WORKSHOP REPORT ON

TRAINING AND MENTORING AFRICAN SCIENTISTS IN STEM CELL AND REGENERATIVE MEDICINE RESEARCH

African Academy of Sciences
Nairobi, Kenya

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04 to 06 August 2014

African Academy of Sciences

Nairobi, Kenya

Organised by

The African Academy of Sciences

KNAS

In Collaboration with

ACADEMIA BRASILEIRA DE CIENCIAS

KAVI-ICR
KAVI - Institute of Clinical Research
UNIVERSITY OF NAIROBI

Institute of Primate Research

The Aga Khan University Hospital

Financial support received from

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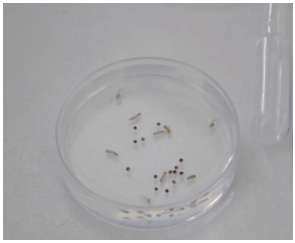
National Commission for Science, Technology and Innovation



Cover Photograph

The cover photograph is one from the practical session of the workshop at KAVI-ICR. It shows frog embryos at different stages of development. It was taken during the experiment conducted by Prof. Fabio Almeida Mendes on “Frog embryos as models for embryonic development and regeneration”.

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Acronyms

AAS	The African Academy of Sciences
CB/RM	Cell Biology/Regenerative Medicine
IAP	The Global Network of Science Academies
INSA	The Indian National Science Academy
IPR	The Institute of Primate Research
iPSCs	inducible Pluripotent Stem Cells
KAVI-ICR	The Kenya AIDS Vaccine Initiative - Institute of Clinical Research
KEMRI	The Kenya Medical Research Institute
KNAS	The Kenya National Academy of Sciences
KNH	The Kenyatta National Hospital
LOC	Local Organising Committee
MSC	Mesenchymal Stem Cells
NACOSTI	The Kenya National Commission for Science, Technology and Innovation
NCDs	Non-Communicable Diseases
SCR	Stem Cell Research
Sida	Swedish International Development Cooperation Agency
ST & I	Science Technology and Innovation
STIAS	Stellenbosch Institute for Advanced Study
TB	Tuberculosis
TWAS-ROSSA	The World Academy of Sciences – Regional Office for sub-Saharan Africa
UoN	University of Nairobi

Acknowledgements

This workshop was organized and convened by the African Academy of Sciences (AAS), the Kenya National Academy of Sciences (KNAS) and the Indian National Science Academy (INSA). It was sponsored by IAP - the Global Network of Science Academies, the National Commission for Science, Technology and Innovation (NACOSTI) and the World Academy of Sciences (TWAS). We express gratitude to Dr. Moses Rugutt, Ag. Chief Executive Officer for NACOSTI for the logistical support, Prof. Henry Thairu, Chair, Commission for University Education for the inaugural address, Prof. Raphael Munavu, Chairman of KNAS for coordinating the funds from IAP; Prof. Solomon Mpoke, the Kenya Medical Research Institute (KEMRI) and Dr. Ngalla Jillani the Institute of Primate Research (IPR) for giving impetus to this project. Special thanks also to Prof. Omu Anzala, KAVI-Institute of Clinical Research, University of Nairobi, for the continued support and provision of well-equipped laboratories for the practical session.

We commend Prof. Dorairajan Balasubramanian (India), Prof. Abdallah Daar (Canada), Prof. Vivaldo Moura-Neto (Brazil), Prof. José Garcia Abreu (Brazil), Prof. Fabio Almeida Mendes (Brazil), Prof. Susan H. Kidson (South Africa), Dr. Anjali Shiras (India), Dr. Hiba BadrEldin Khalil Ahmed (Sudan), Dr. Venant Tchokonte-Nana (South Africa) and Dr. Christoff Pauw (South Africa) for sharing their knowledge and ideas and for the valuable opportunity for mutual co-operation, joint research, student and faculty exchange programs in hstem cell research and regenerative medicine. We thank Prof. Omu Anzala and Dr. Marianne Mureithi of KAVI-Institute of Clinical Research, University of Nairobi for hosting the laboratory demonstrations and outlining the advancement of stem cell research in Kenya. We are also thankful to Dr. Denis Russa for sharing the advances made in translating stem cell research into practice at Muhimbili University, Tanzania, Dr. Michael Ong'echa for his presentation on application and opportunities for stem cell research improvement of human health and Dr. Christine Wasunna for highlighting the need for uniform guidelines for stem cell research in Africa.

We also thank the chairpersons of sessions and all participants for the lively and thought provoking discussions as well as session rapporteurs and the chief rapporteur (Mosab Ali Awad E. Mohammed) for recording of the proceedings of the workshop. We sincerely thank the Local Organizing Committee; Dr. Marianne Mureithi (Chair), Mrs. Noel Abuodha, Dr. Atunga Nyachieo, Dr. Christine Wasunna and the AAS secretariat (Ms. Olivia Osula and Ms. Janet Kariuki) for working tirelessly to deliver a successful workshop.

Berhanu Abegaz
Executive Director, AAS

Executive Summary

On 4th – 6th August 2014, the AAS, KNAS and INSA convened a workshop in Nairobi, Kenya, that marked the beginning of an African-driven and African-focused training aimed at promoting the field of stem cell research and its applications. This initiative provides an opportunity for developing alternative therapies and cure for many disorders and debilitating diseases that have plagued the African continent. The rise in diseases such as cancer, diabetes and hypertension (non-communicable diseases) in Africa poses a threat to human health and a drain on the economies. This warrants new approaches for prevention, diagnosis, treatment and cure of such diseases.

The workshop brought together a community of academicians, researchers, clinicians, and regulators with shared interest in building capacity for stem cell research and regenerative medicine in the continent. This forum also presented an excellent opportunity for networking with a multidisciplinary team of experts from South Africa, Brazil and India. The training and mentoring sessions provided knowledge and skills development in stem cell biology and regenerative medicine to early career African scientists and clinicians. A training program was initiated which will involve resource sharing, capacity development and intramural or extramural collaborations and more importantly foster South-South collaborations.

The meeting also highlighted great training opportunities available in China, South Africa, Brazil and India for the early career African scientists and clinicians. It was recommended that AAS co-ordinates these opportunities and where possible identify and facilitate placements for short or long term training for scientists and clinicians to established laboratories based on mutual interests of the mentor and mentee and the institutional sustainability plans for the capacity development activities. It was also recommended that a follow up workshop be organized next year to assess the progress of established collaborations and training activities and highlight new training and research opportunities.

Workshop Background and Objectives

The field of stem cell research and regenerative medicine is one of the most fascinating areas of cell biology owing to its therapeutic potential. By harnessing the power of stem cells to repair or replace tissues that are damaged by trauma or disease, the promise of regenerative treatments is making its way into the clinics. As our understanding of stem cells advances, we can offer better treatments for some of the world's most devastating diseases. However, much work remains to be done to understand how to use these cells for cell-based therapies to treat diseases.

There has been a major increase in burden of non-communicable diseases (NCDs) such as diabetes, cardiovascular diseases and cancer in Africa thereby creating a strain in the health systems. As Africa grapples with health challenges to keep the momentum of declining infectious diseases and curb NCDs, it is important that the new and emerging knowledge in stem cell science and regenerative medicine be explored to help address the challenges by translating basic research discoveries into relevant, accessible and affordable clinical applications to improve human health.

In order to build capacity for stem cell research and regenerative medicine in Africa, the AAS-led workshop provided a mentor-mentee platform to help the early career scientists and clinicians get state-of-the-art training and build or launch their careers in this science. The lectures featured a wide range of topics covering; defining stem cells and regenerative medicine and their clinical applications, stem cell biology, current status of the field to ethical complexities and regulation of SC/RM-related activities in Africa. Hands-on/demonstrations of the basic techniques of stem cell science and technology were also provided by the experts from India and Brazil.

The objectives of the workshop were:

a. To expand collaboration between and within African countries in stem cell research and regenerative medicine.
b. To reinforce capacity development (knowledge, skills and infrastructure) in stem cell research and regenerative medicine among early career African scholars and their institutions with the partner institutions and experts in India, China, Brazil, South Africa, and China.
c. To establish mentored-research and training projects in stem cell research and regenerative medicine between experts in India, China, Brazil, South Africa and other research and academic in Africa.
d. To create a database for information sharing on stem cell research or regenerative medicine among the participating institutions.

The expected outcomes of the workshop were:

a. Research projects or training programs (MSc level and above) identified and at least six (6) early career scholars selected by the AAS fellows for admission to the program this year, 2014.
b. Locally-based mentors for each of the scholars identified.
c. An action plan for each partnership developed in the course of this year clearly defining what is to be done, where it is to be done, and the timeframe.
d. Tripartite collaboration established between at least two institutions in Africa and one mentoring/training institution in India, China, Brazil or South Africa.
e. A repository of stem cell research or regenerative medicine established at the AAS as soon as the program begins.

The anticipated benefits to the participating scholars and institutions include:

a. Enhancing capacity for regenerative medicine and stem cell biology for clinical translation to improve human health.
b. Fostering partnerships with renowned experts in this field of science and expanding the organization's research portfolio and technology transfer as well as advancing the scholar's career in stem cell science or medicine.
c. Educating local communities and other stakeholders on stem cell research and regenerative medicine as well as the on ethical, legal and social implications of stem cell research.

