of 0.19 - 0.24 petagrams C per year, indicating that China's terrestrial biosphere has absorbed about 20% of its cumulated fossil carbon emission during 1990s and 2000s. The sink is mostly located in southern China, which is related to regional climate change, plantation programs, and rising CO_2 concentration.

medical sciences

THE GENETIC BASIS OF HIGH-ALTITUDE ADAPTATION IN TIBETAN POPULATIONS

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The low partial pressure of oxygen resulting from high altitude would have presented a formidable biological challenge to humans. Tibetans have lived on Qinghai-Tibetan plateau for many generations; therefore they have had more time and opportunity for natural selection to occur in response to a hypoxic environment than any other high-altitude human population.

Decades of physiological studies indicated that Tibetans present distinct physiological characteristics compared with other high-altitude residents.

However, little is known about the underlying genetic basis of these traits.

In recent years, we focused on the genetic basis of high-altitude adaptation in highlanders, and reported ten genes that were under strong positive selection in unrelated Tibetans.

Of these ten, we have selected three - *EPAS1* (HIF-2), *EGLN1* (PHD2) and *PPARA* - which are constituents of the HIF pathway or are regulated by HIF; mutations or dysregulation of each of these three genes, or of their products, has been reported to be associated with anemia or polycythemia.

Of these three genes, the haplotypes of two (PHD2 and *PPARA*) were significantly associated with lower hemoglobin in Tibetan highlanders. We have also found that a high-frequency missense mutation in the gene *EGLN1*, that encodes prolyl hydroxylase 2 (PHD2), contributes functionally to the Tibetan high-altitude phenotype. PHD2 triggers the degradation of hypoxia-inducible factors (HIFs) that mediate many physiological responses to hypoxia, including erythropoiesis. The PHD2 variant exhibits a lower K_m value for O_2, suggesting that it promotes increased HIF degradation under hypoxia. Whereas hypoxia stimulates the proliferation of wild-type erythroid progenitors, proliferation of PHD2 progenitors is significantly impaired under hypoxic culture conditions.

These Tibetan highlanders have acquired genetic adaptations to live in a high-altitude hypoxic environment, and one such mechanism is protection from polycythemia through down-regulation of hypoxia inducible factors; this down-regulation of erythropoiesis extends even to low altitudes.

physics

ACCELERATING UNIVERSES AND THE EMERGING LANDSCAPE OF STRING THEORY

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Recent progress in observational cosmology has shown that the universe is accelerating. A small and positive cosmological constant provides the leading theoretical explanation for this phenomenon.

It was initially thought that such an accelerating universe with a positive cosmological constant cannot arise in string theory. We now understand that this is not true and string theory does contain universes with a positive value for the cosmological constant.

The construction of such a universe or vacuum requires a controlled breaking of supersymmetry and also the giving of mass to the many scalar fields usually present in string theory, called moduli. This has been achieved in a new class of string theory compactifications.

In these, fluxes, which are analogous to electric and magnetic fluxes, are turned on along the additional compact directions present in the theory.

The picture that emerges is that of a complicated landscape with many, many, vacua that have widely varying values for the cosmological constant and the other constants of nature. Transitions between these vacua are possible, leading to a rich dynamics in the landscape. The talk will review these and more recent developments and end by asking what they might mean for our quest for the fundamental laws of nature.

engineering sciences

DEFORMATION AND FRACTURE IN AMORPHOUS ALLOYS

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The mechanical properties of amorphous alloys have proven both scientifically unique and of potential practical interest, although the underlying deformation and fracture physics in them remain less firmly established as compared with crystalline alloys.

In this presentation, I shall review the recent advances we made in understanding the fracture behaviour of metallic glasses. In crystalline metals and alloys, the term 'ductile' is synonymous with 'tough,' as they both are linearly correlated. However, the non-existence of such correlation in metallic glasses poses a conundrum. For example, bulk metallic glasses (BMGs) with no tensile ductility whatsoever can exhibit extraordinarily high fracture initiation toughness values.

"What is the physical reason for such high toughness?" is a question that we set out to answer. A related issue is the following: a material physics-based condition, at which fracture will initiate, is essential for reliable design of components and structures. Fracture criteria for brittle materials like ceramics are stress based whereas those in ductile materials like metals and alloys are strain based.

But, both need the identification of a critical length scale, l*, which is related to some microstructural length scale, to be prescribed *apriori*.

