Major Program

Major Program is set up to serve the major needs of national economy, sustainable development of the society and S&T development. It selects scientific issues with strategic significance, assembles innovative human resources, conducts multidisciplinary research, and plays the leading and guiding role for further improving the ability of making indigenous innovation in China's basic research.

Major Program is implemented in the way of unified planning and the initiation of projects in batches. Research areas for the Major Program are proposed on the basis of in-depth discussion and soliciting opinions among scientists according to NSFC's priority areas. It is focused on the growth points resulting from long term funding of NSFC projects, and it is expected that the achievement of important breakthroughs can be made in key scientific issues through considerable amount of funding.

In the Eleventh Five-Year Plan period, NSFC only accepts one integrated application for each Major Program, which should includes both the overall application for the Program and proposals for individual research projects. Attention should be paid to the relationship between various projects. Proposals involving only part of the research areas or one of the research projects indicated in the guide of each Major Program will not be accepted. Each application can contain no more than 5 projects. In general, one project should be carried out by one unit, or 2 at most, and one Program should be carried out by no more than five research units and the applicant of the Program must be one of the PIs of the projects proposed.

Applicants should have the following eligibilities:
1. Experience of undertaking basic research projects;
2. Senior academic position (title).

Post-doc researchers, graduate students or researchers defined in Clause 2, Article 10 of NSFC's Regulations are not qualified to apply.

Applicants should follow the guidelines when writing proposals. "Major Program" should be selected in the funding category and "application for Major Program" or "proposals for projects" in the sub-category, and the research area of the Major Program should be indicated in the annotation. Proposals without correct selections will not be accepted.

In 2010, NSFC announces the guidelines for four Major Programs in the third batch of

the Eleventh Five-Year Plan period. Accordingly, proposals should be refined on key scientific issues with strategic and fundamental significance, put forward clear, concentrated and interdisciplinary scientific targets, and pay attention to the coordination and linkage with other national S&T programs. The research team should have a good accumulation of research work, research conditions and ability of making innovations, and a number of high-level academic leaders. Each project will be funded with 10 million yuan for 4 years.

Evolution of Standardized Genes of Barcodes and Cryptic Biodiversity

The exact identification of species is the necessary premise for our study on nature and sustainable development. The species identification based on morphological characters is getting difficult to meet the magnitude requirement of science development. DNA bar-coding supplies an informational taxonomy criterion and efficient approach of classification, and is becoming one of the most rapid developing frontline. Through the study of DNA bar-coding, people discovered many cryptic species, and revealed much more abundance of biodiversity. DNA bar-coding technique provides unique magnanimity datum for the principle study of species evolution and genetic variation. The phylogenetic tree covering of standard DNA bar-coding series from a great amount of species affords a new chance for the process study of biological evolution. Through genome analysis, we can screen standard genes broadly adapting to DNA barcodes, further study the variation rules of those standard DNA barcodes, and then establish the theoretical basis of the optimization of standard gene designing, which is the crux of the development of Barcode of Life program. This Major Program, based on the former foundation of research, is to select animal species with well taxonomic basis, and with preponderance groups in China, explore the theory and methods of discovering new species and cryptic species based on the DNA barcodes series, reveal the cryptic diversity, improve animal standard DNA bar-coding system, and study their evolution rules and important evolution events relating to species phylogeny.

I. Scientific goals

To filter new animal standard DNA bar-coding genes, study the variation rules of those standard DNA barcodes and optimize the design of standard genes, so as to provide theoretical basis of mark gene selection and design for different animal groups;

To promote the discovery of cryptic diversity of animals in China, and seek the theory and methods of discovering new species and cryptic species based on the DNA barcodes series;

To obtain 6,000 standard DAN barcode series, and conform them to the nodes of iBOL

China Mirror;
To organize and conduct researches on several important animal groups internationally;
To study important events of evolution and its rules based on the relationship of phylogeny.

II. Main research contents

1. The screening and optimization of animal standard DNA barcode genes. By analyzing different animals genome (especially Mitochondria genome), it is to study 2-3 new standard DAN barcode genes broadly apt to various animal species and their biological significance, to study the variation rules of current (CoI) and new standard genes of bar coding at different animal species, and to establish the theoretical basis for the optimization of standard gene designing.

2. By using the theory and methods of discovering new species and cryptic species based on the DNA barcodes series, it is to reveal the cryptic diversity, and by the combination of morphological analysis, ecology and biological features with DNA bar-coding, to comprehend species diversity and biological characters in the fine scale.

3. Evolution events relating to species phylogeny. By the establishment of phylogenic tree based on the standard DNA barcode series, it is to study and discuss evolution problems such as species differentiation, biogeography, etc.

III. Period of funding

Four years (January 2011 - December 2014).

IV. Funding

10 million yuan.

Key Biogeochemical Processes in Representative Paddy Soils and Environmental Quality

Paddy soils are of utmost importance in food security and environmental health in China. China is a country with huge population and rapid urbanization, ensuring agricultural productivity is a fundamental national policy. In the wake of increasing demand for food, decreasing arable land and deteriorating environmental quality, it is imperative to investigate how to improve the productivity of paddy soils while maintaining ecosystem health, environmental quality as well food safety.