Resource Persons

The invited speakers and resource persons in this field of science and bioethics were:

- Prof. Dorairajan Balasubramanian from L. V. Prasad Eye Institute, India.
- Prof. José Garcia Abreu from the Institute of Biomedical Sciences, Federal University of Rio de Janeiro, Brazil.
- Prof. Fabio Almeida Mendes from the Institute of Biomedical Sciences, Federal University of Rio de Janeiro, Brazil.
- Dr. Anjali Shiras from the National Centre for Cell Sciences, India.
- Prof. Omu Anzala, KAVI-Institute of Clinical Research at the University of Nairobi, Kenya.
- Prof. Susan H. Kidson, University of Cape Town, South Africa.
- Dr. Venant Tchokonte-Nana, Stellenbosch University, South Africa.
- Dr. Hiba BadrEldin Khalil Ahmed from Al Neelain University, Sudan.
- Dr. Christine Wasunna, Kenya Medical Research Institute, Kenya.
- Dr. Christoff Pauw, Stellenbosch Institute for Advanced Study, South Africa.

Format of the Workshop

The workshop consisted of a series of lectures over two days with a third day devoted to demonstrations and hands on practical work. The mix of plenary and round table discussions offered participants opportunities to interact and learn the current practices and emerging issues in Cell Biology and Regenerative Medicine.

Organization and Participants

The workshop was organised by AAS, KNAS and INSA. It was funded by IAP, TWAS and NACOSTI. The participants were drawn from Ethiopia, Tanzania, Sudan, South Africa, Zimbabwe and Kenya each with diverse expertise and experience.

AAS constituted a local committee to assist in organizing the workshop. The committee comprised representatives from local partner institutions namely KNAS; KAVI-Institute of Clinical Research, University of Nairobi (KAVI-ICR, UoN); KEMRI; IPR and the Aga Khan University Hospital (AKU). The members were:

- Prof. Berhanu Abegaz – Executive Director, African Academy of Sciences.
- Dr. Marianne Mureithi – Lecturer and Senior Program Scientist, Department of Medical Microbiology, School of Medicine University of Nairobi/KAVI-ICR.
- Mrs. Noel Abuodha – Kenya National Academy of Sciences.
- Dr. Atunga Nyachieo – Senior Research Scientist, Institute of Primate Research.
- Dr. Christine Wasunna – Principal Research Scientist, Kenya Medical Research Institute.
- Ms. Olivia Osula – Programmes Assistant, African Academy of Sciences.
- Ms. Janet Kariuki – Executive Assistant, African Academy of Sciences.

The early career scientists and clinicians who participated in the workshop were those involved in or had demonstrated interest in cell biology and regenerative medicine. The following participants were assigned the role of rapporteurs to record the various sessions:

- Chief Rapporteur: Mosab Ali Awad E. Mohammed
- Rapporteurs for Day 1 : Farisai Chidzwondo and Clare Njoki Kimani
- Rapporteurs for Day 2 : Dimakatso Bertha Gumede and Lucy Macharia
- Rapporteurs for Day 3 : Dorcas Wachira and Jafer Kedir Ababora

Opening Remarks and Keynote Address

Prof. Romain Murenzi, Executive Director, TWAS
Read by Prof. Berhanu Abegaz

Prof. Murenzi stated that TWAS attributed great importance to this workshop given the successful outcome of the sensitization workshop that was held in November 2013 on "Capacity Building and Regenerative Medicine". He was happy that AAS, which hosts TWAS-ROSSA, had co-organized the workshop with KNAS and INSA as this reflected the true spirit of South-South cooperation.

He noted that events like this workshop represented corner stones in building science capacity in the south and asked the participants to consider other possible venues for promoting scientific capacity in the region. Participants were informed of the various grants offered by TWAS for students, scholars and research groups and that these could be accessed via the TWAS website, www.twas.org. Prof. Murenzi acknowledged the Government of Italy and Sida for their continued support to TWAS and to the TWAS regional offices activities.

Prof. Berhanu Abegaz, Executive Director, AAS

In his introductory remarks Prof. Abegaz gave a brief background of the workshop. The African Academy of Sciences was established in 1965 by three African scientists. Over the last three years AAS has redefined its mandate particularly with regard to the support it gives its young people. A year ago, AAS took stock and came up with an ambitious strategic plan which entailed three aspects: recognizing excellence; capacity building in areas of major concern to the continent e.g. energy, food security, climate, agriculture and mathematics and putting up a funding platform for AAS. He continued by indicating that the stem cell and regenerative medicine workshop was the brain child of a few TWAS fellows.

He highlighted that stem cell and regenerative medicine are emerging fields with potential for great contributions in the future. There has been great attention in communicable diseases like malaria and HIV and the prevalence and mortality from these diseases is on a decline. The World Health Organization predictions indicate that by 2030, 80% of the disease burden in developing countries will come from non-communicable diseases. He mentioned that the first workshop on stem cell and regenerative medicine was held in November 2013 and that the current workshop was made possible through the support of TWAS, IAP and NACOSTI with the mentors coming from Brazil, South Africa, India and the Republic of Sudan. All invited mentors had indicated strong commitment to supporting stem cell research in Africa. The vision to develop stem cell and regenerative research in Africa is a Pan African initiative.

Prof. Aderemi Kuku, President, AAS
Read by Prof. Berhanu Abegaz

Prof. Kuku considered it a great honour and privilege to send his address to the workshop participants. The workshop was part of a series of AAS capacity building programmes for younger African Scientists in the area of cell biology and regenerative medicine. The motivation for stems cells research and regenerative medicine arose out of a global desire to use frontier technologies to ensure considerable decline in infectious diseases and combat non-communicable diseases such as diabetes, Parkinson's disease, traumatic spinal cord injury, heart disease and vision impairing loss.

Prof. Kuku informed participants that he was aware of the first workshop which had drawn participants from Africa, India, China and Brazil and the presentations made which had highlighted the experience of participants in various aspects of the topics of the workshop. It was clear that the current workshop was a follow-up to the first one. He was delighted to see the presentations that had been slated for the three days. He appreciated the Cabinet Secretary for Education, Science and Technology, Prof. Jacob Kaimenyi's acceptance to give the key-note address at the workshop and recalled the courtesy visit he had paid to Prof. Kaimenyi in June 2014 during which the Cabinet Secretary had promised to interact more closely with AAS. Prof. Kuku had also paid a courtesy call on the Director of KEMRI where he had a fruitful discussion with him and his staff about how to foster closer collaboration between KEMRI and AAS and other African-based institutions. He was happy to note that KEMRI was represented on the Local Organising Committee (LOC) of the workshop and had also produced some speakers and participants.

Prof. Kuku extended special recognition and appreciation to Prof. Balasubramanian who had contributed immensely to the success of both workshops. He recognized the efforts of the AAS Secretariat and the LOC for a job well done and wished all participants a pleasant and productive time at the workshop.

Dr. Moses Rugutt, Ag. Chief Executive Officer, NACOSTI

Dr. Rugutt began by welcoming the workshop participants. He stated the importance of science and technology in spurring growth in developing countries. He mentioned that newly industrialized countries attribute development to science technology and innovation and the ability to invest in it and that ST&I is a bedrock for growth of other sectors of the economy. Kenya has made strides in this regard, for example through institutional reorganizations such as the transition from National Council for Science and Technology (NCST) to NACOSTI through an Act of Parliament and the introduction of two other organs - the National Innovation Agency and the National Research Fund.

The ST&I Act 2012 facilitate the promotion, coordination and regulation of the progress of Science, Technology and Innovation (ST&I) in the country. NACOSTI advises the government on research areas of public interest. It is the lead government agency on all matters relating to scientific and technological activities and research necessary for proper development of the country. Currently NACOSTI funds research to the tune of 5 million dollars and this is set to increase to 2% of the GDP. Kenya is the only country to commit such an amount to ST&I. NACOSTI also has strategic collaborations both in Kenya and abroad for example with South Africa, Germany (German exchange program), and IDRC (nanotechnology , material science). He thanked the AAS for working closely with the Kenya National Academy of Sciences and for organizing the workshop. He emphasized the need for public research institutions to be involved in the global arena. He finally stated that the workshop on stem cell and regenerative medicine was a good platform for interested students to find mentors.

Hon. Prof. Jacob Kaimenyi, Cabinet Secretary, Ministry of Education, Science &Technology
Read by Prof. Henry Thairu, Chair, Commission of University Education

Prof. Thairu gave the keynote address on behalf of Prof. Jacob Kaimenyi, Cabinet Secretary for Education, Science and Technology. He recognized the fact that Stem cell and regenerative medicine research has great promise in that engineered cells can be used to replace injured cells. Stem cells offer new approaches to treating NCDs and their potential is enormous. Basic research findings should be translated into applied science so that stem cells and regenerative medicine can be beneficial to those who need it. He emphasized that the workshop would play a great role of sensitization as well as mentoring young African scientists in stem cell and regenerative medicine in Africa. He stated that the workshops was a unique opportunity for African scholars to learn from and create mentorships with mentors from Brazil, South Africa and Asia and the various African institutions for working together to push this great cause forward. He further mentioned that the government of Kenya is committed to offer support to the AAS to help achieve its mandate.