A suitable fracture criterion is needed to identify l* at which plastic to brittle transition takes place. Mixed-mode fracture experiments coupled with detailed finite element simulations are conducted to identify the fracture criterion in a nominally ductile BMG. These results show that fracture in amorphous alloys is controlled by the attainment of a critical strain and that a stable crack grows inside a shear band at the notch root before attaining criticality at l*≈60 mm.

The Argon and Salama model, which is based on meniscus instability phenomenon at the notch root, has been modified to rationalize the physics behind this length scale. This model suggests that the mean ridge heights on fractured surfaces were found be correlated to the toughness of the BMG. In contrast, the fracture mechanism in brittle metallic glasses is elusive. Some interesting morphologies observed on brittle fracture surfaces will be presented.

mathematics

THE BEAUTY OF DISCRIMINANTS

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Discriminants are polynomials with a fascinating combinatorial structure that provide a key tool when examining singularities of systems of non-linear equations. Their theoretical study is a thriving and fruitful domain today, and they are also very useful in a variety of applications.

I will give a gentle introduction to the structure and applications of discriminants, in particular, to geometric modeling problems and to the determination of multistationarity of biochemical reaction networks.

physics

VUV LASER-BASED PHOTOEMISSION STUDY ON HIGH TEMPERATURE SUPERCONDUCTORS

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The mechanism of high temperature superconductivity in the copper-based and iron-based superconductors remains a prominent and challenging issue in condensed matter physics. Angle-resolved photoemission spectroscopy (ARPES), as a powerful technique to directly probe the electronic structure of materials, has played a key role in studying high temperature superconductors.

In this talk, I will first introduce our successful development of a series of vacuum ultraviolet (VUV) laser-based angle-resolved photoemission systems[1]. Then I will highlight some of our

important results in utilizing these state-of-the-art laser-based ARPES systems to study the high temperature copper-oxide superconductors [2-5] and the iron-based superconductors [6-10].

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TWAS-Celso Furtado Prize

SOCIAL POLICY AND THE PROBLEMS OF PEACEFUL CO-EXISTENCE IN CONTEMPORARY SOCIETIES: PROMISES AND CHALLENGES

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As an economist specialized in development studies, as someone deeply inspired by Celso Furtado's work, I have been working in the field of social policy during the last fifteen years. Social policy constitutes an interesting field of academic inquiry where comparative research carried out with an interdisciplinary perspective yields very fruitful results.

The field also has an important political relevance in the way it engages with the problems of social justice, solidarity and peaceful co-existence in complex modern societies.

Today these problems are particularly pressing. Economic, social and political transformations of the last few decades have led to a situation where many people were uprooted from their accustomed forms of life and livelihood.

As a result, all countries with different socio-political structures which had evolved against different historical backgrounds have found themselves in a position to redefine the ways of access to means of livelihood and basic services, or the terms of an individual's participation in society in general.

These transformations have ushered in two seemingly contradictory developments in social policy regimes throughout the world. On the one hand, there has been a widespread questioning of the sustainability of the mature welfare states of development capitalist countries. On the other hand, the countries of the periphery, where the concern with economic development had previously dominated formal social policy intervention, the insertion in the global market economy has ben followed by a "social turn" whereby social protection has acquired a novel significance and new institutions and policy instruments have been introduced.

One could discuss the possible trajectories of social policy development in a globalized world by raising the following questions: will social policy intervention be transformative in its impact on

employment relations or will it mainly aim at supporting and sustaining market expansion? How and to what extent will traditional gender roles be modified through the policy making processes? What will be the relative significance of the roles played by market exchange, state redistribution and different forms of reciprocity relations in determining the coordinates of an individual's position in society? To what extent will social policy intervention be guided by the principle of rights based participation in society and what would be the responsibilities assumed by the nation state and international organizations in giving content to social rights?

THE INTERACTION OF THE ENVIRONMENTAL AND SOCIAL CONDITIONS OF POPULATION HEALTH IN CHINA

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Population health, as one of the most crucial elements of society, always plays a decisive role in the national development. Among many current population health issues, children, women, old population and disabled population's health promotion strategies are of considerable concern in China. Through 30 years' continuous research in Chinese poor areas, the theory of interaction association within environmental and social factors on population health has been developed by our interdisciplinary research team. A framework of healthcare and health services was proposed based on our theory.

Moreover, reproductive health is an indispensable component of population health. We firstly introduced the ICPD reproductive health theory into China, enriched this theory and developed intervention framework of maternal and child's health and mortality. This intervention framework promoted the implementation of Millennium Development Goals (MDGs) in China.

