

ORGANIZATION OF MIE UNIVERSITY GRADUATE SCHOOL OF MEDICINE

三重大学大学院医学系研究科

Graduate School of Medicine, Mie University

医科学専攻 (修士課程)

Medicine (Master Course)

生命医科学専攻 (博士課程)

Medical Life Sciences (Doctoral Course)

基礎医学系講座		Division of Basic Medical Sciences (Research Fields)
1	分子病態学	Molecular Pathobiology & Cell Adhesion Biology
2	免疫学	Immunology
3	環境分子医学	Environmental and Molecular Medicine
4	公衆衛生・産業医学	Public Health and Occupational Medicine
5	医学医療教育学	Medical Education

臨床医学系講座		Division of Clinical Medical Sciences (Research Fields)
6	循環器・腎臓内科学	Cardiology and Nephrology
7	消化器内科学	Gastroenterology and Hepatology
8	神経病態内科学	Neurology
9	家庭医療学	Family Medicine
10	小児科学	Pediatrics
11	放射線医学	Radiology
12	胸部心臓血管外科学	Thoracic and Cardiovascular Surgery
13	脳神経外科学	Neurosurgery
14	運動器外科学・腫瘍集学治療学	Musculoskeletal Surgery and Multimodality Therapy for Cancer
15	耳鼻咽喉・頭頸部外科学	Otorhinolaryngology-Head and Neck Surgery
16	麻酔集中治療学	Anesthesiology and Critical Care Medicine

その他講座		Other Division (Research Fields)
17	遺伝子・免疫細胞治療学	Immuno-Gene Therapy
14	スポーツ整形外科学	Orthopedics and Sports Medicine
18	脊椎外科・医用工学	Spinal Surgery and Medical Engineering
9	地域医療学	Community Medicine

Molecular Pathobiology

The Molecular Pathobiology Laboratory studies the fundamental mechanisms that regulate leukocyte trafficking and vascular biology in the context of inflammation (atherosclerosis, autoimmune diseases, and septic shock) as well as therapeutic manipulation of the immune system aiming at the development of novel anti-inflammatory therapies and vaccines against infectious diseases.

On-going research projects include:

- (1) How vascular inflammation is induced and how it causes remodeling of vascular walls? This question specifically addresses the underlying mechanisms of atherosclerosis
- (2) How vascular endothelial cells communicate with immune cells via cell adhesion molecules (e.g., integrins, connexins) and signaling molecules? This question specifically addresses the underlying mechanisms of rheumatoid arthritis and multiple sclerosis.
- (3) How physical and chemical environment in the extracellular matrix substrates dictates cell fate (e.g., stem cell differentiation and proliferation). This question explores novel therapeutic targets that globally affect cell fate determination in the field of regenerative medicine.
- (4) How immune cells travel from the bone marrow to the mucosal tissues, thereby developing effective immunity to infectious diseases. This question specifically addresses the molecular pathogenesis of inflammatory bowel diseases and molecular clues as to the development of mucosal vaccines against infectious diseases.
- (5) How the immune system is interconnected to coagulation and wound healing mechanisms. This question specifically addresses the molecular pathogenesis of septic shock and multiple organ failure seen in critically ill patients.
- (6) How to develop animal models that better recapitulate human infectious and immune disorders.

Ph.D. course students will be trained to master basic cellular and molecular biology techniques and involved in an independent research project under full guidance of the faculty member of the department.

Motomu Shimaoka, M.D., Ph.D.

Professor and Chairman

Shimaoka@doc.medic.mie-u.ac.jp

Immunology

The immune system plays a critical role in the defense mechanism against infectious microbes and foreign substances, and Immunology studies the cellular and molecular events that occur during immune responses. However, several medical diseases may also be the result of excessive or inappropriate immune responses against foreign antigens (allergy), self antigens (autoimmune disease) or transplanted foreign cell (graft rejection). Most of the mechanistic and regulatory pathways of the host immune response-related diseases remain unclear. Clarification of these pathways may allow the development of new therapies for several incurable disorders. Therefore, in our laboratory the following investigations are being currently carried out:

