Syllabus 2023

Faculty of Pharmaceutical Sciences
Tohoku University

INDEX

◆Basic Educational Subjects

◇Lecture

1st Semester

2nd Semester

3rd Semester

4th Semester

5th Semester

Subject	Introduction to Pharmaceutical Sciences 1				
Course Numbering	YAL-PHA201J	Categories	Required		
Preferable Participants	1st	Semester	1	Credits	2
Instructor	Profs. Nakabayashi Takakazu, Tokuyama Hidetoshi, Yoshikai Naohiko, Inoue Asuka, Konno Tomohiro, Asai Teigo, Saito Yoshiro, Matsuzawa Atsushi, Kurata Shoichiro, Sasaki Takuya, Oe Tomoyuki, Akita Hidetaka, Mano Nariyasu, Takahashi Nobuyuki, and Tomioka Yoshihisa				
Practical business					
Objectives and summary of class	Learn that science of medicine is made up of research in a wide field. In addition, the prospect of the research field of its own to learn pharmaceutical sciences and pharmacy in the near future, to understand the importance of learning courses to learn at the university in the future. This class is to be learned as part of introduction of pharmaceutical education.				
Goal of study	Outlook a wide discipline in the future study at Faculty of Pharmaceutical Sciences, to understand the importance of learning a wide range of specialized subjects.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Nakabayashi	Introduction(1)	Class guidance, Drug and light
2	Tokuyama	Introduction(3)	Drug and molecular structure
3	Yoshikai	Introduction(3)	Drug and chemical synthesis
4	Akita	Introduction(4)	Safety and control of kinetics (DDS) of drug
5	Konno	Introduction(5)	Medicine and biomaterials
6	Asai	Introduction(6)	Drug produced by organisms
7	Saito	Introduction(7)	Medicine and metabolism
8	Matsuzawa	Introduction(8)	Medicine and mechanism of cellular stress
9	Kurata	Introduction(9)	Drug and biological function
10	Sasaki	Introduction(10)	Pharmacological effects
11	Oe	Introduction(11)	Measurement of drug
12	Inoue	Introduction(12)	Drug activity *in vitro*
13	Takahashi	Introduction(13)	Journey of Medicines to get prescribed
14	Mano	Introduction(14)	Analysis in biomedical science at the pharmaceutical department in hospital
15	Tomioka	Introduction(15)	Medicines and diseases

Record and evaluation method	Evaluated by report (70%) and class performance (30%)
Textbook	Not specified
Reference	

Preparation and Review	About the special field and research content of each professor in charge of the class, prepare at the laboratory homepage.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. (See student handbook)
In addition	

Subject	Functional Morphology 1					
Course Numbering	YAL-PHA231J	Categories	Elective			
Preferable Participants	1st	Semester	1	Credits	2	
Instructor	Professor Hirasawa Noriyasu					
Practical business						
Objectives and summary of class	This course provides students with basic knowledge about human body. Functional Morphology 1 covers cells and tissues, respiratory systems, and digestive systems.					
Goal of study	Students can explain the structures and functions of organelle in cells, blood cells, hematopoiesis, and organs in respiratory system and digestive system.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Hirasawa	Structure of human body	Students understand the significance to study functional morphology in Pharmaceutical sciences. In this course, students learn the outline of organs and their locations.
2	Hirasawa	Structure and functions of Cells (I)	Students learn the outline of cells and the structure and function of cell membrane.
3	Hirasawa	Structure and functions of Cells (II)	Students learn structures and functions of organelle.
4	Hirasawa	Structure and functions of Cells (III)	Students learn cytoskeleton, cell cycle and cell adhesion.
5	Hirasawa	Blood and hematopoiesis	Students learn types of blood cells and their functions, and hematopoiesis and differentiation of blood cells.
6	Hirasawa	Lymphatic system	Students learn structure and function of lymph node, spleen and thymus.
7	Hirasawa	Epithelial tissue	Students learn the structure and function of epithelial cells.
8	Hirasawa	Connective tissue	Students learn the structure and function of connective tissues.
9	Hirasawa	Respiratory system	Students learn the structure and function of respiratory system.
10	Hirasawa	Digestive system	Students learn outline of digestive system, and basic structures of digestive tracts.
11	Hirasawa	Stomach	Students learn the structure and function of stomach.
12	Hirasawa	Small intestine and large intestine	Students learn the structure and function of small and large intestines.
13	Hirasawa	Liver (I)	Students learn outline of liver and its functions.
14	Hirasawa	Liver (II)	Students learn the micro-structures of liver and the relation to the functions.
15	Hirasawa	Pancreas	Students learn the structure and function of pancreas.

Record and evaluation method	Students are evaluated on the final examination (100%).
Textbook	Materials are provided via ISTU.
Reference	
Preparation and Review	

Language Used in Course	Japanese
Office hours	Questions are accepted at any time. Make an advance appointment via e-mail or other means.
In addition	

