Division of Life, Medical, Natural Sciences and Technology

Research Division Introduction

With the establishment of the Organization of Advanced and Integrated Research (OAIR) in 2016, five projects in the life and medical field (Graduate School of Medicine and Graduate School of Health Sciences) have joined this division. In addition, following the completion of the Core research project in the 2018 academic year, the "Kaitaku project" system aimed at fostering seeds for next-generation advanced research and interdisciplinary research utilizing the characteristics of Kobe University was established, and nine projects were launched to address research themes related to natural science in April 2019. We conduct advanced and interdisciplinary educational and research activities and aim to form a global educational and research base that is highly regarded internationally.

Projects

No.	Research Theme	Project Leader
20	International Collaborative Research Center for the Infectious Diseases	MORI Yasuko
21	Signal Transduction Medical Research Aiming to Develop Innovative Prevention,Diagnosis, and Therapy	TAKUMI Toru
22	Fusion Research of Medical Device Production and Medical Engineering System	FUKUMOTO Takumi
23	Creation of an Innovative Research Area on Lifelong Mental Health by Multidisciplinary Approaches	FURUYASHIKI Tomoyuki
24	Joint Development of a Seamless Healthcare System in Asian Countries: A Proposal for a Future Healthcare System that Innovates Living	TANEMURA Rumi
KAITAKU 01	Development of Innovative Sustainable Low-carbonization Systems	UCHIYAMA Yusuke
KAITAKU 02	Development of innovative light energy conversion systems by hierarchical approach	TACHIKAWA Takashi
KAITAKU 03	Dark Matter in the Universe	MIUCHI Kentaro
KAITAKU 04	Genome Function in Higher-Order Life Phenomena	FUKAKI Hidehiro
KAITAKU 05	The biodiversity and ecosystem service relationship in magacity rivers	USHIMARU Atushi
KAITAKU 06	Digital-Smart Manufacturing	TSUBOKURA Makoto

No.	Research Theme	Project Leader
KAITAKU 07	Deployment of environmentally-friendly nanoparticles to bionics,photonics and electronics	FUJII Minoru
KAITAKU 08	Research and Development of Offshore Energy Station to Generate Electric Power and Hydrogen from Offshore Renewable Energie	OHSAWA Teruo
KAITAKU 09	The next generation of agriculture and resource production by Kobe University	HONDA Kazuhisa

International Collaborative Research Center for the Infectious Diseases

Project Leader　MORI Yasuko

～Outline of Research Project～

We will promote the basic research for development of diagnostic methods and prophylaxis, and also educate young researchers, investigating the Infectious Diseases in Indonesia. These studies will be done in collaboration with the researchers in Institute of Tropical Disease (ITD), Airlangga University, Surabaya, Indonesia.

Influenza

The endemic of highly pathogenic avian influenza A/H5N1 virus will be investigated in Indonesia.

Dengue Fever and HIV Infection

Epidemiological survey and diagnosis of dengue fever and HIV infection: Indonesia is the largest dengue-endemic country in Southeast Asia, and there are many imported cases of dengue infection from tourist places such as Bali to Japan. In addition, in recent years, rapid epidemiological growth of HIV infection has found in Indonesia. Therefore, we will conduct molecular epidemiological surveys of dengue virus and HIV across Indonesia. In addition, since no therapeutic agent for dengue has been approved yet, we will research and develop new antiviral agents and rapid diagnostic methods.

Molecular Epidemiological Study for AMR (Antimicrobial Resistance) and Cholera

To investigate the distribution of carbapenem-resistant Enterobacteriaceae (CRE), which is rapidly emerging worldwide, and cholera, which still has a large number of victims in developing countries, and conduct genetic analysis of those bacterial strains. International infection control measures can be established by using these molecular epidemiological data. In addition, the gene information obtained here will be

accumulated in the databank and used for the development of new diagnostic and therapeutic agents.

Viral Gastroenteritis

Norovirus is a major cause of nonbacterial acute gastroenteritis worldwide in all age groups, whereas rotavirus is a major cause of gastroenteritis in infants and young children. We conduct epidemiological study of norovirus and rotavirus to determine how these viruses spread though the world and understand the mechanism of viral prevalence. We aim to contribute to establishment of a surveillance system to prevent vaccine-resistant rotavirus from spreading in Japan.