Prof. Raphael Munavu, Chairman, Kenya National Academy of Sciences

Prof. Munavu stated that the mandate of KNAS is to promote science and technology within and outside Kenya for national development. He explained that Kenya's Vision 2030 recognizes the important role of research and innovation in accelerating economic development in the country. Through the constitution (Article 11) government recognizes the importance of ST&I in development and therefore government shall promote application of science, research and indigenous technology in developing the country. Prof. Munavu referenced Article 43 of the constitution which stipulates that every Kenyan is entitled to the best attainable health care resulting in the devolution of this important service to the county level. He said that capacity development is a critical issue not only in areas where we have gaps but more importantly in emerging areas such as stem cell and regenerative medicine. He envisioned that by the year 2040, Africa will have the largest workforce. An important question in this regard is the quality of this workforce. He explained that in response to this realization, 2% of the GDP (about 70 billion Kenyan shillings) is necessary to ensure training of quality workforce 2040. Prof. Munavu stressed that it is important to invest in training, mentorship and adopt good practices in stem cell science and regenerative medicine. He concluded that Africa is well placed to provide leadership in ensuring quality health services, lifestyle and in indigenous technology. He reaffirmed that KNAS will continue to work closely with AAS to move this field of research forward.

Prof. Balasubramanian, Director of Research, L.V. Prasad Eye Institute on behalf of the Indian National Science Academy (INSA)

Prof. Balasubramanian explained that the idea to promote stem cell research in Africa came about in a TWAS meeting in China. He mentioned that international collaborations with a number of countries allowing for mentorship and travel to workshops have been productive in the field of physics, mathematics and regenerative medicine and can be applied in this initiative. He clarified that while stem cell technology is cell-based, regenerative medicine involves application of a different array of technologies. He pointed out that over the last five years rapid strides have been made in stem cell research such that any somatic cell can be converted into a stem cell directed at a particular lineage. He finally emphasized the importance of having standardized guidelines for stem cell research similar to guidelines in India, Japan and England which need to be developed under the leadership of AAS and KNAS. He thanked the AAS for organizing the workshop.

Prof. Solomon Mpoke, Director, Kenya Medical Research Institute Read by Dr. Christine Wasunna

Dr. Christine Wasunna delivered the message from Prof. Solomon Mpoke who expressed KEMRI's commitment to building on its excellent biomedical research capacity by exploring new research and development (R & D) opportunities like stem cell research

and regenerative medicine. The accredited laboratories across the various centres of excellence at KEMRI, provided great potential for training and mentoring upcoming scientists.

Prof. Mpoke envisaged the workshop and future capacity development program as an opportunity to integrate information, technologies and skills from biological sciences as well as legal and ethical disciplines so as to prepare the trainees as they embarked on their academic or research journeys. He commended the African Academy of Sciences and partner institutions, particularly KEMRI, for hosting and preparing for the workshop. In his message, Prof. Mpoke concluded that KEMRI has vibrant research programs, access to ultramodern facilities and an excellent scientific community through which the early career scientists and clinicians could be supervised, mentored and trained. He looked forward to the opportunities for new partnerships in the field of stem cell science and regenerative medicine.

Dr. Ngalla Jillani, Director, Institute of Primate Research

Dr. Jillani, of Institute of Primate Research (IPR) introduced IPR as a primate research centre of excellence in biomedical research. He stated that the workshop was a great initiative with great potential in changing the provision of healthcare. He further stated that IPR is on a journey to restructure its ways of conducting research so that it can carry out its research mandate more effectively ensuring that all research questions are adequately answered and accommodate a newly upcoming stem cell research group. The Institute has
earmarked diabetes, neurobiology and reproductive health towards realizing a vibrant Stem Cell and Regenerative Medicine Research Group with Dr. Atunga Nyachieo spearheading this initiative. He gave a commitment to support this initiative and concluded by inviting anyone interested in conducting stem cell and regenerative medicine research to IPR.

Overview of the workshop
Dr. Marianne Mureithi: Chair, Local Organizing Committee (LOC)

Dr. Mureithi outlined the workshop activities including a series of lectures, round table discussions, laboratory demonstrations facilitated by experts from Brazil and India and an evaluation of the meeting.

L-R: Prof. Henry Thairu, Chair, Commission of University Education; Prof. Raphael Munavu, Chairman, Kenya National Academy of Sciences; Dr. Ngalla Jillani, Director, Institute of Primate Research; Dr. Moses Rugutt, Ag. Chief Executive Officer, NACOSTI.

Session 1
Chair: Prof. Dorairajan Balasubramanian

Stem cell Research in Kenya
Prof. Omu Anzala (Presented by Dr. Marianne Mureithi)

Stem cells were defined as cells that have the ability to continually divide and differentiate into other cell types and that there are several types of stem cells which include; totipotent stem cells can develop in a new individual, pluripotent ones can form over 200 cell types, multipotent are differentiated cells that can form other cell types. Adult stem cells are undifferentiated cells found among specialized or differentiated cells in a tissue or organ. These include neural stem cells in the brain, dental pulp stem cells in teeth, hematopoetic and mesenchymal stem cells in the bone marrow and testicular stem cells. Adult stem cells have potential applications in the treatment of stroke, blindness, diabetes mellitus, genetic bone marrow disease, prostate diseases, kidney cancer, Alzheimer's disease and Parkinson's disease.

The presentation highlighted the proposed initiative of KAVI-ICR stem cell research platform on the establishment of assays for culture and manipulation of hematopoetic stem cells from cord blood. Cord blood is rich in stem cells (adult stem cells of infant origin). It is a less invasive approach than bone marrow or peripheral blood. It also provides for greater compatibility and is less expensive. The aims of this project include: a) Feasibility to obtain umbilical cord blood, b) Establish assays for isolation of stem cells c) Establish assays and systems for culture and manipulation of hematopoietic stem cells; d) Initiate long term research projects using cord stem cells in understanding most prevalent cancers in Kenya, diabetes and burns; d) Initiate long term projects using cord blood for HIV treatment.

The methodology will entail: Identification of potential volunteers attending Kenyatta National Hospital and Pumwani Maternity Hospital; Ethical review KNH/UoN ethical and research review committee. Other projects in the pipeline include: Extracted stem cells converted into induced pluripotent stem cells and reconverted to T cells to attack cancer and HIV; Study of tumoral stem cells from glioblastoma and medulloblastoma; Contributions to diagnostics and therapy; Skin regeneration following burns and adipose tissue and regenerative therapy.

Translating stem cell research in Africa into therapy: a Muhimbili experience
Dr. Denis A. Russa

Various cell isolation and manipulation techniques have been conducted at Muhimbili University. Methods in cell manipulation include cell culture, antibody and fluorophore

staining, immunocytochemistry and fluorescent imaging. Novel findings include anti-cancer suppression of Ca^{2+} metabolism, inhibition of Ca^{2+} metabolism during mitosis and elucidation of Ca^{2+} spark/burp signals in different cells though their significance is yet to be determined. Planned therapeutic projects include: Determination marking and reactivation of programmed pancreatic beta stem cells among type 1 and type 2 diabetic patients; Determination marking and reactivation of hepatoactive stem cells for liver cirrhosis patients; Stem cell therapy for albino patients and Stem cell therapy for treatment of hair loss. The question is 'where is the stem cell agenda in the pecking order?' More priority has traditionally been given to infectious diseases. Other challenges include: logistical support (culture media procuring), stable power supply and personnel support. The way forward includes advocacy (policy, funding) increase expertise (technicians, post docs), universities to train BSc (basic and clinical) in biotech and bioengineering, dedicated centres (clinical trial centres, laboratories, quality control centres) and regional block initiatives.

Session 2

Chair: Prof. Susan Kidson

Stem cell research and clinical applications in India
Prof. Dorairajan Balasubramanian

Basic science defines what stem cells are and how to obtain them. There are currently 15 laboratories in India that are well versed in stem cell research from dental pulp stem cells, bone marrow (hematopoietic and mesenchymal). Only less than five however take stem cell therapy to the patient. Bone marrow derived stem cells have been in use for a long time. Some take bone marrow and separate hematopoietic stem cells from mesenchymal stem cells and culture these separately. Mesenchymal stem cells are used in cases of cardiomyocitis e.g. myocardial infarct patients. Survival rate is about 65%. For hematopoietic stem cells the survival rate is about 72%. The disconnect between scientists and clinicians must be addressed so that progress can be achieved. Limbus stores stem cells that get trans-differentiated into corneal epithelial cells. Survival rate is at 72%. This procedure can be performed directly on the patient.

Regenerative medicine- gene repair inside the cell: in a patient with a monogenetic disorder for example, can be treated by taking the wild type gene package in an appropriate vehicle and introducing it into the cell. This has happened in three cases. In the case of a recessive situation (two mutated genes/ autosomal recessive situation) treatment can be through cell delivery methods. Is delivery of a gene through nanoparticles possible? Current tools to edit a mutated gene involve use of enzymes that include: Zinc finger nucleases – a particular set of proteins that bind to a mutated gene and then add the appropriate gene recombination; Transcription activator-like effector nucleases (TALENS)- found in a variety of ancient bacteria they target the region around the mutation, Have a recognition area and a killing area, and then do a recombination with the appropriate gene; finally the CRISPER- Correction of a genetic disease by a CRISPER. This technology requires a simple cell biology laboratory. Correcting a gene for generations is possible.