We established a maternal-child cohort in the poor areas and analysed the associations between poverty, malnutrition and birth defects/infant death during our national program on key basic research projects. We proposed a strategy of birth defect prevention from pre-natal–perinatal care to pre-pregnancy–peri-pregnancy care based on our findings, which has been applied in the national family planning network and the national population development strategy since 2006.

Meanwhile, environment pollution has always been considered as an important risk factor of population health. We developed an assessment model for the environmental risk factors and neural tube defects (NTDs), and found the association between the soil heavy metals components, geographical history living condition, cultivated land, coal-mining area and birth defects. In addition, geographic information system (GIS) was firstly used for birth defects research and a predicted and detected system of birth defects was developed.

SYMPOSIUM IV: EYES AND EARS ON THE UNIVERSE USING RADIO WAVE AND GRAVITATIONAL WAVE ASTRONOMY

THE DISCOVERY OF GRAVITATIONAL WAVES FROM A BINARY BLACK HOLE: THE BEGINNING OF GRAVITATIONAL WAVE ASTROPHYSICS

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The prediction of the existence of gravitational waves is perhaps the most radical departure of the General Theory of Relativity from earlier theories of gravity. Less than one year after he formulated the field equations of General Relativity, Einstein found the first wave-like solutions for them.

It then took forty years for the theoretical community to come to agreement about their physical reality, that they stretch and squeeze space on perpendicular axes transverse to the direction of the wave's propagation. This pattern is ideally matched to a Michelson interferometer, but the size of the effect for any conceivable gravitational wave source is minute.

For this reason, it has taken a further sixty years for the experimental community to develop the capability to detect the effects of a gravitational wave. The Laser Interferometer Gravitational-wave Observatory (LIGO) operates detectors at two sites in the US, using advanced lasers and optics to compare the lengths of two 4-km long arms with sensitivity better than one one-thousandth the diameter of an atomic nucleus.

Earlier this year, the LIGO scientific collaboration and the Virgo collaboration announced that they had observed a short burst of gravitational waves from the inspiral and merger of two black holes using these newly commissioned detectors. This opens a widely anticipated new field of astrophysical research.

EXPLORING THE NEW FRONTIER OF GRAVITATIONAL-WAVE ASTRONOMY

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The first direct detections of gravitational waves, announced by the LIGO scientific collaboration and the Virgo collaboration, open the vast new frontier of gravitational-wave astronomy. These first detections of merging black holes confirm that Einstein's General Theory of Relativity gives a good description of the most extreme spacetimes ever encountered.

This provides a comfortable base for future detections of matter in these extreme spacetime conditions. Different methods have been optimized to search for different classes of future events. Extracting the best science from these future observations will require building out the international network of gravitational-wave detectors to optimize localization of the sources and to recover full polarization information from events.

From the first observations of merging black holes, we extrapolate that such mergers occur hourly somewhere in the observable universe. This motivates continuation of the evolution of detectors with greater sensitivity, eventually probing mergers of black holes formed by the first generations of stars, deeply probing the nature of extreme spacetime and the nature of matter at extreme density.

THE SQUARE KILOMETRE ARRAY TELESCOPE AND THE AFRICAN DATA INTENSIVE RESEARCH CLOUD: BIG SCIENCE IN AFRICA

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Africa bid successfully to host the Square Kilometre Array Telescope. The telescope will be constructed in Africa and Australia from 2018 unto 2030 and will be the largest science infrastructure in the world. The bid was supported by the heads of state of the African Union as a major step in human capital development. Science and technology are now recognized very widely as being central to the agenda for the sustainable development of Africa and its economies.

South Africa's MeerKAT Telescope, a precursor to the SKA, will be completed in 2017 and has already demonstrated its superb performance, beyond the initial specifications. It is in great demand by scientists around the world and will be the premier mid-frequency telescope until the SKA is built.

The MeerKAT and SKA have been the focus of a very large SKA South Africa human capital development programme for South Africa and the African SKA partners, which has established research chairs and a pipeline from undergraduate physics, engineering and technology through MSc and PhD to post-doctoral positions. This HCD programme also trains artisans and technicians.

The programme has trained many students from other African countries and has now been supplemented by a targeted bursary programme for African SKA partner countries from South Africa and from the UK- RSA Newton Fund.

Training of researchers, technicians and artisans in SKA African partner countries has also taken place through the African Very Long Baseline Interferometry Network (AVN) programme and the Newton Fund.