Human Herpesvirus-6 (HHV-6) Infectious Diseases

There is no report regarding HHV-6 study in Indonesia. Therefore firstly we will do epidemiological survey of HHV-6 in Indonesia.

Molecular Epidemiological Study of Hepatitis B Virus

In Indonesia, universal vaccination program was introduced in 1990s. However, there are still lots of viral carries even among younger generation. Based on the epidemiological study, the expected results are to clarify the problem of vaccination system and the potential risk of infection, and ultimately to decrease the viral carries.

Signal Transduction Medical Research Aiming to Develop Innovative Prevention,Diagnosis, and Therapy

Project Leader　TAKUMI Toru

～Outline of Research Project～

We have a super-aged society, and it is an urgent issue to develop more effective and safe preventive, diagnostic, and therapeutic methods against various age-related disorders, including cancer, metabolic diseases, neurological diseases (e.g. dimentia), and immune/inflammatory diseases. For this purpose, there is a need for the development of more appropriate and effective prevention methods and ultra-early diagnostic methods based on the molecular etiology and pathology of various age-related diseases. Furthermore, it has become evident that most of these diseases can be attributable to abnormalities in signal transduction molecules and signal transduction mechanisms.

In this research project, we will focus on cancer signaling, metabolic signaling, brain/mental signaling, immune/inflammatory signaling, and perform seamless analyses at

cell, tissue, and organ levels as well as comprehensive omics analyses to elucidate the patho-physiological mechanisms of these diseases, eventually aiming to identify candidate target molecules for diagnostic and therapeutic approaches. From the viewpoint of drug discovery and regenerative medicine, we will develop novel molecular targeted therapy, using low molecular weight compounds and biologics, and novel regenerative medicine. Moreover, in this research project we will cooperate tightly with Institute for Precision Therapy, University of Washington (Seattle, USA) and Nordic Center for Molecular Medicine, University of Oslo (Norway) to establish an International Drug Discovery Research Organization.

Fusion Research of Medical Device Production and Medical Engineering System

Project Leader　FUKUMOTO Takumi

～Outline of Research Project～

Recently biomedical engineering is a hot-topic, especially in the field of cell biology such as iPS and molecular target drugs. By contrast, there is no methodology focusing on how to produce medical devices using medical engineering system. This is because medical devices could not be produced by clinicians and technicians who produce medical devices have no connection with clinicians.

Our project targets how to fusion the production of required medical devices and medical engineering system. This will be achieved by constituting a 'medical-engineering partnerships.' More specifically, medical forum will be planned to select the research project contributes to much-needed resolution of challenges in clinical medicine by involving fresh and distinguished clinicians and technicians. The most prominent effect of the project is end-to-end medical device production; from clinical evaluation to commercialization. will be achieved for the first time.

Creation of an Innovative Research Area on Lifelong Mental Health

Project Leader　FURUYASHIKI Tomoyuki

～Outline of Research Project～

Although mental health is essential for well-being and welfare of our society, mental illness is increasing year by year. In super-aged society with a low birth rate, mental problems may arise from people of diverse generations and conditions. However, a strategy to solve such problems remains to be established. To promote mental health in the whole society, this research project aims to conduct multi-disciplinary studies integrating psychology, social and life sciences, and engineering on the themes about "diversity, empathy and sociality of the mind", "stress resilience and lifestyle habits for the mind", and "development and aging of the mind". Through collaborations of life, psychological and social sciences, the principles of mental health and illness will be elucidated towards development of objective measures of mental states based on neural and physical functions and multidimensional scales of mental problems that are studied in social sciences. These scales can be applied to develop social interventions such as community health guidance, nursing, care and rehabilitation, ICT-supported self-awareness and control, and environmental improvement that may be proposed for our society, and to invent technologies and products for mental health promotion in collaboration with pharmaceutical, food and healthcare equipment industries. With this strategy, this research project may be useful to develop prescriptions that cover various mental problems of our society and to nurture the next-generation of this research area integrating psychology, social and life sciences, and engineering.