Induced pluripotent stem cells: Challenges and opportunities
Dr. Anjali Shiras

The Nobel Prize in 2012 was received by S. Yamanaka and J. Gurdon for their discovery of the phenomena of Cellular Reprogramming. A process whereby adult somatic cells can be converted to an embryonic stem cell-like state known as Induced Pluripotent Stem Cells (iPSCs). In this way a somatic cell such as a skin fibroblast can be induced to become a pluripotent stem cell. This stem cell can now be made to differentiate into all three germ layers of the embryo known as ectoderm, mesoderm or endoderm.

Examples of ectoderm cells are fibroblasts, keratinocytes, melanocytes and neural stem cells. Examples of mesoderm cells are umbilical cord mesenchymal cells and peripheral blood mononuclear cells. Examples of endoderm cells are liver cells, stomach cells, dental pulp cells and pancreatic beta cells. Cellular reprogramming is the reversion of differentiated cells into an undifferentiated state of pluripotency.

Reprogramming of adult somatic cells can be done by use of: 1.Use of transcription factors; 2. Somatic cell nuclear transfer (SCNT). The generated iPSCs are good models for use in disease modelling, regenerative medicine, gene correction and therapy, drug screening, understanding the mechanism of cellular reprogramming and personalized medicine.

As there are no good animal models for understanding biology of neurodegenerative diseases such as Parkinson's disease and Alzheimer's disease, a cell line can be developed using iPSCs generated from the skin of a patient who is suffering from this disease to mimic what actually may be occurring in the patient. Such cell lines circumvent cross-species differences and allow for high throughput screening. Induced pluripotent stem cells (hiPSCs) have a great potential for generating organs that are difficult to regenerate such as lungs for the treatment of chronic lung diseases. There are very few clinical trials using iPSCs to date. Japan has a stock of 75 iPS cell lines from homologous HLA donors (allogenic banking).

Wnt/beta- Catenin signalling in development and diseases
Prof. Jose Garcia Abreu

Stem cells were discovered through developmental biology showing the need to review basic science first. How does a single cell develop into a whole organism? A ball of cells, which all look the same BUT are different lead to positional axis, then to tissues and finally a whole organism. Information on position is obtained from morphogen gradients. The "Organizer Effect" was discovered in the Spermann and Mangold Experiment of 1924. One given tissue can give rise to many other tissues depending on where it is transplanted to e.g. a hair from one embryo into another embryo can lead to two tissues of each. The cell therefore obeys signals and arrangement of signals will result in different types of cells. The Wnt signaling pathway is responsible for development e.g. double axis, for regeneration e.g. a fin of a fish and cancer e.g. stomach cancer. The Wnt signaling pathway operates on a homeostasis. Experiments are looking for functional mutations i.e. focusing on morphology, gene and function.

Introducing STIAS: A creative space for the mind in Africa
Dr. Chrisoff Pauw

Dr. Pauw opened the discussion by explaining that an Institute for Advanced Study (IAS) is an established tradition in the North e.g. IAS located in Princeton, New Jersey and USA. IASs are centres generally established to encourage and support creative/

innovative thinking to advance knowledge in the way we understand the world through contributions in the fields of science and humanities. Typically, IAS's host research fellows to give them an opportunity to advance in their field of research for a fixed or variable fellowship period. It is a cross-disciplinary, diverse engagement that facilitates cutting-edge research for achieving excellence in any field.

Dr. Pauw said that Stellenbosch Institute for Advanced Study (STIAS)- "a creative space for the mind" was conceived in 1999 and founded in 2005 to nurture and encourage renowned researchers and intellectual leaders to develop innovative and sustainable solutions to real-life problems facing the world and in particular, Africa. Dr. Pauw reiterated that STIAS has a firm belief in Africa's potential as a producer of new knowledge and not just a consumer. He further stated that the main objectives of STIAS are: (1) African-centred, including providing opportunities for young talent (2) to advance the cause of science and commitment to the highest standards of scholarship through a competitive scholarship program (3) to serve as an intellectual hub and (4) to provide an independent environment where innovative ideas and original thinking can prosper.

Why an IAS for Africa? Dr. Pauw answered that it is time to advance research excellence in Africa. Africa has developmental challenges such as poverty, health problems and high population growth and needs to balance economic growth and human development. This requires a special kind of institution where constraints can be removed. One of its long term research themes is Health in Transition. Health presents global challenges especially in Africa for example, interaction between impacts of HIV/AIDS with growing epidemics of chronic disease, need for balance between prevention and care and treatment.

To date, STIAS has hosted over 350 fellows and caters for all disciplines and advocates for cross-pollination of ideas.

Session 3

Chair: Prof. Jose Garcia Abreu

Basic principles of successful therapeutic stem cell trial
Dr. Hiba BadrEldin Khalil Ahmed

The basic principles of a successful therapeutic stem cell trial were outlined based on a study on "Repairing of Knee Articular Cartilage Injury Using Mesenchymal Stem Cells." These principles were: Select /Define your disease e.g. osteoarthritis/ degenerative arthritis; Determine disease severity e.g. Grade I to IV; study anatomical structure and cell function of target tissues; avoid risk factors of other treatment options; determine your aims; Select your patients; in designing protocols, define baseline and have back-up; record every observation and get a strong team for success

Use of neural crest stem cells for treatment of corneal blinding disease
Prof. Susan H. Kidson

There are a number of blinding diseases in Africa and of these the cornea can potentially be repaired. In corneal opacity, light cannot penetrate. The structure of the cells and how the molecules are arranged is important. If the corneal epithelium is damaged, stem cells in the limbal niche proliferate and repopulate. The stroma contains collagens and various GAGs in a very ordered arrangement and if this changes a bit it can lead to opacity. Stromal oedema disrupts collagen organization and leads to opacity. The corneal endothelium is important. Its cells are arranged in a honeycomb pattern and are connected by tight and adherens junctions. Pump-leak mechanism is used. As we grow older, we lose the corneal endothelium it increases in size with age but cannot regenerate. Corneal grafting presents a challenge due to the shortage of donors and inadequate expertise. The growth of the corneal endothelium is difficult and the cells are arrested at G1. There is thus a need for a source of stem cells that can be transformed into corneal endothelial cells. The lens induces corneal development. Cells closest to lens transform from mesenchymal cells to endothelium. Can corneal stromal cells be a source of corneal endothelium?

Biotechnology-Based technologies and opportunities in stem cell research for health
Dr. Michael Ong'echa

iPSCs are produced by reprogramming somatic cells to express genes that are essential in maintaining the properties of embryonic stem cells. Pluripotent stem cells can be generated through fertilization, nuclear transfer, cell fusion and use defined transcription factors. Applications of iPSCs include modelling monogenic and multigenic disease, autologous cell therapy, study of complex genetic traits and basic research. In the use of iPSCs to treat genetic disease, there are several approaches that could be used in profiling the diseased populations: 1) Candidate gene approach; variation within a specific gene and their implications on expression and its role in disease outcomes: 2) Genome wide association study (GWAS); scanning of genetic markers across the entire genome of many individuals to identify genetic variation associated with particular disease outcomes: 3) Whole genome sequencing (WGS); full genome sequencing provides raw data of all the bases in an individual's DNA to analyse and detect all disease-related genetic variants. The current exponential progress in low-cost next-generation sequencing technologies is opening opportunities of new genomics, epigenomics, transcriptomics and proteomics technologies, with the potential of targeting individual cells. Exploitation of the "omics" networks in profiling normal, pathological, and reprogrammed cells will be critical in the application of iPSCs in stem cell research and regenerative medicine. Understanding the stem cells systems informatics and applying the systems biology approach to the "omics" data will likely fasten the application of stem cell therapies in managing different human pathophysiological conditions.

Session 4:

Series of Lectures and Hands-on Experiments

Chair: Dr. Ngalla Jillani

The regenerative capacity of pancreatic duct ligated tissues: implication for islet cell therapy
Dr. Venant Tchokonte-Nana

He has 3 students, 2 PhDs and 1 MSc student. His research is funded by the NRF & SACORE. In diabetes β cells are lost and there is lack of pancreas donors; therefore, the study focuses on islet neogenesis as a new source of donor pancreas. The experiments involve pancreatic duct ligation in Wistar rats, which causes destruction of acinar compartments of the pancreas after 6 hours; however islet portion of the pancreas continues to survive and there is a total recovery of the acinar compartments with formation of new islets - neogenesis. The research question asked was whether PDL can be used as therapy. Experiments were carried out for 120 hours to determine whether post ligation expression signaling was activated. At 84 hours it was found that islet cell morphology was well formed. At 72 hours, insulin expression index was measured. In Wistar rats that were STZ –induced showed decreased blood glucose levels. The rats also showed regeneration of islet cells. At 120 hours Ngn3+ was expressed in adipose tissue. It was noted that despite new β cell formation the animals remained diabetic and it was suggested that if the time was increased to measure the effect there might be changes. Dr. Tchokonte-Nana also indicated that there's a need to confirm the origin of new β cells. There's also a need to map gene expression in a recovering pancreas. During duct ligation it was noted that there were still pre-existing islet cells present and that the duct cells (centroacinar) may be the ones producing the newly formed islet cells, which can be produced by co-culture of pre-existing islet cell with mesenchymal cells. Major optimization of MSC separation technique was necessary in this model. Dr. Tchokonte-Nana reported that the MSCs did not adhere with the use of the original protocol. The protocol was optimized by trypsinising after collagenase treatment.