Subject	Organic Chemistry 1					
Course Numbering	YAL-PHA221J	Categories	Elective			
Preferable Participants	1st	Semester	2	Credits	2	
Instructor	Associate Professor Masaatsu Adachi and Assistant Professor Kosuke Ohsawa					
Objectives and summary of class	In this course, students will understand basic concepts of organic chemistry following Chemistry C of the General Education in which atomic orbitals, molecular orbitals, and the theory of chemical bonding are introduced. This course covers stereochemistry for spatial understanding of molecular structure. Students will also learn about substitution reactions (S_N1 and S_N2 reactions) and elimination reactions (E1 and E2 reactions) of alkyl halides based on the fundamental theory of chemical reactions.					
Goal of study	The aim of this course is to help student explain the meaning of basic terms for stereochemistry with specific examples. The aim of this course is to help student explain the organic reactions based on thermodynamic and kinetic point of view. The aim of this course is to help student explain characteristics, reaction mechanisms, stereochemical outcomes, and factors affecting reactions regarding substitution reactions with alkyl halides (S_N1 and S_N2 reaction). The aim of this course is to help student explain characteristics, reaction mechanisms, stereochemical outcomes, competition with substitution reactions, and factors affecting reaction regarding elimination reactions with alkyl halides (E1 and E2 reaction).					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Adachi	Stereochemistry (1)	Students will learn about classification of isomers and concept of stereogenic center.
2	Adachi	Stereochemistry (2)	Students will learn about stereogenic center of cyclic compounds and rules to define absolute configuration (R and S).
3	Adachi	Stereochemistry (3)	Students will learn about diastereomers and *meso* compounds.
4	Adachi	Stereochemistry (4)	Students will learn about technical terms of optical activity, optical purity, and enantiomeric excess.
5	Adachi	Understanding of organic reactions (1)	Students will learn about category of organic reaction, writing style of chemical equation, and bond-dissociation energy.
6	Adachi	Understanding of organic reactions (2)	Students will learn about organic reactions from thermodynamic point of view.
7	Adachi	Understanding of organic reactions (3)	Students will learn about organic reactions from kinetic point of view, and learn about catalysts and enzymes.
8	Adachi	Substitution reaction with alkyl halides (1)	Students will learn about properties, structures, nomenclature of alkyl halide and concept of nucleophilic substitution reaction.
9	Adachi	Substitution reaction with alkyl halides (2)	Students will learn about category of nucleophilic substitution reactions (S_N1 and S_N2 reaction) and reaction mechanisms of S_N2 reaction.

10	Adachi	Substitution reaction with alkyl halides (3)	Students will learn about reaction mechanisms of S_N1 reaction.
11	Adachi	Substitution reaction with alkyl halides (4)	Students will learn about factors affecting S_N1 and S_N2 reactions.
12	Ohsawa	Elimination reaction with alkyl halides (1)	Students will learn about concept of elimination reactions, and structure and physical property of elimination products, alkenes.
13	Ohsawa	Elimination reaction with alkyl halides (2)	Students will learn about reaction mechanism of E2 reaction and factors affecting mechanisms of E2 reaction.
14	Ohsawa	Elimination reaction with alkyl halides (3)	Students will learn about reaction mechanisms of E1 reaction and factors affecting mechanisms of E1 reaction.
15	Ohsawa	Elimination reaction with alkyl halides (4)	Students will learn about relationships between E2 reaction and stereochemistry, and factors determining course of reactions (S_N1, S_N2, E1, or E2 reaction).

Record and evaluation method	Evaluated mainly by examination (80%) and class performance (20%)
Textbook	'Organic Chemistry — 5th edition' J. G. Smith
Reference	
Preparation and Review	Prepare for the textbook before attending the lecture. In addition, after the lecture, review the content of the lecture and solve the end-of-chapter problems to deepen your understanding.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means before students will visit office. E-MAIL: TEL: masaatsu.adachi.d7@tohoku.ac.jp, kosuke.ohsawa.a1@tohoku.ac.jp
In addition	Conducted exercises and SGD every time

Subject	Organic Chemistry 2				
Course Numbering	YAL-PHA222J	Categories	Elective		
Preferable Participants	1st	Semester	2	Credits	2
Instructor	Professor Hidetoshi Tokuyama and Assistant Professor Juri Sakata				
Objectives and summary of class	In the organic chemistry 2, studied are 1) the structure, property and reaction of alcohols, ethers, and epoxides; 2) the structure, property and reaction of alkenes and alkynes; 3) basis of multistep synthesis. Reactions include hydrogenation and oxidation of alkenes and alkynes along with radical reactions, which are fundamental expertises of medicinal chemistry.				
Goal of study	To be able to explain structure, nomenclature, chemical property, and reaction of alcohols, ethers, and epoxides To be able to explain structure, nomenclature, and property of alkenes and alkynes To be able to explain mechanism, selectivity, and stereochemistry of alkene and alkyne addition reactions To be able to explain C-C bond forming reaction using acetylide To be able to explain reduction and oxidation reactions To be able to explain radical halogenation reaction				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Tokuyama Sakata	Alcohol, ether, and epoxide 1	Structure, property, and nomenclature of alcohols, ethers, and epoxides
2	Tokuyama Sakata	Alcohol, ether, and epoxide 2	Synthesis of alcohols, ethers, and epoxides
3	Tokuyama Sakata	Alcohol, ether, and epoxide 3	Reaction of alcohols
4	Tokuyama Sakata	Alcohol, ether, and epoxide 4	Reaction of ethers and epoxides
5	Tokuyama Sakata	Alkene 1	Structure, property, and nomenclature of alkenes
6	Tokuyama Sakata	Alkene 2	Addition reaction of hydrogen halide, water, and halogen to alkenes
7	Tokuyama Sakata	Alkene 3	Alkene hydroboration and oxidation
8	Tokuyama Sakata	Alkyne 1	Structure, property, and nomenclature of alkynes
9	Tokuyama Sakata	Alkyne 2	Addition to alkynes
10	Tokuyama Sakata	Alkyne 3	C-C bond formation using acetylides and multiple step synthesis
11	Tokuyama Sakata	Oxidation and reduction 1	Hydrogenation of alkenes and alkynes
12	Tokuyama Sakata	Oxidation and reduction 2	Oxidation of alkenes, alkynes, and alcohols
13	Tokuyama Sakata	Radical reaction 1	Structure of radical and alkane radical halogenation