Joint Development of a Seamless Healthcare System in Asian Countries:A Proposal for a Future Healthcare System that Innovates Living

Project Leader　TANEMURA Rumi

～Outline of Research Project～

The emergence of aging societies is an urgent issue throughout the world. In Asian countries, measures to deal with aging societies are needed in countries with declining birthrates and growing proportions of elders, such as South Korea, Taiwan, Singapore, and China, and in the core ASEAN countries of Thailand, Vietnam, and Indonesia. However, with a population exceeding 500 million people in Southeast Asia, there are many destabilizing factors, such as social problems caused by economic disparities and

ethnic and religious diversities. The instability is exacerbated by the presence of highly Infectious Diseases, such as malaria and dengue fever, in tropical areas, and many regions are burdened by their multiple needs to respond to lifestyle-related diseases, aging, and Infectious Diseases. The unique healthcare and hygiene issues of individual countries and the region demand a healthcare system that can flexibly respond to each situation. Thus, it is vital to create a developmental foundation for educational and research environments that cross language, regional, and national borders, and for educators and researchers to form the core of healthcare sciences in Asia, particularly women researchers, who often work in care-providing settings.

Kobe University, in the international city of Kobe, has foreign satellites throughout Asia, including China, Hanoi, and Gadjah Mada, Indonesia. At present, these bases are the focus of our collaborative and cooperative efforts with ASEAN countries to promote the development of highly specialized human resources and researchers in the medical field. This research is characterized by its focus on health and sanitation issues in Asian countries using the organic collaborative work of the foreign bases of Kobe University and the joint research networks of foreign universities, research institutions, and international organizations, such as the WHO. The seamless healthcare system (Kobe-type healthcare and the medical model) research project uses the current educational and research approach along with the aforementioned network.
It aims to be the future of health sciences systems that facilitate comprehensive solutions to issues through project proposals. The projects will conduct surveys and analyses of the status of the diverse health and sanitation issues, study seamless (combined humanities and sciences in regional and foreign collaborations) methods for countermeasures, and apply and implement research results at the societal level that will yield measurable improvements.

Development of Innovative Sustainable Low-carbonization Systems

Project Leader　UCHIYAMA Yusuke

～Outline of Research Project～

Creating a sustainable society is now an urgent issue worldwide. Toward a "low carbon society", the emission of carbon dioxide (CO_2), which is the main cause of the global warming, must be significantly suppressed. In this research project, we bring together the knowledge of researchers working on fluid mechanics and new material science at Kobe University and other domestic and foreign institutions, and conduct highly collaborative subprojects to accomplish a low carbon society though game changing

technology with accelerating the innovative development of environmental and energy technologies. Furthermore, with a strong motivation for evaluation, social implementation and future expansion of the related field, researchers in the fields of humanities participate to joint the projects.

The contribution of science and technology is pronouncedly expected for proposing "relaxation measures" to curb greenhouse gas emissions themselves. In addition, as technological options, we pursue to reduce CO2 emissions with energy generation, energy storage, energy saving, and new "carbon neutral" technologies.
For these purposes, we carry out research and development (R & D) on advanced technologies based mainly on physical and chemical principles. Our specific themes cover R & D issues in various stages, from basic researches relevant to the creation of new concepts, to more applied researches by harvesting technological seeds to feedback the society directly, on new technologies on saving and creating energy.
In particular, we investigate innovative energy generation systems and devices, innovative low energy-loss technology that is more sufficient than existing systems, energy saving technology for sustainable production of chemical products, conversion of biomass to useful chemical substances, improvement of fuel efficiently, new low-cost raw material separation technology, long-term CO2 fixation technology, etc.
Through these research activities, we aim for the innovation of the paradigm by establishing a pathway to low greenhouse gas emission and low carbon society.

Development of innovative light energy conversion systems by hierarchical approach

Project Leader　TACHIKAWA Takashi

～Outline of Research Project～

The development of science and technology that utilize renewable solar energy is one of the most important issues for us to realize a sustainable society. In this project, we will develop innovative light-to-energy conversion systems, such as highly efficient photocatalysts for solar hydrogen production, on the basis of a hierarchical multiscale approach where chemical reaction networks with different time and space scales are designed, analyzed, and controlled. To this end, researchers in various fields will cooperate with each other to promote integrated researches that lead to the establishment of theories and technologies that go beyond conventional concepts.