The MeerKAT and SKA are huge data-producing machines. A great deal of R&D is therefore taking place on the collection, transport, storage, processing, analysis and visualization of the huge MeerKAT and SKA astronomy data sets. The big aata Africa programme aims to use the SKA to catalyze the development of African capability to play a significant role in the rapid growth of the global big data economy.

The inter-university institute for data-intensive astronomy (IDIA) has been launched in South Africa. Five universities currently participate. It is hoped that other universities in Africa will become members. IDIA is prototyping the African data-intensive research cloud, which will enable collaboration between researchers and students in Africa and between Africa, Europe and the rest of the world. It aims to give researchers in Africa access to huge data sets and services and tools to analyse them.

The research cloud will be a platform for research in many disciplines and will not be limited to astronomy. Earth observation, health, bio-informatics, agriculture, climate change and other disciplines will be able to use it. It is intended that the African research cloud will be linked to the new European open science research cloud.

GAS, DARK MATTER AND STAR FORMATION IN EXTREMELY FAINT DWARF GALAXIES

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In the current model of galaxy formation, large galaxies like our own formed by the hierarchical merger of smaller progenitors. These progenitors are expected to have low heavy metal content, and a large gas to stellar mass ratio. Similar conditions are observed in the extremely faint nearby dwarf galaxies.

Detailed studies of these galaxies hence provide insights and constraints on galaxy formation models. In this talk, I will present results from the faint irregular galaxy GMRT survey (FIGGS), a large survey of some of the dwarf galaxies done using the Giant Metrewave Radio Telescope.

Topics that I will discuss include distribution and kinematics of the gas, the distribution and total dark matter content, as well as the processes that govern the conversion of gas into stars.

PRESENTATIONS BY TWAS'S YOUNG AFFILIATES

biological sciences

STUDY OF AVIDITY OF ANTIGEN SPECIFIC ANTIBODY FOR MEASUREMENT OF IMMUNOLOGICAL MEMORY IN NATURALLY INFECTED TYPHOID FEVER PATIENTS AND TYPHOID VACCINEES IN BANGLADESH

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Typhoid fever caused by *Salmonella enterica* serotype typhi is a potentially life-threatening systemic disease. High prevalence rates of typhoid fever have been reported in the resource limited regions of the world, with children under five years of age being the largest target. The antibody avidity maturation in patients with typhoid fever or in individuals following oral typhoid vaccination has not been reported till date.

We measured lipopolysaccharide (LPS) specific immunoglobulin G (IgG) and IgA avidity maturation in naturally infected Bangladeshi typhoid fever patients of all age groups, as well as individuals aged below five years after immunization with liquid formulation of Vivotif vaccine.

We assessed the antibody avidity responses at acute stage in patients or prior to vaccination in vaccinees and then in follow-up at day seven and then at day 21. Both patients and vaccinees mounted LPS-specific IgG and IgA antibodies of high avidity. After vaccination IgA and IgG antibodies with significantly higher avidity are induced in the vaccinees that lasted throughout the study period of 21 days. The patients with an age below five years showed a higher IgA avidity index in the first two study day points, followed by a decrease at day 21. We compared the avidity response in patients of different age groups (young children: below five years; older children: 6-17 years and adults: above 18 years). Adults showed significantly higher antibody avidity indices than young and older children at day seven for LPS-specific IgG; whereas for IgA avidity indices the patients of all age group had similar responses at all study days.

This is the first demonstration of antibody avidity response in typhoid fever patients and the findings also suggest that the liquid formulation of Vivotif vaccine induces the antibody avidity in children under five years of age.

CONTRIBUTIONS OF *SOLANUM MACROCARPON* LINN (SOLANACEAE) IN HUMAN HEALTH AND INTEREST OF THE ANAEROBIC BIO-DIGESTION OF CHICKEN MANURE USED FOR ITS CULTIVATION IN BENIN

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S. macrocarpon is a vegetable produced by nearly of 95% of growers in Benin. Although the consumption of this vegetable is very important in this country, there is no data on its nutritional and hygienic properties. This study aimed to assess the nutritional and medicinal properties of *S. macrocarpon* and then propose a technique for producing vegetable with improved health quality, based on anaerobic bio-digestion of chickens' manure.

The evaluation of the nutritional properties and phytochemical screening were carried out on powders of leaves and fruits of *S. macrocarpon*. The cytotoxicity was tested on the shrimp larvae. In vivo toxicity, cholesterol lowering's activities and a histological exploration of the liver were determined with Wistar rats. A method of vegetable's production based on anaerobic digestion of chickens' manure was finally proposed and evaluated.