14	Tokuyama Sakata	Radical reaction 2	Stereochemistry of radical reaction
15	Yoshikai	Radical reaction 3	Halogenation at the allylic position
Record and evaluation method		Evaluated mainly by examination (80%) and class performance (20%)	
Textbook		'Organic Chemistry — 5th edition' J. G. Smith	
Reference			
Preparation and Review			
Language Used in Course		Japanese	
Office hours		Make an advance appointment via e-mail or other means. E-MAIL: tokuyama@mail.pharm.tohoku.ac.jp, juri.sakata.e8@tohoku.ac.jp	
In addition			

Subject	Analytical Chemistry 1					
Course Numbering	YAL-PHA211J	Categories	Elective			
Preferable Participants	1st	Semester	2	Credits	2	
Instructor	Professor Oe Tomoyuki					
Practical business						
Objectives and summary of class	Medicinal drugs are used to cure, treat, or prevent diseases. The qualities should be assured to avoid adverse reactions and are strictly controlled by low. Therefore, reliable analytical methods are required to monitor the impurities, contents of the ingredients, *etc.* This course covers quantitative drug analyses in Japanese Pharmacopoeia, 16th Ed (JP16) and aims to help students understand the concept of quantitative analysis.					
Goal of study	Better understanding of chemical equilibrium to explain/calculate pH values of solutions and buffer solutions. Better understanding of gravimetric and volumetric analyses to quantitate chemicals.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Oe	Introduction: analytical chemistry	Overviewing analytical chemistry: How to contribute in pharmaceutical sciences
2	Oe	Overview: quantitative analysis of drugs	Overviewing quantitative drug analysis in JP16, in terms of the technical terms, reagents, apparatus, and handling of analytical data
3	Oe	Weighing scale and gravimetric analysis	Learning about the principle of weighing scales to understand the basis of gravimetric analysis
4	Oe	Overview: volumetric analysis	Overviewing volumetric analysis: categorization, operation, and preparation/standardization of standard solutions
5	Oe	Acid-base titration I	Learning about the definition of “acid and base”, and chemical equilibrium to understand acid-base titration
6	Oe	Acid-base titration II	Learning how to calculate pH value of acid, base, and salt solutions
7	Oe	Acid-base titration III	Learning about Henderson–Hasselbalch equation to understand how buffer solution can work
8	Oe	Acid-base titration IV	Learning about acid-base titrations appeared in JP17
9	Oe	Non-aqueous titration	Learning about typical acid-base titrations and redox titration (Karl Fisher method) performed in non-aqueous solution
10	Oe	Chelatometric titration I	Learning about coordination complex to understand Chelatometric titrations
11	Oe	Chelatometric titration II	Learning about chelatometric titrations appeared in JP16
12	Oe	Precipitation titration	Learning about Fajans–Paneth–Hahn Law and examples in JP17
13	Oe	Redox titration I	Learning about the definition of “oxidation and reduction”, and Nernst equation to understand redox titration
14	Oe	Redox titration II	Learning about typical redox titrations (iodometry, iodimetry, and permanganometry) appeared in JP16
15	Oe	Practice	

Record and evaluation method	Based on the written exam
Textbook	Analytical Chemistry I (パートナー分析化学 I), 4th Ed., Ed. J. Haginaka, K. Kato, Nankodo Co., Ltd., 2021 (ISBN 978-4-524-40384-4)

Reference	Quantitative analysis（図解とフローチャートによる定量分析), Ed. S. Asada, S. Uchide, M. Kobayashi, Gihodo Shuppan Co., Ltd., 1987 (ISBN 4-7655-0342-9) Basic reactions in analytical chemistry (分析化学反応の基礎), Ed. The Japan Society for Analytical Chemistry, Hokkaido Branch and Tohoku Branch, Baifukan Co., Ltd., 1994 (ISBN 4-5630-4535-7) Quantitative drug analysis (定量薬品分析), Ed. T. Momose, Hirokawa Publishing Co., Ltd., 1989 (ISBN4-567-25204-7) Experimental analytical chemistry（新分析化学実験), Ed. The Japan Society for Analytical Chemistry, Hokkaido Branch and Tohoku Branch, Kagaku-Dojin Publishing Co., Inc., 1989 (ISBN 4-7598-0199-5) Quantitative analytical chemistry (定量分析化学), Ed. S. Kawai, T. Kinoshita, A. Tsuji, and M. Watanabe, Maruzen Co., Ltd., 1993 (ISBN 4-6210-3111-2)
Preparation and Review	
Language Used in Course	Japanese
Office hours	An appointment required by E-mail (t-oe@mail.pharm.tohoku.ac.jp) or phone (795-6817).
In addition	