1. Molecular mechanisms of allergic diseases including bronchial asthma hay fever
2. The role of immune response and coagulation system abnormalities in incurable chronic diseases including pulmonary fibrosis, chronic obstructive pulmonary disease, pulmonary arterial hypertension, glomerulosclerosis, rheumatoid arthritis, chronic gastritis, hepatitis and others.
3. Development of transgenic or genetically modified animals with incurable diseases including organ fibrosis and cancer.
4. Development of novel therapies for chronic incurable diseases including organ (lung, kidneys, skin, liver, peritoneum) fibrotic diseases.
5. Evaluation of microbiome in health and disease.
6. Molecular and cellular mechanisms of tissue remodeling in chronic inflammatory diseases
7. Defense mechanisms during organ injury
8. Immune response against malignant tumors
9. Mechanistic pathways of CD4+ T cell- and dendritic cell-mediated immune responses
10. The role of clotting factors anti-coagulants in immune response and disease.
11. Immune response during graft rejection
12. Mechanistic pathways of vascular diseases and complications caused by diabetes mellitus and obesity (metabolic syndrome).
13. Development of nucleic acid-based drugs for fibrotic and allergic diseases.

Environmental and Molecular Medicine

The aims of our studies are preservation of environment, prevention of diseases, health promotion and life extension. This division focuses on “Interaction between environmental factors and host”. On the basis of our basic research, performed by molecular biological and physicochemical techniques, we approach to the prevention of cancer and various diseases associated with environment factors and life style. We are carrying out the following projects:

- 1) Oxidative DNA damage induced by environmental carcinogens
- 2) Evaluation of the safety of cancer chemopreventive agents based on DNA-damaging ability
- 3) Molecular mechanism of inflammation-mediated carcinogenesis
- 4) Acceleration of aging and its regulation by antioxidants
- 5) Evaluation of the risk of endocrine disrupting compounds on human health
- 6) Molecular mechanism of apoptosis induced by chemotherapeutic drugs
- 7) Oxidative DNA damage induced by ultraviolet radiation in the presence of endogenous photosensitizers
- 8) Amplification of the effect of chemotherapeutic drugs by DNA-binding drugs (“amplifiers”)

We train students to acquire various experimental techniques, such as subcloning of human cancer relevant genes, analysis of sequence specificity of DNA damage, quantification of oxidative products of DNA bases, immunohistochemical analysis for DNA lesions, analysis of free radicals by electron spin resonance, measurement of intracellular reactive oxygen species and mitochondrial membrane potential by flow cytometry, analysis of interaction of biomolecules by surface plasmon resonance biosensor, mass spectrometry, proteomics approach, using experimental animals, human cultured cells and isolated DNA fragments. We teach the students how to write papers and encourage them to publish their papers in international journals.

Public Health and Occupational Medicine

The Department of Public Health and Occupational Medicine finds possible ways to improve health of population in community or in workplace, evaluates the evidences of them, and practices them. We welcome persons in any background, who are interested in the theme with high motivation. The Department trains graduate students to acquire fundamental research skills and techniques such as setting research object (research design), conducting research, analyzing data, and writing thesis, which are necessary for full-fledged researcher. Moreover, the department offers comprehensive academic guidance on research methodology including epidemiology and medical statistics. The department encourages its graduate students to publish their research in academic journals through guidance of how to read and write papers. If you have original idea about risk of health or the way to improve health, you may test the idea by getting real data in our new cohort systems.

It is also possible to experience the site by hope as an industrial physician and a public health physician. Moreover, going to study in the National Institute of Public Health, the National Center for Child Health and Development, the National Institute of Occupational Safety and Health, and another in Japan and the Harvard Public Health Graduate School and another in foreign countries are mediated by hope and the necessity.

The main research topic on which this department is emphatically working now is as follows.

1. Epidemiologic study on influence of work-related factors (including working hours)
2. Examination of low fertility using administrative data in Japan
3. Examination of influence of electromagnetic field on health
4. Examination of influence of social capital on health
5. Epidemiologic study that applies regional cancer registration by cooperation of the administration and university
6. Research that uses quality of life (QOL) as an outcome
7. Examination of influence of exercise on health

Medical Education

Education should be the most important activity at medical school. Previously, medical education in Japan has been conducted based on the ideas of each teacher. The education in the 21st century has to be evidence-based and outcome-based education. In addition, it is required to meet the global standard and be internationally acceptable.

New types of educational methodology such as problem-based tutorials, basic clinical skill training and clinical clerkships have been introduced for the last decade. Some distinct programs have also been conducted at our school. The large-scaled global electives in Asian and African countries are attracting the interest of other schools. The community based health-profession education is greatly expected to develop human resources in community medicine.