Dark Matter in the Universe

Project Leader　MIUCHI Kentaro

～Outline of Research Project～

"Dark Matter", the unknown matter in the universe, have played an important role for the formation of the galaxies and stars in the universe during its evolution since the Big Bang. Despite of a considerable number of efforts, the nature of the dark matter is still unknown and revealing its particle nature is one of the largest problems in the astrophysics and particle physics of today. There are three experimental approaches to identify the nature of the dark matter, namely "direct searches", "accelerator experiments", and "indirect searches". These three approaches are complementary ones and combination of these approaches is essential for the discovery and understanding of the dark matter. This project, "Dark Matter in the Universe" aims to study the nature of the dark matter covering these three approaches with international collaborations such as "XENON", "ATLAS", and "Super-Kamiokande / Hyper-Kamiokande" together with "NEWAGE" and "Graine" lead by the Kobe University.

Genome Function in Higher-Order Life Phenomena

Project Leader　FUKAKI Hidehiro

～Outline of Research Project～

Multicellular organisms are composed of various cell types and tissues / organs specialized for their functions, and have complex forms that are characteristic of each species. For example, mammals including humans develop organ systems such as limbs, brain, nervous system and digestive system based on the body axis established in embryogenesis, and realize a body plan possessed by an adult. On the other hand, in vascular plants including seed plants, only a few organs are generated during embryogenesis, and after sprouting, organs such as roots, stems, leaves, and flowers are repeatedly born to form morphologies according to the growth environment. Regardless of animals and plants, multicellular organisms can respond appropriately to various stresses in the environment in which they grow (abiotic stresses such as temperature, moisture, light, radiation, and gravity, and biological stresses such as pathogens), thereby allowing them to continue life. However, the details of the genomic functions responsible for these higher-order biological phenomena (construction and maintenance of multicellular organisms, environmental responses, etc.) have not yet been elucidated even at the time when life science has made great progress.

In this KAITAKU project, we will clarify the genomic functions responsible for higher-order life phenomena found in multicellular organisms, taking advantage of the advantages of various model experimental organisms (animals and plants).
In particular, we will clarify the expression mechanism of genome function through spatiotemporal control of genome information and epigenome information at the cell, tissue, organ, and individual level, as well as cultured mammalian cells, small fish, vascular plants, non-vascular plants, and filamentous fungi, and find commonality and diversity of genome functions based on knowledge from various species.

Main research

① Elucidation of genome function in higher-order life phenomena of animals

1.1 Elucidation of the mechanism of construction and maintenance of multicellular animals using small fish and cultured mammalian cells

1.2 Elucidation of the molecular mechanisms involved in processing of genome damage and pathogenesis caused by their failure

② Elucidation of genome function in higher-order life phenomena of plants

2.1 Elucidation of the mechanisms of development and environmental response of multicellular vascular plants using Arabidopsis thaliana

2.2 Elucidation of the mechanisms of development and environmental response of Marchantia polymorpha

2.3 Elucidation of genome maintenance and environmental response mechanism in filamentous fungi

The biodiversity and ecosystem service relationship in magacity rivers

Project Leader　USHIMARU Atushi

～Outline of Research Project～

Today, more than 50% of world's population lives in city areas and a proportion is predicted to increase up to ca. 70% in 2050. During the last decades, the rapid urbanization with drastic economic growth have caused an increase in developed lands and subsequent loss and degradation of diverse ecosystems globally. This, in turn, leads to loss of ecosystem services, which provide various benefits for humans. Especially, urban rivers are an ecosystem which have been heavily modified with channel straightening and consolidated embankment and whose biodiversity is currently under threat.

In the project, we investigate the biodiversity-ecosystem service (BES) relationship in rivers of the Osaka-Kobe metropolitan area, the second megacity area in Japan. We examine urban river biodiversity (freshwater fish and insect diversity) and ecosystem services by combining environmental survey DNA methods, GIS technique and an internet-based social survey. Especially, we will pay attention to "cultural ecosystem services" which have rarely been evaluated in urban ecosystems.

Digital-Smart Manufacturing

Project Leader　TSUBOKURA Makoto

～Outline of Research Project～

Through the first, second, and third industrial revolutions caused by the steam engine, electric power, and digital technology, respectively, our world economy has been supported by mass production and mass consumption. However, in order to maintain international competitiveness as an industrial power, while ensuring sustainable development under the circumstances of global environmental problems and decrease in population in the developed countries, it is indispensable for Japanese industry to realize a new tailor-made manufacturing system, which will give added value to various industrial products by responding each consumer′ s preferences and needs.