Subject	Physical Chemistry 1					
Course Numbering	YAL-PHA214J	Categories	Elective			
Preferable Participants	1st	Semester	2	Credits	2	
Instructor	Associate Professor Kajimoto Shinji					
Practical business						
Objectives and summary of class	In this course, students will understand the nature and structure of molecules on the basis of quantum theory. Molecular science is increasingly becoming important in the fields of analysis and development of drugs. This course covers from the introduction to molecular orbital theory to the structural analysis of molecules by using electronic spectra. Completion of "Physical Chemistry 1" is important for understanding "Structural Chemistry" that is held at Semester 4.					
Goal of study	(1) This course helps students understand molecular orbital method and obtain wave functions and their energy levels of σ orbitals of hydrogen molecule and π orbitals of ethene and butadiene by calculation. (2) Students will understand the difference between bonding and antibonding molecular orbitals based on the wave functions. (3) Students will be able to determine whether an electronic transition is allowed or forbidden based on the symmetry of molecular orbitals. (4) Students will be able to explain electronic transitions such as π–π*, n-π* and d-d transition. (5) Students will learn about the principles, measurements and applications of ultraviolet (UV)-visible absorption, fluorescence and circular dichroism.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Kajimoto	Molecular orbital method (1)	Students will obtain molecular orbitals (MOs) of hydrogen molecule using one electron approximation, LCAO MO approximation and variational calculus.
2	Kajimoto	Molecular orbital method (2)	Students will obtain wave functions and energy levels of π orbitals of ethene and butadiene by the simple Hückel method, and understand the electronic ground and excited states of these molecules.
3	Kajimoto	Molecular orbital method (3)	Students will understand the effects of the π bond formation and the conjugation of double bonds on the stabilization of the ground state of molecules with double bonds. Extension of the conjugated system lowers the energy of the HOMO-LUMO gap to give a UV-visible absorption at longer wavelength.
4	Kajimoto	Molecular symmetry and group theory (1) Symmetry operation and Point group	Students will be able to find symmetry operations of molecules. Students will understand that a complete set of symmetry operations of a molecule forms a point group. Students will study the relationship between molecular symmetry and properties of some organic and inorganic molecules.
5	Kajimoto	Molecular symmetry and group theory (2) Representation and character	A symmetry operation can be mathematically expressed by a matrix called representation. Students will understand properties of the character which is the sum of the diagonal elements of representation matrix.
6	Kajimoto	Molecular symmetry and group theory (3) Character table	Students will be able to block-out a reducible representation to irreducible representations by using a character table.
7	Kajimoto	Symmetry of electronic states	Students will be able to estimate the symmetry of MOs and electronic states of ethene and butadiene.

8	Kajimoto	Allowed and forbidden electronic transitions	Students will learn a method to judge an electronic transition is allowed or not based on the symmetry of MOs and the electronic states.
9	Kajimoto	Various electronic transitions	Students will understand (1) various electronic transitions such as π-π* and n-π* transition and (2) solvent effects on the energy levels of electronic states and absorption spectrum of molecules.
10	Kajimoto	Electronic states and absorption spectrum of various molecules	Students will be able to judge electronic transitions of various molecules such as benzene and formaldehyde are allowed or not. The obtained results are compared to absorption spectra of the molecules.
11	Kajimoto	Absorption spectra of metal complexes	Students will understand that the colour in transition metals is due to the splitting of the d orbitals into different energy levels by the ligand field and electronic transitions between the d orbitals (d-d transition).
12	Kajimoto	Franck–Condon principle	An electronic transition involves the simultaneous changes in electronic and vibrational energy levels of a molecule (vibronic transition). Students will be able to explain the intensities of the vibronic transitions and the shape of an absorption band based on the Franck–Condon principle.
13	Kajimoto	Fluorescence and phosphorescence	Students will understand the relaxation process for fluorescence or phosphorescence emission after the excitation of a molecule.
14	Kajimoto	Application of electronic spectra (1) absorption and emission	Electronic spectra can provide information on the molecular structure. Students will learn about the principles, measurements and applications of UV-visible absorption and fluorescence spectra.
15	Kajimoto	Application of electronic spectra (2) circular dichroism	Students will understand why optically active chiral molecules show optical rotation and circular dichroism.

Record and evaluation method	Students are evaluated on the final examination (about 70%) and all the small tests (about 30%).
Textbook	
Reference	Atkins' Physical Chemistry (10th edition), Peter Atkins and Julio de Paula, Oxford University Press, ISBN: 978-0199697403.
Preparation and Review	The session time is limited and therefore self-directed learning is important. Students are required to prepare and review for each class.
Language Used in Course	Japanese
Office hours	Students are welcome to visit the office (taking an appointment by e-mail is recommended). E-MAIL: kajimoto@tohoku.ac.jp
In addition	

Subject	Functional Morphology 2					
Course Numbering	YAL-PHA232J	Categories	Elective			
Preferable Participants	1st	Semester	2	Credits	2	
Instructor	Takahashi Nobuyuki, Sato Emiko, Arimura Nariko, Tamura Atsushi					
Practical business	○					
Objectives and summary of class	In this course, students will understand the functional morphology of cardiovascular system, kidney and urinary tract system, endocrine system, central and peripheral nerve system, sensory organs, and musculoskeletal system. Students will also understand the mechanisms of homeostatic maintenance through interactions of organ systems. Together with Functional Morphology 1, this course provides basic knowledge for students to study pathophysiology and pharmacotherapeutics in advanced courses.					
Goal of study	This course is designed to help students understand the structure and functional role of cardiovascular system, kidney and urinary tract system, endocrine system, central and peripheral nerve system, sensory organs, and musculoskeletal system.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Takahashi	Cardiovascular 1	Blood circulation is essential for life. Students will learn the roles heart, arteries and veins together with the mechanisms of their maintenance in relation to common diseases.
2	Takahashi	Cardiovascular 2	The purpose of this class is to help students understand the anatomy of heart and its supplying vessels (coronary arteries), conduction system, electrocardiography, ischemic heart disease, arrhythmia, and blood pressure regulation.
3	Takahashi	Kidney 1	The kidney filtrates blood and produces urine to control the amount of body water, electrolytes, and acid-base balance. Students will learn structure and function of nephron, a unit of kidney function.
4	Takahashi	Kidney 2	The purpose of this class is to help students understand physiology and function of renal tubules and its regulation.
5	Sato	Endocrine 1	Endocrine system is important for the regulation and maintenance of whole body function. In this class, students learn about the hypothalamo-pituitary-adrenal axis.
6	Sato	Endocrine 2	Students learn about biological functions and regulatory mechanisms of thyroid hormone and parathyroid hormone.
7	Sato	Endocrine 3	Students learn about the hormones secreted by the pancreas, adrenal gland, and sexual glands.
8	Sato	Endocrine 4 and Midterm Exam	Students learn about the kidney as an endocrine gland. A midterm test is given.
9	Arimura	Central Nerve 1	Understanding the spinal and central control of movement and sensory organization through the spinal cord.
10	Arimura	Central Nerve 2	Understanding the anatomy of central nervous system and the methods to define the functional analyses of nervous system.
11	Arimura	Central Nerve 3	Understanding the specific brain regions accounting for disorders in sleep, memory, epilepsy and pervasive development.
12	Arimura	Peripheral Nerve	Understanding the regulation of peripheral homeostasis through autonomic nervous system and somatic sensation.
13	Tamura	Sensory Organ 1	Understanding the functional morphology of somatic and visceral sensation, and visual system.