Setting up and running a stem cell laboratory
Prof. Susan H. Kidson

Prof. Kidson conducted a group discussion on the major requirements and hurdles of starting a stem cell laboratory. Some of the points discussed were: Training, Lack of expertise, Ethical issues and Patient expectation. Prof. Kidson stated that before any laboratory start can be made there needs to be a research question. The researcher must focus on one question. A researcher needs to have a team and people who will join to answer more questions from the primary question. It was further suggested that it is important to collaborate and recognize the person who brings input. Other suggestions raised were: Mentors must go to institutions where their mentees reside to help with establishing the training received by the mentee; Encourage collaboration by sharing of ideas and facilities; There is also a need to translate basic science to clinical science, and to regulate the ethical burden of applying for stem cell treatment; Keep sharing ideas despite the challenges that come with that.

Frog embryos as models for embryonic development and regeneration
Prof. Fabio Almeida Mendes

The laboratory in Federal University of Rio de Janeiro uses Xenopus laevis as a model to study cell communication. This model can also be used to study genetic diseases and embryonic mal formations. The laboratory focuses on Wnt/β-catenin signalling pathway. The study uses xenopus frog eggs which are squeezed out of the female after hormone stimulation and fertilized in vitro. Once fertilization has taken place the eggs change and are no longer ES cells after the 8^{th} cleavage. The dorsal lip of the blastophore is called the organizer because it moves cells around to their appropriate developmental positions. Wnt signalling switches on gene expression and works together with BMP signalling to form the dorso-ventral and anterior-posterior axis. When dorsal genes are injected elsewhere they change the cell fate increasing head and nervous system territories. These signalling pathways become again important during tissue regeneration. TGF-β signalling is activated in early steps of tadpole tail regeneration. Regeneration also seems to require apoptosis since caspase 3 inhibition blocks regeneration. The laboratory also works with natural compounds that can activate or inhibit Wnt signalling pathways. Recently we showed the mechanism by which Flavonoids can modulate Wnt signalling pathway.

Generation, handling and maintenance of induced pluripotent stem cells
Dr. Anjali Shiras

During reprogramming of somatic cells to induced pluripotent stem cells, the c-myc oncogene is one of the reprogramming factors that open up the chromatin. The Klf4 factor inhibits apoptosis and senescence during reprogramming. Direct cell reprogramming can be performed using specific factors and non-viral plasmid and vector-free processes. In this study Ginir-RNA (Lentivirus/Piggy-Bac construct) was used to reprogram somatic cells. Colonies appeared 21 days after infection.

Session 5: Laboratory Visit

Chair: Dr. Venant Tchokonte-Nana

This session took place at KAVI-ICR centre. The mentees observed the QiaSymphony which is a high throughput DNA/RNA machine which is operation during continuous loading. It has magnetic beads and is used a stand-alone machine. The laboratory also has a rotor-gene machine which is used for analysis of viral DNA. It is used to give a positive or negative analysis of high risks only. The vaccine laboratory is also used as a safety test laboratory for clinical trials, HIV, Hep-B and Hep-C. Other tests performed in the vaccine laboratory analysis of biopsies for enzyme digest assays, FACS and ELISPOT for interferon-γ.

Practical session feedback
Lab practical session 1: Characterization of stem cells and cancer stem cells
Dr. Anjali Shiras

The laboratory report was presented by one mentee as follows: We defined the different potencies of stem cells (totipotency, pluripotency, multipotency & unipotency). Cancer stem cells were also defined as cells that continuously proliferate and that push cancer cells to continual growth as well as being resistant to chemotherapy. Different cell types from normal fibroblasts, mouse embryonic fibroblasts, human dermal fibroblasts, cancer cells and endothelial cells were studied under the light microscope. We were also discussed the steps of iPSC formation and went through the protocol of how to prepare inactivated mouse embryonic fibroblasts to use as feeder cells for iPSCs. We also discussed ES markers that are checked in iPS cells for characterization. The reprogramming protocol was also discussed which included how to maintain iPSCs. The importance of feeder cells for the survival and growth of iPSC.

Lab practical session 2: Frog embryos as models for embryonic development and regeneration
Prof. Fabio Almeida Mendes

The laboratory report was presented by one mentee as follows: This session started with identifying embryonic stages of the frog as well as the different phenotypes after manipulation to observe regeneration. The eggs were placed in a BATH buffer solution to enhance the different stages of development. The blastula with all the germ layers were present. It was also mentioned that the lithium chloride treatment favours dorsalisaion while UV treatment favours ventralisation. All the abnormal phenotype were graded using the dorso-anterior index. Embryonic regeneration of tadpole tail was also identified at day 0, day 3 and day 7.

Session 6:

Presentations from Mentees
Chair: Dr. Hiba BadrEldin Khalil Ahmed and Dr. Atunga Nyachieo

Ms. Dimakatso B. Gumede, University of Cape Town
Determining the role of a FAM111B mutation in Hereditary Fibrosing Poikiloderma using induced pluripotent stem cells

Hereditary Fibrosing Poikiloderma is an inherited condition affecting multiple organs and the pathology includes poikiloderma, fatty infiltration in skeletal muscle tendon contracture and fibrosis. The project involved reprogramming human dermal fibroblast into iPSCs for the first month then the next nine months involved the passaging, characterization and selection of stable colonies from which: Pluripotent markers of derived iPSCs expression were established, in vitro differentiation of iPSCs for the expression of endoderm, mesoderm and ectoderm markers was performed. We also demonstrated that the established iPSCs cultured in feeder free environment had normal Karyotype. Future work will involve investigating if differentiated cells express fibroblast markers i.e. CD10, CD 37. The iPSC-derived fibroblasts will be trans-differentiate into myofibroblasts to determine fibrogenesis through the activation and expression of fibrotic markers (i.e. α-SMA; TGF-βRI; fibronectin,COL1A1, COL3A1;CTGF).

Dr. Farisai Chidzwondo, University of Zimbabwe
Regenerative medicine in treatment of burns: "Setting the stage for unlocking the potential of skin stem cells in the treatment of burn wounds in children"

The proposal aimed at setting the stage for unlocking the potential in skin stem cells in the treatment of burns in children. The presenter outlined the project by explaining the challenges that have to be overcome before a new technology can be adopted. The presentation started off with an illustration of how skin stem cells can play a role in wound healing from burn injury. After explaining the science behind the project, the presenter then pointed out the need to acquire equipment and to develop protocols. As Zimbabwe does not have regulations that cover regenerative medicine, the presenter emphasized the need for navigating the regulatory and policy environment as accessing patients would require clearance. The presentation ended up with the identification of potential funders and setting up of key milestones to track the progress of the project.

The presenter was advised to start small by acquiring a tissue culture facility. Prof. Susan Kidson (University of Cape Town) pledged to assist with some culture cell lines provided there is laboratory infrastructure to support tissue culture.

Dr. Jafer Kedir Ababora, Department of Ophthalmology, Jimma University
The need and promise of stem cell regenerative medicine in treatment of blinding ocular surface diseases

Dr. Jafer emphasized that the area of ophthalmology is in urgent need of stem cell technology. There are 39 million blind people in the world (prevalence: 0.3% - 1.6%) with 80% of them in the developing countries. It is estimated that 80% of this blindness can either be prevented or treated. The Major Causes of blindness in the developing countries are: cataract, corneal scarring, glaucoma and retinal diseases. The major causes of corneal scarring in the developing countries include trachoma, onchocerciasis, trauma, infectious corneal ulcers and vitamin A deficiency. In Ethiopia, the commonest causes of blindness are cataract = 49.9% and Corneal scar = 19.3%.

Most causes of corneal blindness need surgery which ranges from simple epithelial debridement to total corneal replacement (transplantation). Corneal transplantation is the most successful & the most commonly performed solid organ transplantation in the human body. However, it has several drawbacks which include: rejection - due to introduction of foreign tissue; infection - due to poor immunity, avascularity, stitch related; poor wound healing and integrity; need of long term steroids with its complications ; need of epithelialization by the host limbal cells; need of deceased human donor and the need of an eye bank . In order to overcome these drawbacks and complement corneal transplantation surgeries, limbal stem cell transplantation is urgently required especially for complicated vascularized corneal scars.

There are various types of limbal stem cells which can be derived from different tissues that can be utilized for such cases. Excision of segments of limbal tissue from contralateral eye and transplantation to diseased limbus (autograft); Tissue retrieval from cadaver and transplantation (allograft); Tissue retrieval from living related donor and transplantation (allograft). The current concept of ex-vivo cultivation of sheets of epithelium from few limbal stem cells (tissue bioengineering) is very promising as a source of tissue for transplantation.