The study showed that the leaves and fruits of *S. macrocarpon* were rich in nutrients and were safe for consumption. The parts of the vegetable contribute to the lowering of total cholesterol, triglycerides, VLDL-cholesterol and LDL-cholesterol. It also increased the level of 'good' cholesterol (HDL-cholesterol). In addition, these extracts regenerate hepatic cells. With the anaerobic digestion of manure used for the cultivation, levels of bacteria decreased in the compost. For example, the study showed decreased values from 6.5.106 CFU/g to 3.4.104 CFU/g for fecal coliforms and from 3.5.105 CFU/g to 5.4.103 CFU/g for enterococcus.

Lead complexed by chemical reactions was reduced with an amount from 2.39 mg/kg to 0.204 mg/kg. The value of these chickens' manure was improved by increasing phosphorus equivalent of 9.96 % to 16.40 % and the reduction of total nitrogen from 18900 mg/kg to 13096.33 mg/kg. The data from this study allow to consider a large-scale production of *S. macrocarpon* with improved hygienic quality.

TUMOR BIOLOGY: TARGETS AND DRUGS

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Among the physiological hallmarks of cancer, altered glucose metabolism is perhaps the most common. Aerobic glycolysis is observed in approximately 90% of human tumors and may be required for new biomass formation. In fact, proliferation of cancer cells is accompanied by activation of glycolysis. Moreover,

glycolysis may confer tumor cells upon the ability to adapt to new microenvironments or cope with stress during tumor progression and metastasis.

The aim of our studies is to investigate potential targets for antitumoral therapy through the evaluation of the unique energetic metabolic profile present in cancer cells. Besides, we evaluate the effects of the novel drugs on metabolism and physiology of the cancer cell lines.

These novel approaches may identify treatments that would be more selective to aggressive tumors with minimal effects over non-tumoral cells.

MECHANICAL AND FUNCTIONAL STUDIES OF BIOMOLECULES AT SINGLE MOLECULE LEVEL

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The effect of force on protein structure an associated changes of protein function is a subject of current intensive research. Mechanical forces are generated inside the cell during such diverse molecular processes as transcription, replication, translation, chromosomal segregation, protein unfolding, translocation of proteins across membranes, cell locomotions among others.

Recent technological advances now allow the application and measurement of forces on biomolecules with extreme precision. In particular, the so-called "analytical optical and magnetic tweezers" instruments can manipulate single molecules, such as proteins and nucleic acids, while measuring their internal stress forces generated in the course of biological processes.

In this study we used the optical tweezers (OT) to study the mechanical stability of adenylate kinase (AK) from the thermophilic organism Aquifex. AK was first characterized in OT and was found to unfold around 25 pN during force-extension experiments with a fast (mseg) 4 nm intermediate at 15 pN.

This intermediate could correspond to the ATP binding domain unfolding independently of the rest of the protein. In another project we study the effect of the chaperon BiP in the folding and unfolding pathways of different protein. We found that BiP bound to the proteins in the unfolded state.

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CONSERVATION OF LOCAL CHICKEN GENETIC RESOURCE FOR FOOD SECURITY

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Conservation of local genetic resource has been found to be one of the surest ways of ensuring food security, especially in the developing world. It was against this background that a study was undertaken to describe the morphological features and the useful attributes of different populations of indigenous chickens in five ecological zones of Ghana.

A total of 1484 indigenous chickens comprising 950 females and 534 males in the five agro-ecological zones were studied, based on 10 qualitative traits. Additional data on body weight and linear body measurements (shank length, wing span, body length and chest girth) were also taken. Descriptive statistics (nonparametric and Freidman's tests) were used to analyse the data.

Data obtained showed unique and useful morphological features for adaptation and characterization. In terms of plumage colour, wheat and black were the prominent colours of the indigenous chickens in most of the eco-zones. Single comb was the dominant comb type in all ecological zones.

Most of the chickens in the studied eco-zones had white skin followed by yellow skin. In terms of feather distribution and structure, it was observed that most of the indigenous chickens were normally feathered, with naked-neck and frizzle feathers sparsely distributed in the populations studied.

Male chickens in all populations were heavier and taller than their female counterparts, an indication of sexual dimorphism regarding linear body measurements. Body weights ranged from 1.6kg to 1.8kg for adult males and 1.1 to 1.2kg for adult females.