The research at department of medical education aims to explore the optimal programs for medical education by evaluating it's effectiveness and improving the educational system, curricula and methodologies used.

Cardiology and Nephrology

Clinical and basic research in the cardiovascular field is now being performed. Projects conducted in the Departments of Cardiology and Nephrology are as follows:

Cardiology

- (1) Molecular biology-based research with regards to cardiovascular physiology and disease, with a particular focus on regulation of vascular tone, atherosclerosis, and hypertension.
- (2) Signal transduction in angiogenesis and therapeutic angiogenesis via cell transplantation of bone marrow-derived cells.
- (3) Clinical research focusing on outcomes after revascularization of coronary and peripheral arterial diseases, and development of new cardiac catheterization therapies.
- (4) Clinical research to assess hemodynamics and neurohumoral regulation in patients with heart failure and/or cardiomyopathy.
- (5) Clinical research in electrophysiology, including investigation of the mechanisms of arrhythmia, and development of new therapeutic approaches for tachyarrhythmias; including drugs, electrical devices, and catheter ablation.
- (6) Clinical research of the underlying mechanisms, diagnosis and treatment, and prevention of pulmonary thromboembolism, pulmonary hypertension, and deep vein thrombosis.
- (7) Clinical research with regards to risk assessment and prevention of atherosclerosis related to obesity, lipid metabolism, diabetes, and hypertension.
- (8) A thorough assessment of myocardial structure, function, and perfusion using echocardiography and cardiac magnetic resonance imaging.

Nephrology

- (1) Study of the pathogenesis, treatment, and prevention of progressive renal disease, such as immunoglobulin A nephropathy, diabetic nephropathy, and nephrosclerosis.
- (2) Study of predisposing genetic factors for chronic progressive renal disease.

- (3) Clinical research on the mechanisms underlying the development of cardiac and vascular calcification in patients with chronic renal failure.
- (4) Clinical research in the development of a new blood purification column.
- (5) Clinical research focusing on the development of new treatment for glomerulopathy via blood purification therapy.

The guidance to be given involves a large variety of important techniques related to the research projects described above. Education and training through experimental practice are offered in clinical statistics, clinical genetics, clinical engineering, and gene manipulation, in addition to clinical protocols and procedures indispensable for skillful clinical nephrologists (e.g., renal biopsy, hemodialysis technique, clinical use of immunosuppressive agents).

Gastroenterology and Hepatology

The following investigations are currently carried out with especial focus on the diseases of the gastrointestinal tract and the liver.

a. Gastrointestinal tract and Hepatobiliary system

- (1) The intrinsic defense mechanisms against *Helicobacter pylori* infection.
- (2) Molecular mechanisms and therapeutic approaches for inflammatory bowel diseases using mouse models.
- (3) Diagnosis of gastrointestinal neoplasms and lymphomas using magnifying endoscopy.
- (4) Analysis of intrapapillary capillary loops detected by magnifying endoscopy for diagnosis of GERD.
- (5) Diagnosis of gastrointestinal tumors using the convex-type endoscopic ultrasonography (EUS).
- (6) Endoscopic ultrasound-guided fine needle aspiration cytology (FNA) for the histological diagnosis of pancreatobiliary neoplasms.

b. Liver

- (1) Molecular mechanisms of pathogenesis and carcinogenesis of alcoholic and non-alcoholic steatohepatitis.
- (2) Molecular mechanisms of hepatic iron overload in chronic hepatitis C and its clinical relevance: *in vivo* and *in vitro* approaches.
- (3) Nutritional approaches as a therapeutics for chronic liver disease and its complications.
- (4) Roles of the anti-platelet antibody in HCV-related chronic liver diseases.
- (5) Quantitative evaluation of brain and liver abnormalities detected by magnetic resonance imaging in latent hepatic encephalopathy.
- (6) Analysis of nutritional status and energy composition in liver cirrhosis for predicting survival period.
- (7) Roles of hematopoietic progenitor cells on liver regeneration.
- (8) Proteomics analysis in hepatocellular carcinoma.