The development and evolution of the productivity of paddy soils and its ecological functions represent several aspects of interactions, including the interactions between biogeochemical processes and anthropogenic activities, the co-evolution of soil productivity and ecological functions, the coupling between biotic and abiotic factors influencing biogeochemical processes in paddy soils, as well as the inter-relationship between agricultural production and climate change. Understanding the biogeochemical processes in paddy soils and its relationship with ecological functions will be conducive to the sustainable use of paddy soils, and will provide science-based support towards the coordination among soil productivity, food safety and environmental sustainability.

I. Scientific goals

Using paddy soil as a model system, this Major Program is planned to address the following scientific questions: (ⅰ) Microbe-mediated mechanisms of interconnected biogeochemical cycles of key elements, such as carbon, nitrogen and iron in paddy soils, with particular concerns on the coupled processes occurring at the critical zones of redox gradients; (ⅱ) Sustainability-oriented mechanisms of driving forces in shaping soil productivity and its ecological functions; (ⅲ) Process-based models of biologically-, physically- and chemically-mediated cycles for carbon, nitrogen and iron in paddy soil; (ⅳ) Multidisciplinary and integrated theoretical framework and key technologies for improving soil productivity while maintaining the environmental sustainability of paddy ecosystem.

These scientific goals will be essential components toward building a systematic theoretical framework and technologies for understanding the anthropogenically altered biogeochemical processes on the Earth's surface, providing a scientifically sound basis for developing the environmentally and ecologically sustainable strategies to secure the food production for future demand.

II. Main research contents

1. Microbial mechanisms of interconnected biogeochemical cycles for carbon, nitrogen and iron in paddy soil

Microbiologically mediated transformation of soil carbon and nitrogen, the kinetics of soil iron status changes as regulated by microorganisms and the microbial guilds controlling the coupled transformation of soil C-N-Fe under repeatedly sequential reduction-oxidation processes in paddy soil.

2. Dynamics of carbon and nitrogen transformation and accumulation in paddy soils and its consequence on greenhouse gas emission

Coupling mechanisms of physicochemical and microbial turnover for organic matter and

nitrogen in paddy soils, and the sustainability science for soil productivity and ecosystem service of paddy soils.

3. Degradation of typical pollutants in relation to the coupled microbial processes of C-N-Fe cycling in paddy soils

Degradation and fate of typical pollutants in association with coupled C-N-Fe cycles in paddy soil under repeatedly sequential reduction-oxidation process, and the microbial degradation of pollutants co-metabolized with C-N-Fe in paddy soil.

III. Period of funding

Four years (January 2011 - December 2014).

IV. Funding

10 million yuan.

Investigation on the Engendering, Rupture Process and Hazards of Ms 8.0 Wenchuan Earthquake

The Wenchuan earthquake occurred on May12, 2008 caused disastrously heavy casualty and tremendous property loss, and is the most destructive earthquake with the deepest social impact in China since the 1976 Tangshan earthquake in terms of property damage and human losses. This major earthquake is not only a tremendous destructive natural disaster, but also a convulsion of geodynamical process. The unique tectonic background and complex release process of the vast seismic energy of Wenchuan earthquake would make it one the most significant archived earthquakes in the history of seismological research. It would not only provide us invaluable observed data, but also raise many challenging scientific issues. Thus, Wenchuan earthquake provides Chinese seismologists, as well as seismologists in the world, an unprecedented opportunity of investigating and revealing the earthquake's cause and the general mechanism of earthquake.

The process of "engendering-occurrence-hazards" of earthquake is a very complex physical process that spans several orders of magnitude over the spatial-temporal domain. It is, thus, too difficult to quantitatively solve the whole physical process directly. According to different intrinsic spatial-temporal scales, the system of earthquake evolution can be divided into three sub-systems, i.e., faults system, mesoscale mechanical system of fault rupture, and source-surface oscillating system. Obviously, the major tasks of contemporary earthquake seismology are quantitatively studies on the

nature and dynamics of these sub-systems and coupling among the sub-systems in order to reveal the cause and dynamics of earthquake. Therefore, to explore the engendering, rupture process and hazards of Wenchuan earthquake, it is necessary to promptly carry out, in the vision of contemporary earthquake seismology, a comprehensive study (including field observational, laboratory experimental and numerical computational aspects) on this earthquake by utilizing the invaluable observed data, with multi-disciplinary approaches (such as seismology, geophysics, geodes, earthquake geology, earthquake engineering and rock mechanics). Such a comprehensive study on Wenchuan earthquake is significant for not only advancing the basic seismological research, but also benefiting the mitigation of seismic hazards in China.

