

Modern Biomedical and Environmental Research in Kazakhstan: Challenges and Opportunities

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Environmental research is very important issue in Kazakhstan to be properly addressed and effectively solved. Economic growth, industrialization, and the grave consequences of nuclear weapons testing, uranium mining, pollution are causing heavy environmental and health problems. Economic growth that will benefit present and future generations and establishment of both healthy economics and a healthy environment are of great public concern in Kazakhstan. The ecological disasters that face Kazakhstan mean that environmental and health research is a very large priority for its people. Kazakhstan is poised to become one of the most important 21st century laboratories for studying and solving large scale Environmental & Health problems that face it and the rest of the world.

Previously some of our researchers conducted several joint International project related to Environmental research. For example, in partnership with the Radiation Epidemiology Branch (REB) of the U.S. National Cancer Institute (NCI) they conducted an epidemiologic study titled "Thyroid Abnormalities in Northeastern Kazakhstan" among the population living near the Semipalatinsk Nuclear Test Site (SNTS) in Kazakhstan at the time when nuclear weapons tests were detonated in the atmosphere (between 1949 and 1962). In August, 1998 they jointly with American research team conducted a field study in Kazakhstan. Additional information has been identified that is needed to refine estimates of internal and external radiation dose in the study population. This included data on residential history, records from Regional Archives related to the time of the nuclear weapons tests. Currently, the dosimetric basis for the study is being refined using new information on lifestyle factors, including diet, obtained in September 2007 from focus group interviews in the affected villages. This new information was used to correct current estimates of radiation dose from both external and internal radiation sources in fallout, all of which ultimately depend upon residential history. Results of this study have the potential to improve considerably earlier dose estimates for the cohort members. Based on the focus groups and key informants, several assumptions used in previous dose assessment were modified. In this study new information on food consumption pattern for women during pregnancy and breastfeeding; agricultural practice; evacuation of 1953 H-bomb; and preparation of milk products was collected. Previous dose assessment used data which were based on rather general assumptions regarding these important parameters. Collected data are the first detailed information obtained from the population on several key aspects of daily life in rural villages in Kazakhstan. This data was using to improved thyroid dose estimates in the epidemiological study. New information collected allowed to estimate the uncertainties related to shared and unshared errors in dosimetry model. Information obtained from the focus groups and key informants is being used to define the village-, ethnicity-, age-, and gender-specific (where appropriate) probability density distributions of important behaviour and food consumption parameters of dosimetry models used to reconstruct external and internal doses. These data, combined with physical dosimetry data related to fallout deposition, are

used to stochastically generate multiple sets of individual dose estimates for the persons exposed during childhood to radioactive fallout from nuclear weapons tests conducted at the SNTS between 1949 and 1962.

Our researchers published many papers related to health issues around the Semipalatinsk Nuclear Weapons testing Site. Health issues are really complex and we have realized the necessity to develop state-of-the-art diagnostic and treatment modalities to improve the quality of health condition of the population in Kazakhstan. As global medical trends shift from a curative to a preemptive paradigm, the Life Sciences Center strives to contribute to this transformation. This will be through its research efforts in regenerative medicine, genomics, clinical trials and other areas and will be a central theme underpinning Center's research and development programs. Many of the environmental problems can benefit from the application of state-of-the-art research techniques that have recently been developed or can be developed in the course of working on these challenging problems.

As part of its modernization program, Kazakhstan has singled out institutional reforms in higher education and science as a priority to foster a new generation of world-class scientists, engineers and social workers. The government of Kazakhstan wants to diversify the economy and develop high-value added goods and services. Recently, Kazakhstan has adopted a new law on science that is expected to radically change the research environment in Kazakhstan.

The new law prioritizes the following research areas: (1) Energy; (2) Innovative technologies in processing of raw materials; (3) Information and telecommunication; (4) Life Sciences; (5) Basic research in humanities and the other fields. The new law establishes national research councils in the relevant priority areas as well as three streams of funding: (1) Basic funding to support scientific infrastructure, property and salaries; (2) Grant funding to support research programs, and (3) Program-target funding to resolve strategic challenges. In addition, the new law establishes a system for peer review of research grant applications.