CHEMICAL AND MOLECULAR TOOLS TO MAP THE RISK OF ARBOVIRAL DISEASES WITH A FOCUS ON RIFT VALLEY FEVER

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Rift Valley fever virus (RVF) is a mosquito-borne anthropozoonosis of major veterinary and public health concern in Africa. Like most viral zoonoses, the disease occurs in the form of outbreaks. While the magnitude of such outbreaks in Africa continues to be high, understanding the disease ecology and epidemiology have been minimal which requires proper sampling and hence, the need for effective sampling tools.

Using chemical ecology, standard virology and molecular biology approaches, this presentation highlights progress made in the development of improved surveillance and control tools for vectors of RVF; gleaning the epidemiology of the RVF from population genetic structure of the key vectors and examining possible roles of other fly species (sand flies) in maintenance of RVF virus during the inter-epidemic period.

The biodiversity of arbovirus vector interactions will also be highlighted.

UNDERSTANDING THE MANAGEMENT PRACTICES OF ANIMAL MANURE AND ASSOCIATED RISKS OF TRANSFERENCE OF BACTERIAL PATHOGENS TO CROP VEGETABLES

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Manure is an important resource for crop production. The purpose of the study was to:

(i) characterize the practices related to management of animal manure in Mauritius, and

(ii) determine the prevalence of *Escherichia coli* O157:H7 and *Salmonella* in manure, manure-amended soil (MAS) and crops grown in such soil.

A survey was conducted through in-depth interviews with 15 livestock breeders and 30 crop growers, to gather information on their activities pertaining to management of manure.

Informant responses were also gathered on their perception of the safety of manure use. Samples of manure, MAS and vegetables were also analysed to determine counts of *E. coli* O157:H7 and *Salmonella*.

Manure accumulated from farms was typically piled near the barn, until picked up by a 'collector'. Delivery of manure by the 'collector' to the crop growers was free of charge and the material was left on the field itself. Growers indicated manually applying the material to soil prior to sowing of seeds.

They also mentioned applying manure after each crop cycle and using the leftover for the subsequent cycle. Mixing manure with chemical fertilizers was also reported. Cattle and poultry manure tended to be used by lettuce and carrot growers respectively. Growers and 'collectors' had no negative perception of the use of raw manure for crop cultivation and were unaware of any health risks. 100% of manure samples collected from cattle farms were positive for *E. coli* O157:H7 with the pathogen population reaching ≥ 6.0 log cfu/g compared with 71% of poultry litter samples. Presumptive *Salmonella* was also isolated from poultry manure, MAS and lettuce samples.

Our study indicates that raw bovine and poultry manure are widely used fertilizers in Mauritian farms and also points to the microbiological risks associated with the use of raw untreated manure for vegetable cultivation.

physical sciences

A PERSONAL EXPERIENCE AND SOME PERSPECTIVE ON RESEARCH AND STUDY AT THE NATIONAL UNIVERSITY OF SAN MARTÍN (UNSAM), ARGENTINA

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Franco Martin Cabrerizo was born in Buenos Aires, Argentina, in 1976. He received the Bachelor degree in chemistry (2002) and the PhD degree in science (2005) from National University of La Plata, in Argentina. He is currently a research member of CONICET (Argentina). His research activities are framed in different fields such as organic and physical chemistry, photochemistry and photobiology.

As the head of the photochemistry and molecular photobiology research group, at IIB-INTECH (CONICET - UNSAM), his current research focuses on understanding the molecular aspects of mechanisms underlying the processes triggered by UVA and/or visible light. This knowledge provides valuable information for the development of different biotechnological applications that might contribute to attend unresolved and/or neglected socially relevant local and global problems related to some infectious and chronic diseases, as well as to changes in the current energy matrix towards more sustainable and renewable sources of energy.

The research group's working areas can be mainly subdivided in:

(i) health, including the study of mutagenicity and genotoxicity photoinduced by endogenous chromophores, the design and synthesis of novel antimicrobial and antitumor agents, as well as the evaluation of novel strategies for vaccine development and treatment of neglected parasitic infections, and

(ii) energy, by developing dyes-photosensitized solar cells based on the use of natural pigments extracted from native resources, as an alternative for low cost photovoltaic solar cells production in developing countries.

The above mentioned research lines are in progress in cooperation with colleagues and partners from different developed and developing countries (Argentina, Uruguay, Germany, Denmark and Japan).

Certainly, our investigations might be relevant for other developing countries. Thus, we are open for future partnership and cooperation agreements.