14	Tamura	Sensory Organ 2	Understanding the functional morphology of auditory and balance senses, and the chemical senses such as taste and smell.
15	Tamura	Muscle	Understanding the functional morphology and contraction of skeletal, cardiac and smooth muscles.
Record and evaluation method		Students are evaluated based on the midterm examination (45%), term-end examination (45%), and class performance (10%).	
Textbook		The textbook will be designated at the beginning of the course.	
Reference		References are handed out at every class.	
Preparation and Review		Students are required to prepare knowledge of pathology related to content of the class using internet and books.	
Language Used in Course		Japanese	
Office hours		The office hours are from 14:00 to 16:00 on Tuesdays. Make an appointment in advance via e-mail: nobuyuki.takahashi.a8@tohoku.ac.jp (Takahashi Nobuyuki), e-mail: nariko.arimura.a2@tohoku.ac.jp (Arimura Nariko)	
In addition			

Subject	Biochemistry 1				
Course Numbering	YAL-PHA233J	Categories	Elective		
Preferable Participants	1st	Semester	2	Credits	2
Instructor	Kurata Shoichiro				
Practical business					
Objectives and summary of class	To understand diseases based on the functions of body as targets of drugs, it is necessary to know biochemical functions and structures of biological substances. In this course, students will understand the structures and functions of carbohydrates, amino acids, proteins, lipids, nucleic acids, and their related substances.				
Goal of study	The purpose of this course is to help students explain the basic structures, characteristics, and functions of biological substances.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Kurata	Structure of carbohydrates (1)	To understand the structure of typical monosaccharides.
2	Kurata	Structure of carbohydrates (2)	To understand the structure of polysaccharides and glycosidic bonds.
3	Kurata	Functions of carbohydrates (1)	To understand the structure, functions, and characteristics of typical monosaccharides and disaccharides.
4	Kurata	Functions of carbohydrates (2)	To understand the structure, functions, and characteristics of typical polysaccharides.
5	Kurata	Cell surface carbohydrates	To understand the structure and functions of polysaccharides conjugated to proteins and lipids.
6	Kurata	Structure of amino acids	To understand the structure of amino acids.
7	Kurata	Characteristics of amino acids	To understand the characteristics of amino acids.
8	Kurata	Structure of peptides and proteins	To understand the structures of peptides and primary, secondary, tertiary, and quaternary structures of proteins.
9	Kurata	Functions of proteins (1)	To understand the functions and properties of enzymes.
10	Kurata	Functions of proteins (2)	To understand the basic functions of proteins.
11	Kurata	Stractures and functions of lipids	To understand the structures and properties of lipids found in membranes.
12	Kurata	Basic structure of membranes	To understand the structures and properties of membranes.
13	Kurata	Structure of nucleic acids	To understand the structures of nucleic acids and similarities and differences between DNA and RNA.
14	Kurata	Structure of DNA and replication	To understand the structures of DNA and replication process.
15	Kurata	Transcription and translation	To understand transcription and translation.

Record and evaluation method	Evaluation is performed based on class performance including the small tests (20%) and the final examinations (80%).
Textbook	Biochemistry, Editors: Masakazu Maeda, Shinji Asano, Nankodo Co., Ltd.
Reference	Biochemistry: The Molecular Basis of Life, Fourth Edition, Trudy McKee and James R. McKee, Oxford University Press, Inc.

Preparation and Review	Understanding of each themes by textbook and reference book.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: shoichiro.kurata.d5@tohoku.ac.jp　TEL: 795-5916
In addition	It is not necessary to bring your own device.

Subject	Introduction to Pharmaceutical Sciences 2				
Course Numbering	YAL-PHA202J	Categories	Required		
Preferable Participants	2nd	Semester	3	Credits	1
Instructor	Prof. Nakabayashi Takakazu, Assoc. Prof. Kikuchi Masafumi, Tominaga Atsuko, Sato Yoshiaki, Ikeda Koji, Chiba Kenji, Uneyama Chikako, Taniguchi Takahiko, –Takamachi Koji, and Oota Miki				
Practical business	○				
Objectives and summary of class	To clarify the future goals as a pharmaceutical student, it is important to actually see and hear the state of the scene where pharmaceutical graduates are active, such as hospitals, pharmacies, pharmaceutical companies, research institutes, and administrative organizations. In this class, we listen to the experts who are active at each site as early experience learning.				
Goal of study	To raise a will to actively learn pharmaceutical sciences and pharmacy and to find future goals, understand the work of the field at hospitals, pharmacies, pharmaceutical companies, research institutes, etc. where the graduates of faculty of pharmaceutical sciences have fruitful works.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Kikuchi	Guidance/ Introduction (1)	The work and mission of a hospital pharmacist as a medical person
2	Tominaga	Introduction (2)	The role of pharmacists in regional medicine
3	Sato	Introduction (3)	The role of analytical chemistry in pharmaceutical research
4	To be Assigned	Introduction (4)	Lecture related to a drug-induced disease
5	Chiba	Introduction (5)	Drug development in pharmaceutical company
6	Uneyama	Introduction (6)	Food safety and pharmacy
7	Taniguchi	Introduction (7)	Challenge to new drugs: drug discovery research in pharmaceutical company
8	Ota	Introduction (8)	Health administration and pharmacy: roles of medicine officials
9	Ikeda	Introduction (9)	Current status and issues of drug and medical device development
10	To be Assigned	Introduction (9)	Current status and issues of drugs abuse
11	Nakabayashi	Visiting laboratory and institution	Visit the drug discovery research institute, pharmaceutical factory, pharmaceutical wholesale center, and University hospital

