Molecular Biomedical Science and Engineering Course

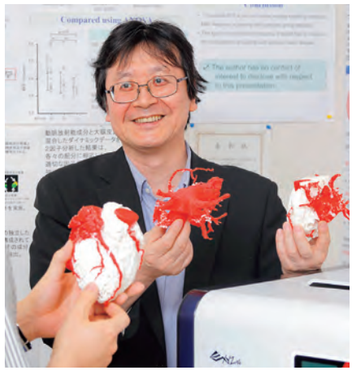
Students are expected to acquire a thorough knowledge of molecular biomedical science and engineering, necessary to apply science and engineering to *in vivo* molecules in medical science, as well as have specialized knowledge and skills in molecular imaging diagnostics, molecular biology, and radiation biology. The training in this course will enable students to conduct international research, and play leading roles in international research and development projects of new molecular image diagnostic equipment and drugs, oncolytic virotherapy, and radiation sensitizers.

Biomedical Imaging

Medical Image Analysis

KATOH Chietsugu,
Professor

This laboratory involves research on computerized processing of images yielded from nuclear medicine tests (PET, SPECT (Single Photon Emission Computed Tomography)), CT, MRI and so on aimed at precisely collecting medical information from such visual data. Regarding tumor images, research is made on estimation of tumor malignancy and volume, estimation of the periphery of lesions, estimation of appropriate range of irradiation, correction of artifacts on images arising from respiratory motions and cardiac beats, and so on. Regarding images of myocardium and brain, compartment model analysis is carried out on serial dynamic images following a dose of contrast material or radioisotope for the purpose of quantitative evaluation of ischemic lesions and quantitative analysis of tissue blood flow, oxygen consumption, etc. Artificial Intelligence technology with deep learning is also adopted for analyzing medical image data. Talents capable of developing programs for achievement of these goals will be cultivated.



Discussion about quantitative analysis for blood flow and oxygen consumption in tissue

Highlighted Keywords: medical image analysis, nuclear medicine examination, compartment model analysis, deep learning

Integrated Molecular Imaging

KUGE Yuji,
Professor

MIZUNO Yuki,
Assistant Professor

For realization of diagnostic molecular imaging, it is indispensable to develop a probe (molecular probe) for conversion of molecular information of the living body into measurable signals. This laboratory is aimed at developing clinically applicable molecular imaging technology through research of new molecular probes, i.e., through exploration of functional molecules, designing of probes, development of probe synthesis technology and synthesis devices, and translational research for clinical application.
This laboratory is also actively conducting research on linking diagnostic molecular imaging technology to accurate treatment, that is, precision medicine and theranostics. In addition, through these research and development activities, this unit will guide students to acquire necessary knowledge/skill systematically so that they can contribute to health-care and society.

Prof. Kuge and Assistant Prof. Mizuno in front of PET・SPECT・CT for animal researches.

Highlighted Keywords: molecular imaging diagnostics, molecular probe design, molecular probe synthesis technology

Biomedical Imaging

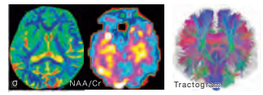
Biomarker Imaging Science

Khin Khin Tha,
Associate Professor

Kenneth Sutherland,
Assistant Professor

Significant efforts have been/ are being paid to achieve "Personalized Medicine". Non- or less invasive imaging techniques such as MRI and CT are extensively used in selection of treatment methods, treatment planning and prediction/assessment of responses to treatment. This laboratory is carrying out researches that target at the development of high resolution and precision imaging diagnostics — which (i) pose little burden on patients, (ii) enable noninvasive detection of early subtle changes of the living body, and (iii) reflect not only morphological information but also the information on physiological changes of the body at cellular/molecular level. Education on normal radiologic anatomy and diagnostic radiology making use of these imaging techniques will also be provided.

An MRI examination



Non-invasive quantitative images with MRI

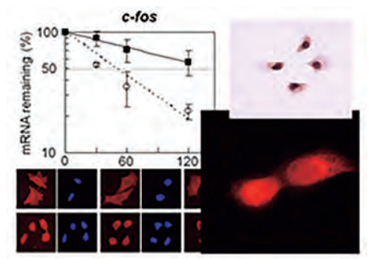
Highlighted Keywords: biomarker imaging science, high precision imaging diagnostics, CT, MRI

Biology for Biomedical Science and Engineering

Molecular Oncology

YASUDA Motoaki,
Associate Professor

Correct understanding of the mechanism for carcinogenesis at the molecular level is necessary for sufficient control of cancer, the leading cause of death among Japanese people. Such understanding is indispensable for development of new cancer diagnosis/treatment methods. In recent years, thorough analysis of RNA including non-coding RNA has been advanced after the end of genome project, and the diverse relationships between carcinogenesis and RNA have been revealed increasingly. At this laboratory, new mechanisms for carcinogenesis are explored on the basis of molecular biological analysis covering RNA, viruses, etc., and systematical education/research, ranging from basics to applied one, will be provided concerning development of new cancer diagnosis/treatment methods making use of the findings from such exploration.



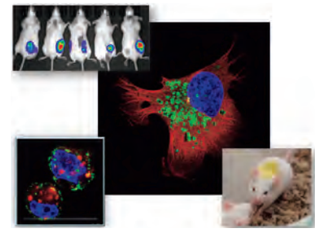
Molecular biological analysis of RNA and RNA-binding protein in cancer cells

Highlighted Keywords: molecular biological analysis, development of new methods of diagnosis and therapies to deal with cancer

Molecular and Cellular Dynamics Research

ONODERA Yasuhito,
Associate Professor

Radiation therapy is commonly used for treatment of cancer as one of the three major treatment modalities. However, as the underlying mechanisms for malignant properties of cancer cells are diverse and variable, the radiation effects and its molecular mechanisms on tumor and surrounding normal tissues still remain elusive. We have been investigating mechanisms inducing/suppressing the cell death in cancer cells, and the resulting unfavorable effects in tumors, which take place under the environmental stresses induced by therapy including radiation and also by cancer cells themselves. We especially focus on the roles of the three-dimensional cell/tissue structures, extracellular microenvironment, cell-cell communication and cellular metabolism, using the experimental techniques of biochemistry, molecular biology, cell biology and synthetic biology. Through the research and education program, we train students to be world-leading scientists and educators with great expertise in cancer research and experimental techniques.



Cancer research using cell and animal models

Highlighted Keywords: cancer invasion and metastasis, vesicle trafficking, extracellular microenvironment, cell-cell interaction, cellular metabolism, radiation biology