As an associate professor at National University of San Martín (UNSAM), Franco Martin Cabrerizo teaches organic chemistry for undergraduate and postgraduate students. UNSAM is a vibrant community of scholarship and learning that provides a stimulating environment for research, education and cultural activities. Chartered in 1992, UNSAM is a public university that offers undergraduate and graduate instruction in the arts and humanities, social sciences, and natural sciences and engineering.

UNSAM has thrived in cooperating with other S&T institutions in the country (CONICET, Atomic Energy Commission, Industrial Technology Institute, National Space Agency, Institute for Research of the Ministry of Defense and the Antarctic Institute) enabling its faculty members to train 15.000 undergrads and 3.000 graduate students with the highest research standards of the country. UNSAM seeks to be recognized as a research university, with a mind open to innovation, pursuing the highest level of teaching and committed to serve the country through the discovery and transmission of knowledge.

IDENTIFICATION OF KEY FACTORS AFFECTING THE ORGANIC FOULING ON LOW-PRESSURE ULTRAFILTRATION MEMBRANES

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The fouling behavior of the hollow fiber ultrafiltration (UF) membrane by the mixtures of dissolved organic matters (DOMs) has been systematically investigated. The organic foulants included humic acid (HA), bovine serum albumin (BSA) and sodium alginate (SA), represented humic substances, proteins and polysaccharides, respectively.

According to experimental results, the filtration process of organic mixtures could be divided into a fast fouling stage and a slow fouling stage no matter what mixture was used. Scanning electronic microscopy (SEM) and the attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR) analysis of the surface of the fouled membranes revealed a significant difference in the structure of fouling layer, which may be attributed to the different deposition rate of the organics.

More importantly, the molecular weight of DOMs, solution zeta potential (ZP) and particle size were examined in order to identify the key factors contributing to the fouling behaviour. A strong correlation was found between fouling resistance and the content of small molecules in DOMs and solution zeta potential base on statistical analysis. Both factors played significant roles in membrane fouling. A more serious fouling could be observed with a higher proportion of small molecules or a more negative charge density of solution. Furthermore, the normalization data indicated that the effect of small molecule on membrane fouling was more important compared to the ZP of the solution.

21-CM COSMOLOGY

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The redshifted 21-cm emission from neutral hydrogen can potentially probe a significant fraction of the universe, shedding light on astrophysical processes and fundamental physics.

Recently, two observational redshift windows have emerged: around the epoch of cosmic reionization (EoR), 21-cm line directly traces the distribution and evolution of neutral/ionized regions, probing the cosmic reionization process that marked the onset of galaxy formation; at redshifts around unity, 21-cm follows large-scale matter distribution and can be used to measure the Baryon Acoustic Oscillation signature in the intensity mapping regime, constraining properties of dark energy that drives the accelerated expansion of the universe.

I will describe current efforts on measuring the 21-cm fluctuation power spectrum to probe the structure of the universe across cosmic time.

TOLERANCE TO UV RADIATION IN MAIZE

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Maize is one of the most important food crops in Latin America, Africa and Asia. It is widely distributed and it is very diverse genetically. Weather models predict that global warming may affect cloud formation and ozone depletion in the tropics and may lead to an increase in exposure to ultraviolet radiation (UV), which

is already known to affect yield in maize. However very little is known about the cellular and molecular responses to UV in maize, including how its DNA is repaired after exposure to this type of radiation.

UV radiation is very harmful since it causes breaks in DNA that lead to mutations and cell death. For this project several highland and lowland Mesoamerican homozygous lines from the CIMMYT seed bank in Mexico have been selected. These lines will be either exposed directly to radiation or indirectly to chemicals that mimic the effect of UV. After exposure, tissue from seedlings will be analysed to observe patterns of gene expression and to establish how quickly its DNA is repaired. It is expected that this information may allow for the discovery of differences in terms of tolerance to UV radiation, and facilitate breeding efforts.

Keywords: Plant breeding, global warming, food security, genotoxicity

MAKING EVERY HARVEST COUNT THROUGH VALUE-ADDITION: A COSMECEUTICAL PERSPECTIVE

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Sunburn renders 15% of pomegranate fruit production unmarketable in fresh fruit and juice industries. Sunburn bleaches the characteristic red colour of pomegranate aril – a term commonly known as "cooking effect". This renders the fruit undesirable for processing into other products, as colour is an important quality attribute for any pomegranate products. As a result, sunburned fruit are useless and their disposal represents an environmental problem.