In fact, the fourth industrial revolution will expect to be promoted by making manufacturing process smarter, which will be realized by three key technologies: rapidly growing IT technology represented by "Internet of Things", "big-data analysis", "AI" (Artificial Intelligence), and Cyber Physical Systems; Computer-Aided-Engineering and digital manufacturing technology based on the 3D modelling/printer and simulation; Smart-factory/Supply-chain technology.

In this project, we focus on design, production-system and processing technologies as the three main pillars of supporting manufacturing. Our main purpose is to construct the framework of next-generation "digital-smart" manufacturing by coupling these three technologies with state-of-the-art digital techniques. We also discuss their validity and the way that the new technologies work in the future.

Deployment of environmentally-friendly nanoparticles to bionics, photonics and electronics

Project Leader　FUJII Minoru

～Outline of Research Project～

In this project, researchers in different disciplines (applied chemistry, material science, medical science and electronics) gather together to explore bionics, photonics and electronics applications of novel nanomaterials such as nanoparticles, nanocrystals, quantum dots and nanowires developed within the group. Through this project, we will develope a foundation for continuously generating new materials and technologies that contribute to realize a sustainable society.

Research and Development of Offshore Energy Station toGenerate Electric Power and Hydrogen from Offshore Renewable Energies

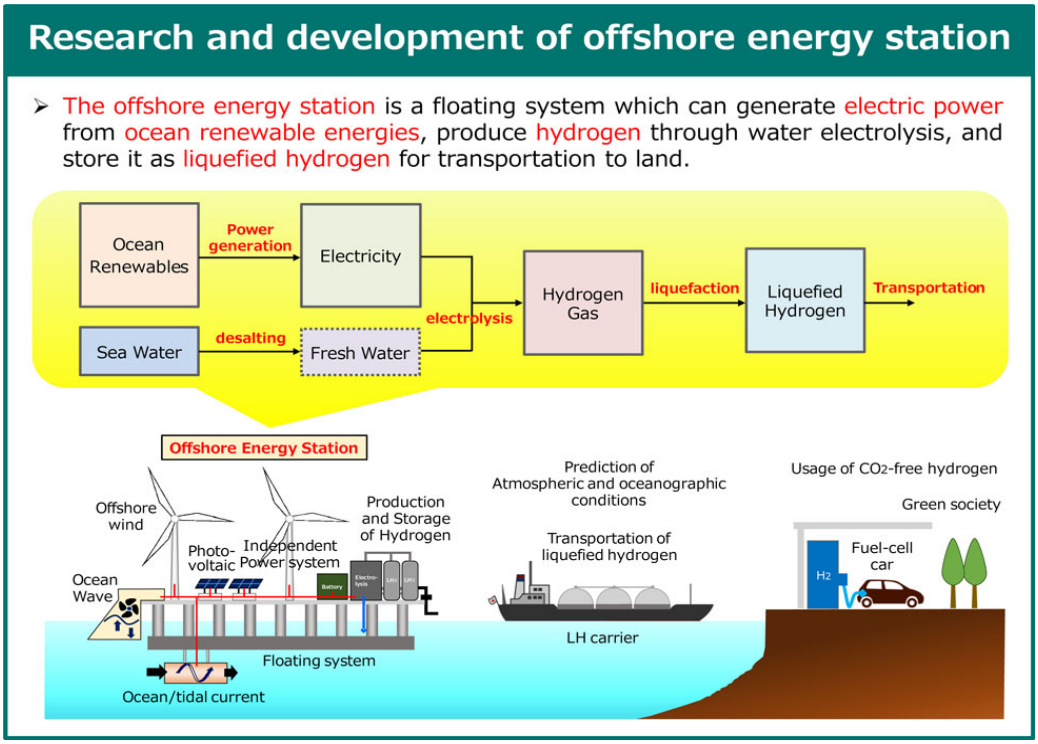
Project Leader　OHSAWA Teruo

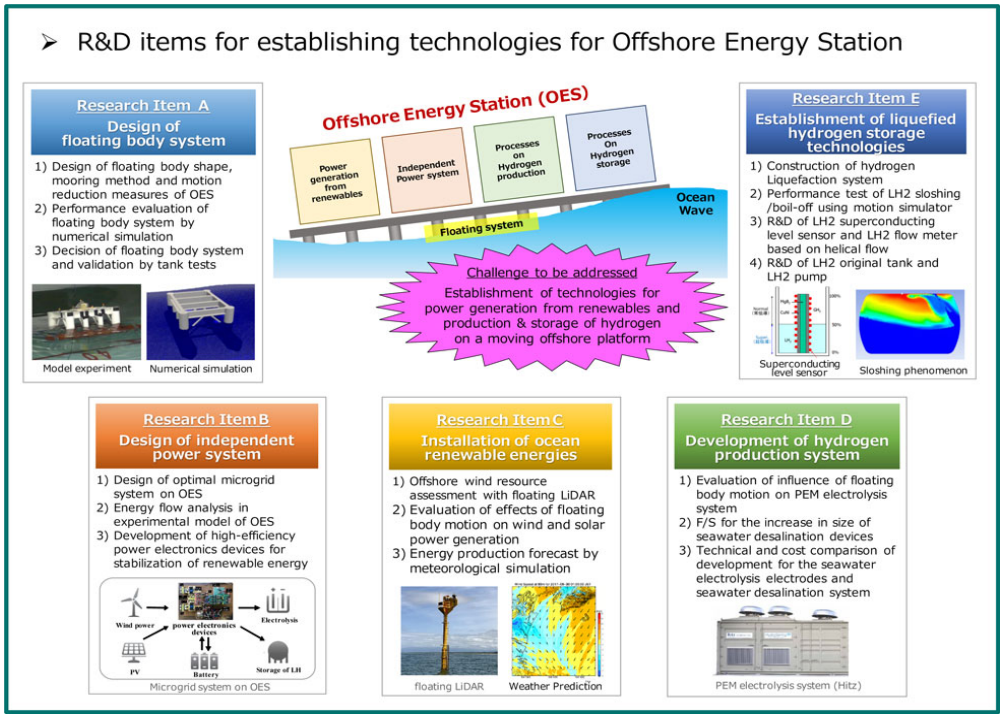
～Outline of Research Project～

Japan has the 6th largest economic exclusive zone in the world, and the development of offshore renewable energies, which are non-fossil, non-nuclear and non-foreign energies, are expected to contribute to the reductions of greenhouse gases and radiation contamination risks and the improvement of energy self-sufficient rate. In order to install a large amount of offshore renewable energies, it is necessary not only to reduce the installation cost but also to establish the technologies to stabilize the power output and storage it offshore, because it is difficult to connect them to the onshore grid due to large fluctuations of power output and long distance to the coast. Our team has already started fundamental researches on hydrogen and offshore wind energy, and we believe that liquefied hydrogen has the potential to be the key technology to store a huge amount of power output from offshore renewable energies such as offshore wind energy on a floating system.