Record and evaluation method	Evaluated by class performance (50%) and report (50%)
Textbook	Not specified
Reference	
Preparation and Review	
Language Used in Course	Japanese

Office hours	Make an advance appointment via e-mail or other means. E-MAIL: takakazu.nakabayashi.e7@tohoku.ac.jp　TEL: 022-795-6855
In addition	Lecture schedule will be notified in Classroom and on a message board.

Subject	Organic Chemistry 3					
Course Numbering	YAL-PHA223J	Categories	Elective			
Preferable Participants	2nd	Semester	3	Credits	2	
Instructor	Yoshikai Naohiko, Kikuchi Jun					
Objectives and summary of class	In the organic chemistry 3, students will learn about modern analytical methods 1) to determine the molecular mass and molecular formula of an organic compound, 2) to identify functional groups contained in an organic compound, 3) to identify the carbon-hydrogen framework of an organic compound. The students will also learn about a) conjugation and resonance of a conjugated compound, b) aromaticity of benzene and related aromatic compounds, and c) reactions of aromatic compounds.					
Goal of study	After successfully completing this course, the students will be able to: ・ Identify structures of simple organic compounds using mass spectrometry (MS), infrared spectroscopy (IR), and nuclear magnetic resonance spectroscopy (NMR) ・ Explain the concept of resonance and draw resonance structures ・ Explain reactions under kinetic versus thermodynamic control ・ Explain the Diels-Alder reaction and its relevance to organic synthesis ・ Define aromaticity and explain the reactivity of aromatic compounds ・ Explain the mechanism and the variation of electrophilic aromatic substitution of benzene derivatives ・ Rationalize substituent effects in electrophilic aromatic substitution and design multistep synthesis of substituted benzenes ・ Explain the mechanism of nucleophilic aromatic substitution of substituted benzenes ・ Explain the chemistry of benzyne and transformations on substituents on benzene					
Method of class	Lecture ・ Practice ・ Training ・ On-site training ・ SGD ・ PBL ・ Roleplay ・ e-learning ・ Others( )					

Term	Lecturer	Theme	Contents
1	Yoshikai Kikuchi	Mass Spectrometry	The principle of mass spectrometry (MS) and its application in structure determination of organic compounds
2	Yoshikai Kikuchi	Infrared Spectroscopy	The principle of infrared (IR) spectroscopy and its application in identification of functional groups in organic compounds
3	Yoshikai Kikuchi	NMR (1)	The basic principle of nuclear magnetic resonance (NMR) spectroscopy and the concept of chemical shift and shielding/deshielding effects
4	Yoshikai Kikuchi	NMR (2)	Spin-spin couplings in ^{1}H NMR and their relevance to structure determination of organic compounds
5	Yoshikai Kikuchi	NMR (3)	^{13}C NMR and its application in structure determination of organic compounds as well as the basics of two-dimensional NMR
6	Yoshikai Kikuchi	Conjugation, Resonance, and Dienes (1)	Conjugation, resonance, resonance hybrid, and electron delocalization in common conjugated systems
7	Yoshikai Kikuchi	Conjugation, Resonance, and Dienes (2)	Kinetic versus thermodynamic control in electrophilic addition to conjugated dienes
8	Yoshikai Kikuchi	Conjugation, Resonance, and Dienes (3)	Diels-Alder reaction: Mechanism and synthetic applications
9	Yoshikai Kikuchi	Benzene and Aromatic Compounds (1)	The definition of aromaticity, and the types and properties of aromatic and heteroaromatic compounds
10	Yoshikai Kikuchi	Benzene and Aromatic Compounds (2)	Molecular orbital analysis of aromatic systems and the theoretical basis of aromaticity (Hückel's rule)
11	Yoshikai Kikuchi	Electrophilic Aromatic Substitution (1)	The general mechanism of electrophilic aromatic substitution and specific reactions including halogenation, nitration, sulfonation, and Friedel–Crafts alkylation/acylation

12	Yoshikai Kikuchi	Electrophilic Aromatic Substitution (2)	Effects of different substituents on the reactivity and regioselectivity of electrophilic aromatic substitution
13	Yoshikai Kikuchi	Nucleophilic Aromatic Substitution	Nucleophilic aromatic substitution reactions and reactions involving benzyne intermediates
14	Yoshikai Kikuchi	Transformation of Substituents on Benzene Ring	Methods for the transformation of different substituents on a benzene ring
15	Yoshikai Kikuchi	Multistep Synthesis of Polysubstituted Benzenes	Approaches to the synthesis of multisubstituted benzene derivatives

Record and evaluation method	Evaluation will be performed based on final examination (50%), midterm examination (30%), and regular assignments (20%).
Textbook	「スミス 基礎有機化学(上・下)第５版」J. G. Smith 著、山本尚・大嶌幸一郎 監訳 化学同人（2017） 「Organic Chemistry」Author: J. G. Smith, McGraw Hill Higher Education
Reference	
Preparation and Review	Students are advised to do preparation and review using the textbook. Selected problems from the textbook will be used as regular assignments.
Language Used in Course	Japanese
Office hours	Make an appointment via e-mail or other means before visiting. E-MAIL: naohiko.yoshikai.c5@tohoku.ac.jp TEL: 022-795-6812
In addition	