Ms. Lucy Macharia, KAVI-Institute of Clinical Research/University of Nairobi
Stem cells in cancer research

Ms. Macharia began her presentation by highlighting her Masters work on the Cancer Burden in Kenya. Cancer is a major non-communicable disease (NCD) and non-communicable diseases are estimated to account for over 60% of total mortality every year and 28% of all deaths in Kenya. The disease continues to receive low public health priority in Kenya, largely because of limited resources and other pressing public health problems, including communicable diseases such as HIV/AIDs, malaria, and tuberculosis. Her research objective was to determine the types of cancer associated with infectious agents at Kenyatta National Hospital and Moi Teaching and Referral Hospital (the largest referral hospitals in Kenya). She projected the common types of cancers in

both hospitals and even those associated with infectious agents which were findings from her research work. She emphasized that strategies to increase the use of preventive measures such as increased awareness, vaccination, early and regular screening and treatment should be enforced in the context of limited resources as majority of these cancers can be prevented.

Cancer stem cells (CSC) is a biologically unique population of cells that is responsible for tumor initiation, progression, metastasis and relapse. CSC targeted cancer therapy may lead to tumor degeneration. She then proposed her next project which was going to be part of her PhD studies in researching Glioblastomas and Medulloblastomas and how to isolate Cancer Stem Cells from these two types of cancers and differentiate the Cancer Stem Cells into different cells to try and eliminate them with drugs and try to control the cancer with suppressor genes. The gliomas (Type of Brain Cancer) can be graded as types I to IV with type IV being the most aggressive, which results in death within 15 months of diagnosis. A solid tumour exists but it is always associated with loose cancerous cells around it that are difficult to eradicate because the properties of the normal and cancerous cells are very similar. Tumors of the central nervous system (CNS) often display a significant histopathological heterogeneity. GBM is one of the most aggressive incurable human cancers with an average survival of about one year. Despite recent advances in cancer biology, treatment outcomes have not changed significantly over the past decade and high-grade gliomas remain fatal. The HypoxamiRs, a class of miRNAs showing increased expression in hypoxia, have important roles in Tumoral Stem Cells (TSCs), making these cells new therapeutic targets to diagnose aggressiveness and control tumor proliferation. The study will hopefully be done from Federal University of Rio de Janeiro, Institute of Biomedical Sciences and part of it will also be done in the Instituto Estadual do Cérebro Paulo Niemeyer (IECP), a public hospital which is a major center for translational research, with 1000 selective neurosurgeries performed every year and a well-equipped laboratory headed by Prof. Vivaldo Moura-Neto who majors in brain-related diseases research. Ms. Macharia will then use the skills learnt in Brazil with reference to stem cell and regenerative medicine and transfer the same to Kenya.

Ms. Clare Njoki Kimani, Institute of Primate Research (IPR)
Antidiabetic plants and islet regeneration in experimental diabetes

The prevalence of diabetes mellitus is increasing throughout the world, particularly in the developing world, along with the associated morbidity and mortality. Current insulin and drug therapies control diabetes but do not cure it. Different

approaches are thus being studied in order to circumvent these shortcomings. One is the identification of novel antidiabetic agents from plant sources. There has also been great interest in approaches to replace insulin producing β-cells in diabetic patients. Though there has been success with islet transplantation technologies, this has been limited by a shortage in the number of donor islet tissues. Stem cells are potential sources for β-cell replacement and thus a permanent cure for diabetes and merit further scientific investigation.

Pancreatic stem cells have been implicated not only in pancreas development in the embryo, but also in the regeneration of the pancreas in response to experimentally induced injuries such as pancreatectomy, duct ligation, streptozotocin and caerulein. Fundamental processes in determining the differentiation pathways of stem cells, their safety and efficacy remain to be elucidated. In order to better gauge the therapeutic potential of stem cells, much basic research and animal model testing is crucial. Ms. Kimani's current interest is on the use of alternative remedies for treatment of diabetes mellitus and the extent to which they affect the proliferation or regeneration of β-cells of the islets of Langerhans. Diabetic rats treated with plant extracts showed apparent normalization of the pancreatic architecture as well as an increase in the number of normal islets of Langerhans. Immediate efforts are directed at studies to identify whether this is a function of proliferation of remnant functioning β-cells or whether it is due to stem cell differentiation, cell fusion or trans-differentiation.

Ms. Dorcas Wachira, Kenya Medical Research Institute (KEMRI)
Functional consequences and gene expression patterns during singular and concurrent application of IL-21 and Rapamycin on Tumor Antigen specific T cells in vitro and in vivo

The work sought to find out if rapamycin and IL-21 will augment immunotherapies against cancer by conferring stemness to antigen specific tumor reactive T cells using experimental animal model. The Tscm subset can provide a continuous reservoir for generating peptide specific tumor-reactive T cells that would eliminate a given tumor. The presenters objective was to arrest T cell differentiation at the Tscm cell stage and expand these cell types through singular and concurrent application of IL-21 and rapamycin in vitro. Additionally, she proposed to evaluate the functional consequences of singular and concurrent application of IL-21 and rapamycin towards tumors in vivo and to quantify and compare the metabolic genes expressed during singular and concurrent application of IL-21 and rapamycin using Illumina sequencing of cDNA libraries generated.

Feedback from Mentors

Chair: Prof. Berhanu Abegaz

Overview by Prof. Berhanu Abegaz

Prof. Abegaz emphasized that the training aimed at focusing on a few committed mentees to develop capacity in stem cell science. For this to be successful, he recommend that there has to be institutional arrangement with AAS (partnership) and enhance sustainability with linkages in China, Brazil, India and African academies.

Remarks by Prof. Dorairajan Balasubramanian

Prof. Balasubramanian emphasized on High level institutions to offer mentorship and that inter institutions and inter countries to seek funding together. The mentees were urged to start with basic and translational research and applications and that there should be replicability of applications where applicable e.g. SOPs, conditions of inclusion and exclusion (same methodologies in the world). Continental based approach to the research would lead to ground breaking work and for this to occur, research in stem cell and regenerative medicine should start by use of animal models. He also highlighted, when considering using humans, the 1st principle to be considered should be clearance of ethical guidelines and therefore the need for institutional stem cell research committee to regulate stem cell research. Lastly he recommended that the mentor-mentee relationship be maintained.

Remarks by Dr. Anjali Shiras

Dr. Shiras remarked that expectations in mentors' institutions should be made clear before the mentees are placed in the institutions and that support to mentees in their host institutions should be paramount.

Remarks by Prof. José Garcia Abreu
Prof. Abreu stated that it is important to discuss current problems in biology and spread courses to young scientists on how to manage emerging diseases. He also urged mentees to get in contact with established institutions in Brazil by networking.

Prof. Fabio Almeida Mendes

Prof. Mendes advised mentees to connect stem cell research with other fields and the mentorship program should include more clinicians because of the applications e.g. dermatologists, plastic surgeons, oncologists.

Dr. Venant Tchokonote-Nana, Stellenbosch University

Dr. Tchokonote-Nana emphasized that it is possible to attain goals with whatever is available and that it is important to develop proper networking in the field of specialization/interest. Countries can collaborate in sharing core facilities like laboratory equipment to lower costs.

Prof. Susan Kidson, University of Cape Town

Prof. Kidson suggested that the workshop should run a bit longer to allow mentees have a hands on experience and noted that majority of students at University of Cape Town are African students and they struggle when they go back to their home institutions due to lack of infrastructure. She advised that it is important to network and broaden the expertise and that the mentorship continue for years till the research group is established.

Dr. Christoff Pauw (STIAS/ Stellenbosch University)

Dr. Pauw highlighted that collaborations are the key ingredients of science by creating linkages of scholars among countries and that no African country should be isolated or marginalized. For institutional development, scientists should seek to identify senior scholars to be linked to STIAS to develop themes for upcoming scientists.

Dr.Hiba BadrEldin Khalil Ahmed Alneelain University-Sudan

Dr. Ahmed made a recommendation to have an African Society of Stem cells and include more African and International mentors. She further added the need to find out academic and institutional support on stem cells and to establish local stem cell centres in countries. Finally all projects need to be defined as per the need and apply basic techniques and protocols of stem cell research.

Dr. Ngalla Jillani, Director IPR

Dr. Jillani spoke on behalf of participating institutions and suggested that having multi-institutional/multi-laboratory interactions is the best way to go as it takes care of various specialties. He advised that mentees should get the ideas first and then seek funding and that IPR will be open for mentees to actualize their thoughts and findings in pre-clinical research.

Round Table Discussions

Chair: Dr. Christoff Pauw

Ethical and Regulatory Issues in Stem Cell Research

Dr. Pauw set the discussion by describing the three normative systems of ethics (a) Deontological ethics (acting from duty): do your actions adhere to a set of moral values? (b)Teleological ethics (acting according to consequences): do my actions lead to beneficial and non-harmful consequences? And (c) Virtue ethics (moral perfection): what do my decisions and actions say about me?

The introduction was followed by airing a YouTube video titled "The Ethical Questions of Stem Cell Research" which was published on 18th October 2012. Here, Johns Hopkins bioethicists, Debra Mathews and Jeremy Sugarman, discuss the issues behind human embryonic stem cell research. They posed the questions: What's the right thing to do? What's the appropriate way of going about it? The bioethicists pointed out that the fierce debates are about the morality of destroying human embryos. They cautioned that researchers involved in stem cell research and treatment should be aware of the issues or areas of concern and therefore pursue their research endeavors in an ethically appropriate manner.