Thus, in this project, we conduct fundamental research on the development of an offshore energy station which can generate green electricity from offshore renewable energies, produce hydrogen through water electrolysis and store it as liquefied hydrogen for transportation to land. The R&D of this study consists of five items: 1) installation of offshore renewable energies, 2) design of floating body system, 3) design of independent power system, 4) development of hydrogen production system and 5) establishment of

liquefied hydrogen storage technologies. The final goal of this research is to build technologies to safely realize all the processes, including power generation from renewable energies, energy conversion from electricity to hydrogen, liquefaction of hydrogen for storage and transportation, on a moving offshore platform. Our team will undertake this research in cooperation with relevant companies.





The next generation of agriculture and resource production by Kobe University

Project Leader　HONDA Kazuhisa

～Outline of Research Project～

The goal of this project is to develop and implement the next generation of agriculture and resource production, including Wagyu, chicken, and Japanese sake brewing rice. We also aim at improving the production system by combining breeding techniques for animals and plants. Other aims include: the development of high value-added Wagyu beef with high meat quality and palatability, methods to evaluate breeding merit and of Wagyu rearing systems, the development of high value-added native chickens and agriculture and poultry production systems, the development of the next generation of brewing rice and its production system, the development of diagnostic techniques for the fertilizing potential of bovine spermatozoa, and the development of self-compatible pear cultivars without artificial pollination. In addition, we will hold an international workshop, help students planning to study abroad or participate in international conventions, and hold a seminar for master's students in order to spread our innovative approach and develop young scientists.