Neurology

The mission of our department is to clarify the cause and pathomechanism of neurological diseases to make diagnosis, treatment and prevention of them. The main subjects of the research are as follows:

1. Neuroradiological research on dementia; Psychological and neuroradiological studies on cerebral amyloid angiopathy and Alzheimer's disease. With the use of clinical 3 Tesla MRI, studies on meticulous changes in the brains are underway.
2. Physiological and neuroimaging studies on cerebral microcirculation using animal models with chronic cerebral hypoperfusion and genetically-manipulated animals.
3. Neuroimaging and neuropathologies in the human brains with stroke, neuroimmunological diseases and dementia syndrome. Animal PET/MRI has been applied to comparative studies on the radiological-pathological findings.
4. Neurodegenerative diseases: Clinical neurophysiology, neuropathology and neurochemistry, neuroimaging studies and genetic analyses of Parkinson disease, spinocerebellar degeneration and motor neuron diseases.
5. Biomarker studies on Alzheimer's disease and dementia syndromes: Tau protein analysis of cerebrospinal fluid and amyloid-related substance analysis of the blood.
6. Neuropsychology and higher brain function study combined with PET study: Combined neuropsychology and neuroimaging on patients with aphasia, apraxia, agnosia and other cognitive dysfunctions due to cerebrovascular diseases and neurodegenerative diseases.
7. Neurophysiological motor unit analysis on ALS.
8. Palliative care and networking system for patients with neurological diseases.

Lectures and practices will be held on clinical neurology and neurosciences, molecular biology and molecular genetics, diagnosis and therapy, and epidemiological study of neurological diseases.

Family Medicine/General Practice/Community Medicine

[Scope of the Research]

Our department uses both quantitative and qualitative research methods to investigate issues essential to providing efficient medical care for supporting family and community health. Consequently, our research also includes elements from the behavioral science, health economics, and medical education. Our department currently focuses on the following major themes:

- (1) Improving the effectiveness of the medical interview
- (2) Confirming the reliability and validity of several research instruments, in the context of Japanese practice, for example: patient satisfaction questionnaire, patient-centeredness questionnaire, JSPS (Japan Scope of Practice Scale, cooperation questionnaire, physician satisfaction questionnaire, etc.)
- (3) Quantifying the relationship between various factors related to clinical practice, including: patient-centeredness medical comprehensiveness, and cooperation and patient satisfaction, adherence and health outcomes, etc.
- (4) Exploring the relationship between access, duration of medical practice with patients, physician satisfaction and patient behavior.
- (5) Understanding the association between various lifestyle-related factors (ex. Green tea intake, breast feeding, smoking, alcohol intake, physical activities etc.) and health status.
- (6) Health economics (ex. frequency of medical consultation and health status)
- (7) Development and evaluation of new medical education and training systems, for enhancing the practice of family and community medicine

[Instructed Skills]

- (1) How to construct a research question
- (2) How to plan a research protocol
- (3) How to obtain grants
- (4) How to obtain research data
- (5) How to design and develop research instruments (questionnaires, etc.)
- (6) How to processes and prepare raw data
- (7) How to analyze and interpret research data
- (8) How to perform qualitative research
- (9) How to write a research manuscripts
- (10) How to present your research
- (11) Research ethics
- (12) Others

Pediatrics

The research activities in this division are oriented towards understanding pathophysiology of diseases that occur between neonatal period and adolescence. The activities are based on hematology/oncology, cardiology, allergic diseases, infectious diseases, and neonatology.

Main research areas in these fields are as follows:

- (1) Hematology/oncology: Translational research for cancer diagnostics and therapeutics, including hematopoietic stem cell transplantation area.
- (2) Cardiology: Pathogenesis of primary pulmonary hypertension
- (3) Allergic diseases: Function of eosinophils and activation pathways in eosinophils
- (4) Neonatology: Immune system in neonates, neurological development and behavior in neonates

Students will learn techniques in flow cytometry analysis, detection of specific proteins or genes, electrophysiological analysis and animal experiments. The direction of research is always towards clinical application.

Department of Radiology

The Department of Radiology in Mie University has an international reputation as one of the most advanced leading sites in Asia in the field of cardiovascular imaging, neuroradiology, aortic stent grafting and interventional radiology. Research fellows including those from foreign countries have engaged in advanced investigational projects, and our department is serving as a center for multi-center studies in cardiac MR and CT. The department consists of four major fields, diagnostic radiology, molecular imaging, interventional radiology and radiation therapy. Main research themes in this department are as follows:

Diagnostic Radiology

1. Assessment of myocardial perfusion, myocardial strain, coronary artery stenosis and plaque using advanced MR data acquisition and image analysis techniques.
2. CT assessment of coronary artery disease, myocardial perfusion and myocardial fibrosis by using the third generation dual-source CT.
3. MR assessment of cerebrovascular disorders and tissue characterization of tumors and other diseases with new MR and CT imaging techniques.