Following this broadcast, Dr. Wasunna stated that because stem cells are capable of dividing and regenerating for long periods of time (essentially immortal) and the fact that they are unspecialized, they have revolutionized treatment for conditions caused by cellular degeneration. She explained that there is need to address the tension between the duty to respect the value of human life and the duty to prevent or alleviate suffering. Dr. Wasunna further clarified that stem cell research should be conducted in accordance with the "benchmarks for ethical research" as described by EJ Emmanuel et al in 2004 and also addressing issues of benefit sharing, access to successful treatments and sound translation from bench to bedside.

She explained that it was important for African countries to enact legislation that govern this field of science. Where there is no policy or regulations, both researchers and institutions should borrow from existing guidelines such as National Guidelines for Stem Cell Research by the Indian Council of Medical Research (2013); the National Academies' Guidelines for Human Embryonic Stem Cell Research (2005) and the International Society for Stem Cell Research: Guidelines for the Conduct of Human Embryonic Stem Cell Research (2006).

Brazil has legislation that permits stem cell research using excess in vitro fertilized embryos that have been frozen for a minimum of three years. India has formal guidelines

for stem cell research that was released in 2013. In South Africa, the National Health Act, Chapter 8, of 2012 allows stem cell research for therapeutic purposes and gives permission for research on embryos not older than 14 days. Early this year, 2014, in Jordan where Dr. Hiba BadrEldin Khalil Ahmed conducted her research, legislation was enacted to control research and therapy using human embryonic stem cells. This law allows the conduct of research or treatment using human embryonic stem cells only in government owned institutions or publicly funded academic institutions. All stem cell-related research activities in the four countries are reviewed and approved by a specialized institutional review and oversight committee.

The following were the recommendations following the discussions:

- The importance of adhering to uniform guidelines across the globe cannot be underscored.
- Finding common ground on important ethical issues/expectations will facilitate the advancement of stem cell research.
- Lack of guidelines should not hinder stem cell research work since there are guidelines that could be adopted before the research is conducted.
- Researchers and ethics committee members should invite experts in this field of science during scientific evaluation and in understanding the ethical implications of the proposed research.
- Ethicists, scientists, patient advocates and human rights groups to be involved in developing national guidelines. Public consultation is equally important.
- It is important for African researchers to eliminate the likelihood of therapeutic misconception.
- Researchers must publish their research findings to inform the science and application of stem cell research and therapy.

Closing Remarks and How to Expand and Promote Stem Cell Research in Africa

Various proposals were given on how to expand and promote stem cell research in Africa. Among them was that the initiative should have a multicenter approach and maintain a mentor-mentee relationship at both the regional and international level; ensure there is institutional support for the mentees after undergoing training; the next workshop be tailored towards mentees' progress and techniques learned. Participants were encouraged to sign up to AAS face book page and Twitter #stemcellsforAfrica.

Prof. Abegaz appreciated the Local Organizing Committee and the AAS secretariat for organizing the workshop. He also greatly appreciated the funding agencies for

this workshop who included IAP - The Global Network of Science Academies; the National Commission for Science, Technology and Innovation (NACOSTI) and the World Academy of Sciences (TWAS). He thanked participants and mentors for making the workshop a success. He pledged strong commitment to support the scientists and clinicians who wished to pursue their careers in stem cell science and regenerative medicine.

Conclusion and Way Forward

The meeting was very successful. The workshop not only educated the participants on stem cell research but also highlighted great training opportunities available in China, South Africa, Brazil and India for young African scientists. It was therefore recommended that AAS co-ordinate these opportunities and where possible place and send the young scientists to established laboratories based on common career interests of the mentor and mentee. It was also recommended that a follow up workshop be organized next year to assess the progress of mentees and sensitize members of new training and research opportunities. Such a workshop, if possible, be held in any African country with established stem cell laboratories to expose the trainees to the requirements for establishing and running a stem cell laboratory.

Workshop Evaluation

All mentees completed an evaluation form at the end of the workshop and rated the pre-workshop information, workshop content, delivery and relevance of each session, organization and usefulness of the workshop and its location. Written comments were also sought to help in improving and customizing future workshops. Marks were requested for the level of agreement with a score of 1 being low and 5, the highest.

The workshop was deemed a success by the participants especially in its usefulness and in enhancing the mentee's knowledge base and creative ideas to support writing of research proposals and seek advice from the experts in the field. Given the importance of hands-on training, the participants felt that more time should be allocated to the laboratory demonstrations and the discussion sessions. The laboratory aspect could provide both basic and advanced training to match the level of the mentees understanding of the techniques or technologies. The mentees also requested for a concrete action plan for the mentorship and training program that will be coordinated by AAS. The general comments were reassuring. For example: "informative", "extremely useful and interactive", "workshop surpassed expectations".

The external experts also gave feedback and observed that the two practical sessions produced useful results and exposure. They observed that the KAVI-ICR laboratory was well equipped to support stem cell research and its close proximity to the national referral hospital will facilitate both research and clinical application of stem cells. They recommended that KAVI-ICR should collaborate with other faculty members in the Department of Medicine at the University of Nairobi to leverage the diverse skills and knowledge and also establish a biobank. Some of the stem cell specialists also advised that:

- An African Society of Stem Cell and Regenerative Medicine could be established under the auspices of the AAS.
- The participants should join other international bodies focussing on stem cell

science and regenerative medicine to learn from other experts with shared interests.

- AAS should expand the pool of mentors from the African continent and other locations and hold annual meetings in different African countries to assess progress and identify priority areas of research and therapy in each jurisdiction.
- Each institution conducting stem cell research must have a written policy governing this field of science and develop research proposals that include basic and emerging technologies for the analysis of stem cells and the processes underlying differentiation and development.
- There is need for cooperation between African institutions and international stem cells centres to train African students and early career researchers.
- AAS should consider establishing a central stem cells centre in partnership with the Ministry of Higher Education, Science and Technology and the Ministry of Health.

Annex 1: List of Workshop Participants

No	Name Resource Persons	Institution and Address	E-mail	Telephone
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Annex 2: Workshop Programme

DAY 1: Monday 4th August 2014		
TIME	**EVENT**	**SPEAKER/FACILITATOR**
8.00am – 8.30am	REGISTRATION	AAS SECRETARIAT
8.30am – 9.15am	OPENING CEREMONY Introductory Remarks	Prof. Berhanu Abegaz, Executive Director, AAS & Coordinator, TWAS-ROSSA
	Welcome Remarks	Dr. Moses Rugutt. Commission Secretary, NACOSTI
	Remarks from Chairman Kenya National Academy of Sciences	Prof. Raphael Munavu
	Remarks from India Academy of Sciences	Prof. Dorairajan Balasubramanian
	Remarks from Director Kenya Medical Research Institute	Prof. Solomon Mpoke
	Remarks from Director Institute of Primate Research	Dr. Ngalla Jillani
	Keynote Address	Prof. Henry Thairu Chair, Commission of University Education
	Overview of Workshop Programme	Dr. Marianne Mureithi Chair, Local Organising Committee
Session 1	**Chair : Prof. Dorairajan Balasubramanian**	
9.15am – 9.45am	Stem Cell Research in Kenya	Prof. Omu Anzala Director, KAVI-Institute of Clinical Research
9.45am –10.15am	Translating Stem Cell Research in Africa into Therapy: A Muhimbili Experience	Dr. Denis Russa Muhimbili University, Tanzania
10.15am – 10.45am	TEA BREAK & MEDIA BRIEFING	

Session 2	Chair : Prof. Susan Kidson	
10.45am-11:15am	Stem Cell Research and Clinical Applications in India	Prof. Dorairajan Balasubramanian Director of Research, L.V.Prasad Eye Institute, Hyderabad
11.15am-11.45am	Induced Pluripotent Stem Cells: Challenges and Opportunities	Dr. Anjali Shiras National Centre for Cell Science (NCCS); Pune; INDIA
11.45am-12.15pm	Wnt/beta-catenin signaling in development and diseases	Prof. José Garcia Abreu Institute of Biomedical Sciences of the Federal University of Rio De Janeiro
12.15pm-12.35pm	Introducing STIAS: A creative space for the mind in Africa	Dr. Christoff Pauw Stellenbosch Institute for Advanced Study (STIAS)/ Stellenbosch University
12.35pm-.00pm	Question & Answer Session (for Session 1 & 2)	
1:00pm – 2:00pm	LUNCH	
Session 3	**Chair: Prof. José Garcia Abreu**	
2.00pm – 2.30pm	The Basic principles in therapeutic stem cell trials	Dr.Hiba BadrEldin Khalil Ahmed Alneelain University-Sudan
2.30pm – 3.00pm	Use of neural crest stem cells for treatment of corneal blinding diseases	Prof. Susan Kidson University of Cape Town
3.00pm-3.30pm	Biotechnology-based technologies and opportunities in stem cell research for health	Dr. Michael Ongecha Centre for Global Health Research, KEMRI/University of Mexico Project
3.30pm-5.00pm	Biodiversity Tour (Giraffe Centre)	
5.30pm - 7.00pm	Cocktail Reception	