I. Scientific goals

This Major Program aims at investigating those important scientific issues raised by the Wenchuan earthquake through multidisciplinary approaches, in order to reveal the engendering, triggering and rupture process of the Wenchuan earthquake, explore the mechanism of seismic hazards caused by this earthquake, enrich the theory of great intra-plate earthquake, and attempt the study of physics-based numerical earthquake prediction. The ultimate goal of launching this project is to advance the nation's fundamental and theoretical studies of seismology, laying a solid scientific foundation for the undertaking of seismic hazard mitigation in China.

II. Main research contents

1. Crustal and up-mantle structures of Longmenshan Mountain and adjacent area, precise determination of source parameters of Wenchuan earthquake series, and the near real-time inversion of disastrous mega earthquakes source rupture process;
2. Material properties, deformation and stress fields of the crust in the source region of Wenchuan earthquake, spatial distribution and slippage of faults, rheology of fault zones, and evolution dynamics of faults system, and feasibility and feasible way for the numerical (middle- and long-term) earthquake prediction;
3. Characters of strong ground motion and mechanism of hazards of Wenchuan earthquake, the rupture dynamics and associated energy radiations of the complex faults system, which directly caused the seismic hazards, and the influence of complex shallow structure and strong irregular topography on the propagation of seismic waves so as to reveal the mechanism of seismic hazards;
4. Geodynamics and seismic hazards of the eastern margin of the Tibetan Plateau, and the development of a physical model to explain some crucial precursors of the Wenchuan earthquake.

III. Funding period

Four years (January 2011 -December 2014).

IV. Funding

10 million yuan.

Basic Research on Molecular Imaging of Cancer

Molecular imaging is a new intercrossing discipline produced by the combination of traditional medical imaging and modern molecular biology. It is a new non-invasive manner and means of scientific research or observation, with which the physiological and pathological processes of molecules *in vivo* can be visualized qualitatively or quantitatively. The key scientific issue of this program is to provide methods and tools for basic research on molecular imaging of cancer by taking a single tumor as a model, studying the theories and methods of molecular imaging, and revealing activity patterns of the occurrence, development and apoptosis of tumor cells *in vivo*.

With the completion of Human Genome Project and coming of post-genome era, the analysis of diseases' pathogenesis through interaction between nucleic acid-protein, protein-protein molecules, and the new approach and means for the early warning, diagnosis and efficacy evaluation of diseases have become a top priority of scientific research and health monitoring. Molecular imaging visualizing the same life-process from a different perspective through the combination of multi-disciplines and multi-methods, multi-modalities and multi-parameters, will be a new effective method and means to explore and explain the mystery of life processes. Thus, researches on molecular imaging will have important scientific significance and application value in understanding the physiological and pathological processes as well as early diagnosis and treatment of diseases.

I. Scientific goals

To select a certain kind of tumor as a model, observe *in vivo* the activities of tumor cells and molecules marked specifically, study the theory and modeling of molecular imaging, target, analyze quantitatively and visualize tumor molecules *in vivo*. All above is to provide methods and tools for the activity patterns of the occurrence, development and apoptosis of tumor cells *in vivo*;

To develop an interdisciplinary research team or technical resources of molecular imaging through this program;

To establish the multidisciplinary cooperation mechanism for the development of

medicine and biology;
To promote the application of molecular imaging in biology, pharmacy and clinical medicine, and
To strengthen the interdisciplinary integration and development through the practical application of molecular imaging.

II. Main research contents

To select a tumor as a model to carry out the following four research aspects:

1. Theory and modeling of molecular imaging
To study the theory of molecular imaging, such as the transportation theory of light, sound, magnetism and so on in the complex biological tissues;
To establish, with a tumor as the research object, the molecular imaging model suitable for different types of biological tissues;
To construct a computing model of molecular imaging based on different imaging modality or multimodality by the integration and analysis of different modality data or information.

2. Targeting, quantification and visualization of cancer molecules *in vivo*
To locate the tumor *in vivo* and to reconstruct quantitatively;
To visualize the signal strength distribution, localization and quantification of the model in two dimensions or three dimensions, using robust and effective reconstruction algorithm, according to the signal strength distribution of the calculation model from the measured data.

3. Molecular probes
To build targeted molecular probes by studying or using a particular tumor-specific markers with the multi-disciplinary strengths. The constructed molecular probes should have a good biocompatibility, high affinity and targeting, as well as strong penetration ability to overcome the associated physical barriers, such as the blood vessel wall, cell gap, cell membranes, blood-brain barrier, etc., and to complete the early identification and labeling of the cancer molecules in the end.

4. Molecular imaging and early diagnosis of cancer
To study the process of targeted molecules into cells and the distribution of molecules in various organs and tissues;
To study the accumulation and changes of signal intensity;
To have the highly sensitive biological signal amplification system due to the very low concentration of molecular probes *in vivo*;
To monitor the interventional effect of cancer in real-time;

To provide quantitatively indicators of the assessment efficacy of cancer, methods and tools for studying the occurrence, development and apoptosis of cancer cells, and interventional mechanisms of a single kind of cancer.

III.Funding period

January 2011 - December 2014.

IV. Funding

10 million yuan.