Within this new framework Nazarbayev University's priority is to develop research infrastructure and to train world-class researchers. Our goal is to establish research environment that encompasses basic science, technological application, coordinated programs, and consulting and analytical services in high-priority development fields. The intention is to attract top-level scientists regardless of nationality by offering the opportunity to conduct advanced research in cutting-edge facilities. As the research university we recognize the challenges of: selecting priorities for research; funding issues; internal peer review process; infrastructure development; and building a competence.

The NU Center for Life Sciences (CLS) strives to transform medicine and healthcare in Kazakhstan through innovative scientific research, rapid translation of breakthrough discoveries, educating future clinical and scientific leaders, advocating and practicing evidence based medicine, and pursuing research in personalized and predictive medicine. The underlying goal of all these activities is to improve health and quality of life.

The main priorities of the Center are as follows:

- Scientific and innovative approaches in the development of tissue bioengineering, cell therapy, genomic medicine and artificial organs.
- Development of translational medicine, rapid and appropriate transfer of the latest discoveries from

the laboratory to the clinic.

- Development of the scientific basis of healthy aging
- Realization of personalized medicine into clinical practice
- Transform medicine and health from a Curative to a Preemptive paradigm

The CLS is the key member of Nazarbayev University Integrated Healthcare System and promotes aligned research and strong integration, this system also includes the National Medical Holding and School of Medicine (in the near future).

The CLS will establish four laboratories in which the following fields of biomedicine will be developed and implemented: Laboratory of Genomics and Personalized Medicine; Laboratory of Regenerative Medicine and Artificial Organs; Laboratory of Tissue Bioengineering, Innovative Cell Technology and Transplantation Medicine; Laboratory of Translational Research, Clinical Trials and Healthy Aging.

Mission and Vision

Mission: To develop fundamental science and discover new knowledge about the nature and behavior of living organisms, as well as application of that knowledge to improve quality of life and longevity, reducing the burden of disease in humans.

Vision:

To improve the quality of life, health and longevity through the practical implementation of modern advances in biomedical science to clinical practice, as well as the establishment of sustainable scientific and legal structures for a competitive biomedical industry, with a subsequent contribution to the diversification of the Kazakhstan economy

Main areas of research

The main research priorities of the Center are: 1) Genomics and Personalized Medicine; 2) Regenerative Medicine and Artificial Organs; 3) Tissue Bioengineering, Innovative Cell Technology and Transplantation Medicine; 4) Translational Research, Clinical Trials and Healthy Aging; and 5) Global Health

A stepwise plan of development for the Center will unfold in three phases.

Phase 1(2011-2013) – establishment of research infrastructure and development of research personnel, integration with the university hospitals and fostering of international partnerships

Phase 2 (2014-2016) – development of intellectual potential, infrastructure development, development of research projects, increasing capacity and contribution to international scientific knowledge, begin integrating CLS with School of Medicine, become actively involved with doctoral programs

Phase 3 (2017-2020) – create a basis to develop venture capital financing of research projects with commercial potential, continued international research contributions

As global medical trends shift from a curative to a preemptive paradigm, the CLS will strive to contribute to this transformation. This will be through its research efforts in regenerative medicine, genomics, clinical trials and other areas and will be a central theme underpinning CLS's research and development programs.

Development Stages

2011 – 2013 yy. Foundation of scientific innovative infrastructure and human resource potential	2014-2016 yy. Formation of intellectual potential, improvement of infrastructure and scientific environment	2017-2020 yy. Commercialization of Biomedicine and Venture Capital Financing of branch
Construction of 1 st phase of the scientific research complex. Training of staff in research centers of foreign partners. Transfer of scientific technologies Determination of innovative research priorities	Design and construction of 2d phase of the scientific research building. Development of staff and researchers. Achieve international patents and scientific publications in high-rated journals. Active participation in international programs. Foundation of scientific research institutes	Completion of construction of second scientific research complex. Commercialization of scientific developments, formation and venture capital financing of biomedical branch

Priorities

Scientific priority	Scientific directions	Strategic goal	Strategic objectives
Human health	<ul style="list-style-type: none"> - Personalized medicine and genomics - Regenerative medicine, bioengineering and artificial organs - Translational medicine and healthy aging - Tissue bioengineering, transplantation medicine and innovative cell technology 	Increase of life expectancy of the Kazakhstani population and reduction of the disease burden through scientific innovation and development in the field of healthy aging, reducing infant mortality and morbidity	<ul style="list-style-type: none"> - Early detection of disease based on genetic and molecular tests Pharmacological and molecular approaches to disease prevention Research cellular and genetic mechanisms for the effective treatment of diseases Healthy aging, healthy diet and behaviour