Molecular Imaging

4. Evaluation of metabolism and molecular alterations in tumors and hearts using Positron emission tomography (PET-CT)

Interventional Radiology

5. Advanced treatment of aortic diseases using stent-grafts
6. Advanced cancer therapy using radio-frequency pulse wave and cryotherapy.

Radiation therapy

7. Advanced image guided radiotherapy and intensity modulated radiation therapy.

Thoracic and Cardiovascular Surgery

Research provides the foundation for innovation and improvements in medicine and the cardiothoracic faculty lead and collaborate with investigative teams in basic science, translational research, clinical trials, and outcomes research, laying the groundwork for current and future improvements in patient care. This culture of medical education and research at Mie University translates to consistent access to the latest technology, medical advances, subspecialty expertise, and clinical trials that ultimately benefit all patients.

Especially our research interests are as follows:

1) Cardiovascular Surgery

- i. Developments of new technique for repair of congenital heart defects
- ii. Mechanisms of pulmonary hypertension with congenital heart disease and its prevention
- iii. Clinical study of antiplatelet agent after coronary artery bypass surgery
- iv. Neointimal hyperplasia of graft failure at coronary artery bypass surgery
- v. Developments of drug-eluting stent graft and its application for aortic aneurysms
- vi. Hematopoietic stem cell transplantation for thoracic aortic aneurysm
- vii. Developments of less invasive methods of cardiopulmonary bypass
- viii. Surgical and pharmacological treatment of atrial fibrillation
- ix. Vein graft adaptation for peripheral vascular surgery

2) General thoracic surgery

- i. Molecular biological methods of expectancy of surgical result of primary lung cancer
- ii. Rationale of minimum invasive surgery for lung cancer
- iii. Gene therapy for lung cancer
- iv. Lung ischemia-reperfusion injury at lung transplantation

Neurosurgery

Our graduate program includes the clinical and basic science research for developing new techniques for diagnosis and treatment of neurosurgical diseases, such as vascular lesions, malignant and benign tumors, traumas, infections, malformations and functional diseases of the central nervous system. Among them, we are focusing on the following projects.

Main Projects:

- 1) Development of devices for neuro-endovascular therapy.
- 2) Analysis of clinical data of neuro-endovascular therapy.
- 3) Biological response of the arterial wall to carotid artery stenting.
- 4) Molecular mechanism of cerebral vasospasm.
- 5) Neuroprotection against brain injury after subarachnoid hemorrhage.
- 6) Multimodality therapy for malignant brain tumors.
- 7) Neuroendoscopic treatment of pituitary tumors.
- 8) Computational flow dynamics (CFD) analysis of cerebral aneurysms concerning the growing and rupture risks.

Graduate students will research one or several areas of the projects using the techniques of neuropathology, neuroanatomy, neurochemistry, neurophysiology, neuropharmacology and neuroimaging.

Orthopaedic Surgery

We are first studying the elucidation of pathology, diagnosis and therapy for musculoskeletal diseases and orthopaedic oncology. Secondly the following investigations are being carried out.

Joint Surgery

- (1) Epidemiologic investigation and evaluation of biochemical markers for osteoarthritis
- (2) Study of matricellular protein in arthritis
- (3) Development of new biomaterial for musculoskeletal reconstruction

Orthopaedic Oncology

- (1) Exploratory studies of the genes related to sarcoma
- (2) Development of custom-made tumor prosthesis
- (3) Analysis of the micro-environment of sarcoma

Osteoporosis

- (1) Study of osteoporotic pain

Spine

- (1) Biology of intervertebral disc and biological repair of intervertebral disc degeneration
- (2) Development of novel spinal instrument
- (3) Population-based cohort study of vertebral fracture

Hand and Microsurgery

- (1) Effect of musculoskeletal drug to Schwann cells for development of peripheral nerve regeneration
- (2) Therapeutic strategy of systemic and local condition due to ischemia-reperfusion injury of skeletal muscles
- (3) Pathophysiology of Dupuytren's disease
- (4) Pathological analysis of synovium in upper extremities' tenosynovial disease including rotator cuff tears and carpal tunnel syndrome

Sports Medicine

- (1) Cohort study about Locomotive syndrome
- (2) Development of a new muscle strength measurement device in lower limbs
- (3) Epidemiological study for sports young athlete injuries

Guidance Themes

Guidance centered on experiments and trainings is provided to obtain fundamental techniques for basic genetic engineering, the analysis of the mechanism of gene expression, the analysis of the mechanism of intracellular transmission of signals, the development of animal models, the biomechanical analysis, the morphological measurement, and to practice the diagnosis, treatment and prophylaxis of diseases.