DAY 2: Tuesday: 5th August 2014 at KAVI-Institute of Clinical Research		
Session 4	Series of Lectures and Hands-on Experiments Chair : Prof. Omu Anzala	
8.30am- 9.00am	The regenerative capacity of pancreatic duct ligated tissues: implication for islet cell therapy	Dr. Venant Tchokonte-Nana Stellenbosch University
9.00am – 9.30am	Setting up and running a stem cell laboratory	Prof. Susan Kidson University of Cape Town
9.30am – 10.00am	Frog Embryos as models for embryonic development and regeneration	Prof. Fabio Almeida Mendes Institute of Biomedical Sciences of Federal University of Rio de Janeiro
10.00am – 10.30am	Generation, Handling and Maintenance of Induced pluripotent Stem Cells	Dr. Anjali Shiras National Centre for Cell Science (NCCS); Pune; INDIA
10.30am – 10.45am	Tea Break	
10.45am -11.00am	KAVI-ICR Lab Orientation	
11.00am – 1:00pm	Lab Session Track 1 (Part 1): Dr. Anjali Shiras National Centre for Cell Science (NCCS); Pune; INDIA) Characterization of Stem Cells and Cancer Stem Cells	Lab Session Track 2 (Part 1): Prof. Fabio Almeida Mendes (Institute of Biomedical Sciences of Federal University of Rio de Janeiro) Frog embryos as models for Embryonic development and regeneration
1.00pm -2.00pm	LUNCH	
Session 5	Chair : Dr. Venant Tchokonte-Nana	
2:00pm – 3:00pm	Lab Session Track 1 (Part 2): Dr. Anjali Shiras National Centre for Cell Science (NCCS); Pune; INDIA)	Lab Session Track 2 (Part 2): Prof. Fabio Almeida Mendes (Institute of Biomedical Sciences of Federal University of Rio de Janeiro)
3:00pm-3:45pm	Lab Practical Feedback	Group Discussion
		Dr. Anjali Shiras and Prof. Fabio Almeida Mendes
3:45pm – 4:00pm	Closing Remarks	Prof. Omu Anzala
4:00pm – 4:30pm	TEA BREAK	

DAY 3: Wednesday 6th August 2014 Mentor: Mentee Session
Presentations from mentees

Session 6	Chair : Dr. Hiba BadrEldin Khalil Ahmed & Dr. Atunga Nyachieo	
8.30am – 8.50am	Determining the role of a FAM111B mutation in Hereditary Fibrosing Poikiloderma using induced pluripotent stem cells	Ms. Gumede Dimakatso University of Cape Town
8.50am – 9.10am	Regenerative medicine in treatment of burns	Dr. Farisai Chidzwondo University of Zimbabwe
9.10am – 9.30am	The need and promise of the stem cell regenerative medicine in the treatment of blinding ocular surface diseases, Jimma, Ethiopia	Dr. Ababora Jafer Kedir Jimma University, Ethiopia
9.30am – 9.50am	Stem cells and Cancer	Ms. Lucy Macharia KAVI-Institute of Clinical Research/ University of Nairobi
9.50am -10.10am	Anti-diabetic plants and islet regeneration in experimental Diabetes	Ms. Claire N Kimani Institute of Primate Research (IPR)
10.10am – 10.30am	Cell based therapies in treatment and management of cancers	Ms. Dorcas Wachira Kenya Medical Research Institute (KEMRI)
10.30am – 11.00am	TEA BREAK	

Session 7	Feedback from Mentors Chair : Prof. Berhanu Abegaz	
11.00am - 11.15am 11.15am - 11.30am	India	Prof. Dorairajan Balasubramanian Director of Research, L.V.Prasad Eye Institute, Hyderabad Dr. Anjali Shiras National Centre for Cell Science (NCCS); Pune; INDIA

11.30am - 11.45am 11.45am – 12.00pm	Brazil	Prof. José Garcia Abreu Institute of Biomedical Sciences of Federal University of Rio de Janeiro
		Prof. Fabio Almeida Mendes Institute of Biomedical Sciences of Federal University of Rio de Janeiro
12.00pm-12:15pm 12.15pm-12:30pm	South Africa	Dr. Venant Tchokonte-Nana Stellenbosch University Prof. Susan Kidson University of Cape Town
12:30pm – 12.45pm	Republic of the Sudan	Dr. Hiba BadrEldin Khalil Ahmed Alneelain University-Sudan
12.45pm -2.00pm	Lunch	
Session 8	Round Table Discussions	Chair: Dr. Christoff Pauw
2.00pm – 3.00pm	Ethical Issues in Stem Cell Research Guidelines for Stem Cell Research in Africa	Dr. Christine Wasunna (KEMRI), and Dr. Christoff Pauw (STIAS/ Stellenbosch University)
3.00pm– 3:30pm	Closing Remarks and How to Expand and Promote Stem Cell Research in Africa	Prof. Berhanu Abegaz (Executive Director, AAS & Coordinator, TWAS-ROSSA)
3.30pm – 3:45pm	Award Certificates of Attendance to Participants	Mrs. Noel Abuodha Deputy Chair, Local Organising Committee, Kenya National Academy of Sciences (KNAS)
3.45pm – 4.00pm	Vote of thanks	Prof. Berhanu Abegaz (Executive Director, AAS & Coordinator, TWAS-ROSSA)
4:00pm – 5:00pm	Farewell Tea and Departure	

Annex 3: Summary of Workshop Evaluation

Participant No.	Q1: Extent to which participant was informed of purpose/ objectives of workshop in advance	Q2: Relationship between workshop content and objectives	Q3: If expectations of participants were met	Q4: Adequacy of preparation	Q5: Confidence in pursuing research opportunities in SCR/RM	Q6: Usefulness of workshop
1	4	4	4	5	5	5
2	4	5	5	4	5	5
3	5	5	5	4	5	5
4	5	5	5	5	4	5
5	3	5	4	4	5	5
6	5	5	5	5	5	4
7	3	4	4	4	5	5
8	5	4	4	3	5	5
9	4	4	4	5	5	5
10	5	5	4	4	4	5
11	4	4	4	4	4	5
12	5	5	5	4	5	5
Mean score	4.33	4.58	4.42	4.25	4.75	4.92

Participant No.	Q7 a: Extent of applicable background information	Q7 b: Relevance of lab demonstrations	Q7 c: Confidence in applying new knowledge	Q7 d: Adequacy of allocated time	Q7 e: Confidence in translating new knowledge into research ideas	Q7 f: Level of motivation to pursue career in SCR/RM
1	4	3	3	4	4	5
2	5	3	5	5	5	5
3	4	3	4	4	5	5
4	5	3	5	5	5	4
5	4	4	4	3	4	4
6	3	4	4	3	4	4
7	3	4	4	4	4	5
8	5	4	3	5	4	5
9	5	4	5	4	5	4
10	5	4	4	0	5	5
11	4	4	4	4	5	4
12	4	3	4	3	4	5
Mean score	4.25	3.58	4.08	3.67	4.50	4.58

Participant No.	Q8 a: Organization of workshop	Q8 b: Organization & delivery of lab demonstrations	Q8 c: Presenter's experience and delivery of lecture	Q8 d: Content & usefulness of presentations	Q8 e: Content & usefulness of round table discussions	Q8 f: Meeting venue (AAS)
1	5	4	4	4	5	5
2	5	4	5	5	5	5
3	5	5	5	5	5	5
4	5	5	5	5	5	5
5	5	5	5	4	5	5
6	3	4	4	3	4	4
7	4	4	5	5	4	4
8	5	5	5	5	5	4
9	5	4	4	4	4	4
10	5	4	5	4	5	5
11	4	4	5	4	4	4
12	5	5	5	5	5	5
Mean score	4.67	4.42	4.75	4.42	4.67	4.58

Participant No.	Q9 a. Confidence to seek out information about a research topic in SCR/RM	Q9 b: Confidence to design a research study in SCR/ RM	Q9 c: Confidence to seek out mentorship or supportive supervision	Q10: Likelihood to participate in another SCR/RM workshop
1	5	5	5	5
2	5	5	5	5
3	5	4	5	5
4	5	5	5	5
5	5	4	5	5
6	5	5	5	5
7	5	5	5	5
8	5	4	5	5
9	5	4	4	4
10	5	5	4	5
11	4	4	4	4
12	5	5	5	4
Mean score	4.92	4.58	4.75	4.75

SUGGESTIONS FOR IMPROVEMENT	WHAT PARTICIPANTS LIKED MOST ABOUT THE WORKSHOP
• Invite other interested heads of institutions	• Participatory & interactive nature of the lectures
• Extend time/days allocated to practical sessions & discussions	• Timeliness of sessions
• Ensure adequate media coverage of the workshop	• Direct learning from the experts
• Ensure equity in placements for training and mentorship	• Lectures and practicals were informative
• Expand the pool of mentors/ participating institutions	• Willingness to share ideas
• Circulate reading materials before the workshop starts	• Usefulness of information provided
• Slow down the pace of presenting	• Lab sessions especially how to set up a SCR lab
• Include a session on scientific communication	• Workshop surpassed expectations
• Provide basic and advance sessions for lab practicals	• Plans for collaborations & mentorship
• Rotate SCR/RM workshop in other African countries	
• Expand the number of clinicians in the workshop	
• Monitor progress made by each participant	
• Devise strategies to guarantee sustainability of this initiative	
• Develop time-bound action plans for this initiative	

Annex 4: Group Photographs

Notes

Notes

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Driving Scientific and Technological Development in Africa

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