Subject	Pharmacognosy 1					
Course Numbering	YAL-PHA226J	Categories	Elective			
Preferable Participants	2nd	Semester	3	Credits	2	
Instructor	Professor Asai Teigo, Associate professor Taro Ozaki					
Practical business						
Objectives and summary of class	This course covers definition, history, scope and development of Pharmacognosy. Students learn the sources, constituents, pharmacological properties and therapeutic uses of crude drugs, together with biosynthetic pathways of constituents.					
Goal of study	The purpose of this course is to help students explain the basic knowledge of crude drugs on their sources, constituents, pharmacological properties and therapeutic uses.					
Method of class	(Lecture) ・Practice ・Training ・On-site training ・SGD ・PBL ・Roleplay ・e-learning ・Others( )					

Term	Lecturer	Theme	Contents
1	Asai Ozaki	Introduction	Definition and history of Pharmacognosy
2	Asai Ozaki	Classification of natural products	Classification of natural products based on structure, origin, biosynthesis and biological activities.
3	Asai Ozaki	Terpenoids 1	Structure, origin, biological activities and biosynthesis of terpenoids.
4	Asai Ozaki	Terpenoids 2	Structure, origin, biological activities and biosynthesis of terpenoids.
5	Asai Ozaki	Polyketides	Structure, origin, biological activities and biosynthesis of polyketides.
6	Asai Ozaki	Shikimic pathway	Structure, origin, biological activities and biosynthesis of natural products from shikimic pathway.
7	Asai Ozaki	Peptide natural products	Structure, origin, biological activities and biosynthesis of peptide natural products.
8	Asai Ozaki	Alkaloids 1	Structure, origin, biological activities and biosynthesis of alkaloids.
9	Asai Ozaki	Alkaloids 2	The same as above.
10	Asai Ozaki	Biologically active natural products	Structure, origin, biological activities, chemical biology and biosynthesis of biologically active natural products.
11	Asai Ozaki	Isolation and Structure elucidation	Methods of purification and structure elucidation of natural products.
12	Asai Ozaki	Discovery of natural products	Strategy to discover novel natural products.
13	Asai Ozaki	Biosynthetic study of natural products	History of biosynthetic study on natural products.
14	Asai Ozaki	Total biosynthesis and combinatorial biosynthesis	Powerful methods to produce natural products and its analogs, total biosynthesis and combinatorial biosynthesis.
15	Asai Ozaki	Natural product-based drug development	Future of natural product-based drug development.

Record and evaluation method	Evaluated by examination (60%) and submitting report (40%).
Textbook	

Reference	「パートナー天然物化学改訂第 4 版」 森田博史、阿部郁朗 編集、南江堂（2021） 「ベーシック薬学教科書シリーズ７　生薬学・天然物化学」吉川雅之編、化学同人（2013） 「医薬品天然物化学」　海老塚豊 監訳、南江堂（2004） 「天然物化学」菅原二三男、浅見忠男、葛山智久、倉持幸司、新家一男、永田晋治、コロナ社（2019）
Preparation and Review	Review frequently using textbooks and handouts distributed during lectures.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means before students will visit office. E-mail: teigo.asai.c8@tohoku.ac.jp　Tel: +81-22-795-6822
In addition	

Subject	Physical Chemistry 2				
Course Numbering	YAL-PHA215J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Professor Konno Tomohiro				
Practical business					
Objectives and summary of class	The purpose of this course is to learn phase equilibrium, interfaces, electrolyte solutions, and electrochemistry.				
Goal of study	This course is designated to help students understand the basics and applications of phase equilibrium, interfaces, electrolyte solutions, and electrochemistry.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Konno	Solution 1	Properties of non-electrolyte solutions
2	Konno	Solution 2	Chemical potential
3	Konno	Solution 3	Raoult's law, Henry's law
4	Konno	Solution 4	Colligative properties
5	Konno	Interface 1	Surface and surface tension
6	Konno	Interface 2	Surface adsorption
7	Konno	Interface 3	Physical adsorption, chemical adsorption
8	Konno	Interface 4	Adsorption isotherms
9	Konno	Electrolyte solution 1	Strong electrolytes, weak electrolytes
10	Konno	Electrolyte solution 2	Ion conductivity, transference number, ion mobility
11	Konno	Electrolyte solution 3	Ionic strength, Debye-Hückel theory
12	Konno	Electrochemistry 1	Faraday's law
13	Konno	Electrochemistry 2	Principle of chemical cells
14	Konno	Electrochemistry 3	Electro-motive force
15	Konno	Electrochemistry 4	Nernst equation, electro-analysis

Record and evaluation method	Students are evaluated on the small quizzes (20%) and final test (80%).
Textbook	
Reference	"Physical Chemistry 2nd Edition.", Publisher: Kagaku-Dojin Publishing Company, (2018) (ISBN: 978-4-7598-1628-0) "Atkins' Physical Chemistry, 10th Edition.", Publisher: Tokyo-Kagaku-Dojin Publishing Company, (2017) (ISBN: 978-4-8079-0908-7)
Preparation and Review	Students are required to prepare and review using handouts and textbook.
Language Used in Course	Japanese

Office hours	Make an advance appointment via e-mail or other means. E-mail: t-konno@tohoku.ac.jp　Phone: 795-6841
In addition	