Otorhinolaryngology-Head and Neck Surgery

The main interests of our department are defense mechanisms of upper and lower airways in normal and diseased states. The following subjects have been studied intensively.

1) Molecular mechanisms of airway mucus hypersecretion

Expression of mucin genes and gene products are analyzed in normal and chronic airway diseases. We are trying to clarify the signaling pathways in secretagogues-induced up-regulation of mucin genes. Mechanisms of inhibition of the mucin genes expressions by macrolide antibiotics are also investigated.

2) Pathophysiology and treatment of allergic rhinitis

We are focusing on the effects and mechanisms of immunotherapy in the treatment of pollinosis and microRNAs in the allergic diseases.

3) Primary ciliary dyskinesia

Electronmicroscopic studies of motile cilia and mutation analysis in the genes associated with ciliary movement are being carried out in collaboration with affiliated facilities.

4) Pathophysiology and treatment of smell and taste disorders

5) Role of microRNAs in the development of head and neck carcinoma

6) Improvement of neural regeneration after olfactory system injury

Anesthesiology and Critical Care Medicine

We investigate pulmonary hemodynamics. Pulmonary vascular changes include new muscularization of normally non-muscular arteries and medial hypertrophy of normally muscular artery. These changes develop in chronic obstructive lung disease, pulmonary fibrosis, congenital heart disease with right to left shunt, persistent pulmonary hypertension of neonate, primary pulmonary hypertension, and late-stage acute respiratory distress syndrome. We characterize physiological, pathological, pharmacological and molecular aspects of pulmonary vasculature. We investigate from living animal to gene. In clinical standpoint we study cardiopulmonary resuscitation.

You can learn following items.

Measurement of pulmonary artery pressure in rat and mouse in vivo

Morphometrical analysis of hypertensive pulmonary vasculature

Nitric oxide inhalation in rat and human

Hypoxia responsive gene

Western blot

PCR

Immunohistochemistry

Measurement of tension in isolated pulmonary artery

Gene therapy of pulmonary hypertension in animal model

Open lung approach in acute respiratory distress syndrome

Elastase and pulmonary hypertension

Cardiopulmonary resuscitation

Multiple organ failure

Artificial ventilation

Anesthesia

Acute lung injury

Immuno-Gene Therapy

Research Themes

Our aim is to develop immune-mediated cell therapy for cancer using gene-transduced lymphocytes engineered to specifically destroy tumor cells. Our research strategy is translation of science-based novelty and methodology into clinical application. Our final goal is to develop novel therapy for cancer to a pharmaceutical level, collaborating with worldwide clinical pharmaceutical developers.

- Cloning of T-cell receptor (TCR) gene of T lymphocytes specific for tumor antigen, MAGE-A4, WT-1 and NY-ESO-1, etc.
- Development of novel chimeric antigen receptor (CAR) –T cell therapy utilizing phage display library, which recognize cell surface peptide-MHC complex of MAGE-A4, WT-1 and NY-ESO-1.
- Transduction TCR or CAR gene to human lymphocytes and their functional analysis.
- *In vivo* tumor effect of the engineered cells in animal models
- *In vitro* expansion of peripheral lymphocytes using cytokine and novel compounds.

Guidance Themes

Guidance centered on experiments and trainings is provided to obtain fundamental techniques for:

- Molecular and cellular biology.
- Cell-culture techniques of human lymphocytes.
- *In vivo* animal experiments of cancer biology.
- Immuno-biological analysis including ^{51}Cr -release assay, ELISA, ELISPOT and flow-cytometry.
- Designing and managing human clinical trials.

Spinal Surgery and Medical Engineering

The department of Spinal Surgery and Medical Engineering has focused on spinal biomechanics and commercialization of products for patients with spinal diseases. Most studies are performed in cooperation with the department of mechanical engineering.

The main themes are as follows.

1. Production of our measurement device for intervertebral instability
2. Basic studies on micromovement of pedicle screws
3. Production of shape memory alloy spinal instrumentation
4. Reassessment and improvement of Tadpole system
5. Stability and roll of crosslink system in pedicle screw and rod system