From industrial perspective, the most effective way to add value to sunburned pomegranate fruit is to utilize the seed oil. In this instance, it is important to investigate its biological properties in other to justify its potential uses as a functional ingredient.

Therefore, the aim of this work was to determine and compare the composition and biological properties of oils extracted from pomegranate seeds of sunburned fruit (SBF) and healthy fruit (HF) to justify the value-adding potential of pomegranate fruit representing losses. Oil samples were extracted after drying using different drying techniques (freeze-, sun- and oven-drying).

Results showed that oven-dried seeds, regardless of seed source (SBF or HF), yielded higher oil ranging from 20.20% to 24.35% of dry matter. However, oil obtained from SBF contained higher total phenolic content (1.4 – 2.8 mg/g) than those obtained from HF. A total of 17 compounds were identified by GC-MS analysis, with the predominant being 9,12,15-Octadecatrienoic acid, a conjugated linolenic acid, constituting 70-72% of total essential oils.

Gamma-tocopherol constituted 95% of total tocopherol while β-sitosterol constituted between 85-87% of total sterols. Overall, strong antioxidant capacity (scavenging activity) was exhibited by all the investigated oil samples, with inhibition concentration at 50% (IC_{50}) ranging from 34.77 to 59.29 ug/mL. Antioxidant capacity was influenced by seed source ($p = 0.006$) and drying method ($p = 0.025$). All the oil samples showed good ability to inhibit tyrosinase enzyme (enzyme implicated in pigmentation) regardless of seeds source and drying method, with monophenolase and diphenolase IC_{50} ranging between 0.31 - 0.49 mg/mL and 0.64 - 2.43 mg/mL, respectively.

This study indicates that seeds of sunburned pomegranate fruit can be exploited for high quality oil due to similar yield and bioactive composition comparable to oil extracted from healthy fruit. In general, regardless of drying method, oils from seeds of SBF and HF both had good antioxidant activity and tyrosinase enzyme inhibition ability, biological activities desirable in the cosmeceutical industry.

NEW KID ON THE BLOCK: ALIEN INVASIONS TO THE SUB-ANTARCTIC

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Worldwide, alien invasive species (exotic species introduced by humans, which establish and spread of their own accord) constitute one of the greatest threats to biodiversity. These organisms outcompete native species, change the structure and function of ecosystems, and often have large economic costs.

Therefore, to prevent and manage invasions, it is of utmost importance to understand invasion risks and impacts. The Sub-Antarctic Islands are remote pieces of land in the vast expanse of the Southern Ocean, which harbour a unique flora and fauna.

Although they are mostly considered to be fairly pristine and little impacted by humans, most islands have been significantly affected by several invasive species. Here I will present work on invasion risks to Sub-Antarctic Islands, why invasive species are as successful as they are, and what some of the impacts of alien invasion are for Sub-Antarctic islands.

We use a global pool of invasive species to assess which global invasives have a high probability of establishing on the islands. In addition, using a trait-based approach, we assess what characteristics of plants make them successful invaders.

We find that weedy, generalist species with few specialised defences against extreme weather are particularly effective invaders. Worryingly, these species are predicted to become significantly more successful with climate change, at the expense of the native species.

Our results allow us to make recommendations on which species to be careful about introducing to islands and to prioritise the eradication of alien plant species on the Sub-Antarctic Islands.

WEAKLY-BOUND MOLECULES OBTAINED BY LASER-ASSOCIATION OF COLD ATOMS, AND THE ANALYSIS BY THE VIBRATIONAL QUANTUM DEFECT

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In the context of cold molecule physics, spectroscopic data and their analysis play an important role, in particular to find efficient processes which end in a molecular ground state. The laser-photoassociation of cold atoms which creates molecules in an excited state is a starting process in the route to ground-state molecules. Applied to alkali dimers the photoassociation-spectroscopy has provided high resolution data for vibrational levels lying close to the dissociation limit, which are useful in this context.

To identify the relevant coupling between molecular potentials, which determine the main routes to form molecules, we have investigated the spectrum analysis by the so-called vibrational quantum defect (VQD).

This quantity issues from the analogy between the Rydberg law for atoms and the LeRoy-Bernstein one for molecules. VQD-graphs can be deduced from spectroscopic data and in case of coupling between molecular potentials, they exhibit resonances that can be modelled, measured and used to characterize the coupling.

To present the VQD method, I will first introduce lasers-cooling techniques and the photoassociation spectroscopy. Then I will focus on the use of the VQD method and the extension to the rotational constant analysis.