Laboratories

- Genomics and Personalized Medicine
- Regenerative Medicine and Artificial Organs

- Tissue Bioengineering, Innovative Cell Technology and Transplantation Medicine
- Translational Medicine, Clinical Research and Healthy Aging
- Global Health

2 GENOMICS AND PERSONALIZED MEDICINE

The Center for Life Sciences believes in transforming medicine from a curative to a preemptive paradigm and would like to contribute to leveraging knowledge of an individual's genetic makeup to create a more personalized approach to healthcare.

Genomic medicine uses genotyping to improve the quality of life. It includes identification of an individual's predisposition to acquiring disease. In a broader sense, personalized medicine represents an integrated medicine which includes the development of personalized means of treatment based on genomics, testing to predisposition to illnesses. Personalized medicine has the potential to eliminate unnecessary treatments, reduce the incidence of adverse reactions to drugs, increase the efficacy of treatments and ultimately, improve health outcomes.

At the Center for Life Sciences researchers plan to study the impact of genetic polymorphisms on heart failure prognosis among patients of Kazakh ethnicity. We are also interested in the role of genetic polymorphisms in multi-drug resistant tuberculosis and the other diseases prevalent in Kazakhstan.

We plan performing whole-genome sequencing to determine risk of developing certain conditions. The results will be compared to databases of disease-related gene variants to identify genes and mutations with known links to disease.

3 REGENERATIVE MEDICINE AND ARTIFICIAL ORGANS

Center for Life Sciences sets the following priorities in the field of regenerative medicine :

- Contribution to international scientific development and the role of regenerative medicine in furthering human well-being
- Training scientific, technical and administration staff with specific skills in biomedical research and regenerative medicine
- Creating a regenerative medicine translational research laboratory
- Fostering collaborations with elite universities and companies worldwide
- Incubating new companies and new technologies

The Center for Life Sciences plans the following joint research projects with University of Pittsburgh McGowan Institute of Regenerative Medicine:

- Adipose Stem Cell/Bioreactor Technology
- Pediatric Cardiopulmonary Mechanical Support and Tissue Engineering
- Development of a Cancer Stem Cell Program
- Development of Advanced Technology for Donor Organ Perfusion Utilizing Blood Soluble Drag-Reducing Polymers
- Advanced technology in blood transfusion
- Biopolymers and stem cells in tissue regeneration

4 TRANSLATIONAL MEDICINE, CLINICAL RESEARCH AND HEALTHY AGING

Center for Life Sciences provides infrastructure support to sponsors and investigators who are testing new drug candidates and other cutting-edge therapies and seeking to identify and validate novel biomarkers.

Early-phase, proof-of-concept clinical trials

- Test new drug candidates and other cutting-edge therapies
- Identify and validate new biomarkers

A dedicated clinical unit located at the National Medical Holding

In addition to providing a full range of clinical research services, Center for Life Sciences is dedicated to:

- Providing scientific leadership in the conduct of clinical research
- Disseminating new knowledge throughout the medical community in Kazakhstan and the former Soviet Union
- Advancing clinical research methodology
- Educating future generations of clinical researchers

The goal of the Center's longevity research program is to address critical issues regarding the general biology of aging, age-associated diseases and disabilities and development of gerontechnology and gerontoengineering

The specific areas of research interest in biology of aging are as follows:

1. Epidemiological studies in Kazakhstan
2. Identify and validate new biomarkers of processes of aging and healthy aging
3. Research on geroprotectors, gerontechnology and gerontoengineering
4. Study of disease features, early diagnosis and effective treatment of cardiovascular and cancer diseases, diabetes, Parkinson's disease, Alzheimer's, etc.
5. Study and development of technologies of healthy aging
6. Identification of genetic polymorphisms of aging
7. Study of DNA damage and repair mechanisms
8. Identification of genetic polymorphisms related to different states of pathological aging

5 GLOBAL HEALTH

Center for Life Sciences is working on initiatives of the further development of global health. The Centre has established a partnership with Columbia University, to study the social, biological and genetic aspects of tuberculosis and drug-resistant forms of tuberculosis in different regions of Kazakhstan.

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