Subject	Biochemistry 2				
Course Numbering	YAL-PHA235J	Categories	Elective		
Preferable Participants	2nd	Semester	3	Credits	2
Instructor	Inoue Asuka				
Practical business					
Objectives and summary of class	Biochemistry is a molecular understanding of chemical processes in cells. In this class, students will learn synthesis, folding and function of proteins. By focusing on enzymes, students learn kinetics and regulation of enzymes as well as their underlying molecular mechanisms.				
Goal of study	The purpose of this course is to help students learn how proteins are made in cells and exert their functions such as signal transduction, immune response and metabolism. Students will also learn methods of protein analysis and genetic engineering.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Inoue	Introduction	To review the basic knowledge of biochemistry and understand the significance of biochemistry in the pharmaceutical sciences.
2	Inoue	Protein diversity	To understand the structures of amino acids and proteins.
3	Inoue	Protein structure	To understand the folding of proteins and protein misfolding disease (proteopathy).
4	Inoue	Protein synthesis	To understand the synthesis of proteins in cellular machinery.
5	Inoue	Receptor (I)	To understand the diversity of receptors.
6	Inoue	Receptor (II)	To understand the functions of receptors.
7	Inoue	Antibody	To understand the structures and the functions of antibodies as well as generation and applications of antibodies.
8	Inoue	Enzyme (I)	To understand the properties of enzymes.
9	Inoue	Enzyme (II)	To understand the kinetics of enzymes.
10	Inoue	Enzyme (III)	To understand the regulations of enzymes.
11	Inoue	Vitamin	To understand the function of vitamins as coenzymes.
12	Inoue	Protein analysis (I)	To understand the methods to analyze expression and the function of proteins.
13	Inoue	Protein analysis (II)	To understand the central dogma and to review the structure and the function of nucleotides (DNA/RNA).
14	Inoue	Protein analysis (III)	To understand the central dogma and to review the structure and the function of nucleotides (DNA/RNA).
15	Inoue	Summary of the course	To review the course and understand the biochemistry of proteins.

Record and evaluation method	Evaluation is performed based on class performance including the final (80%) examination and the class performance (20%).
Textbook	Biochemistry, Editors: Masakazu Maeda, Shinji Asano, Nankodo Co., Ltd., Essential Cell Biology, Fifth Edition, Editor: Bruce Alberts et al.
Reference	Molecular Biology of the Cell, Sixth Edition, Bruce Alberts et al.

Preparation and Review	Understanding of each theme by textbook and reference book.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: iaska@tohoku.ac.jp　TEL: 795-6861
In addition	

Subject	Biochemistry 3				
Course Numbering	YAL-PHA235J	Categories	Elective		
Preferable Participants	2nd	Semester	3	Credits	2
Instructor	Kurata Shoichiro, Yano Tamaki, Inoue Asuka, Yanagawa Masataka				
Practical business					
Objectives and summary of class	In this course, students will understand the structures and functions of proteins involved in biological reactions and intra-and extra-cellular signal transductions and learn the metabolism of amino acids and nucleotides and the biosynthesis of bioactive metabolites.				
Goal of study	The purpose of this course is to help students explain the structures and functions of proteins involved in biological reactions and signal transductions and the metabolism of amino acids and nucleotides.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Kurata	Introduction	To understand the biochemical significance in the pharmaceutical sciences related to biological reactions and signal transduction.
2	Kurata	Post-translational protein modifications	To understand the mechanisms and functions of post-translational protein modifications.
3	Kurata	Intracellular signal transduction and cancer	To understand the mechanisms of intracellular signal transduction and cancer.
4	Yano	Hormone and signal transduction	To understand the communication between cells and tissues via hormones, the extracellular signaling molecules.
5	Yano	Membrane transport	To understand the molecular mechanisms of membrane transport, which contribute to receptor clearance (Endocytosis), hormone secretion (Exocytosis), and protein degradation.
6	Yano	Cell-cell contact and cell matrix	To learn the molecules essential for cytoskeleton, cell-cell junctions, and extracellular matrix.
7	Kurata, Yano	Summary of the first half of this course	To confirm the contents that was handled in the first part of this course.
8	Inoue/Yanagawa	Amino acid metabolism (I)	To understand the role and the use of amino acids in the body.
9	Inoue/Yanagawa	Amino acid metabolism (II)	To understand the nitrogen metabolism of amino acids.
10	Inoue/Yanagawa	Amino acid metabolism (III)	To understand the carbon metabolism of amino acids.
11	Inoue/Yanagawa	Amino-acid-derived bioactive metabolites (I)	To understand the biosynthesis of bioactive amines through decarboxylation.
12	Inoue/Yanagawa	Amino-acid-derived bioactive metabolites (II)	To understand the heme metabolism, the nicotinamide biosynthesis, and the nitric oxide biosynthesis.
13	Inoue/Yanagawa	Nucleotide metabolism (I)	To understand the biosynthesis and the degradation of nucleotides, ribonucleotides, and deoxyribonucleotides.
14	Inoue/Yanagawa	Nucleotide metabolism (II)	To understand the role of nucleotides as second messengers and drugs targeting nucleotide metabolism.
15	Inoue/Yanagawa	Summary of the last half of this course	To confirm the contents that was handled in the second part of this course.
Record and evaluation	Evaluation is performed based on class performance including the small tests (20%), the midterm (40%) and the final (40%) examinations.		

method	
Textbook	Biochemistry, Editors: Masakazu Maeda, Shinji Asano, Nankodo Co., Ltd., Essential Cell Biology, Fifth Edition, Editor: Bruce Alberts et al.
Reference	Biochemistry: The Molecular Basis of Life, Fourth Edition, Trudy McKee and James R. McKee, Oxford University Press, Inc. Molecular Cell Biology, Fifth Edition, Lodish et al., W. H. Freeman and Campany
Preparation and Review	Understanding of each theme by textbook and reference book.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: shoichiro.kurata.d5@tohoku.ac.jp TEL: 795-5916 E-MAIL: tamaki.yano.e7@tohoku.ac.jp TEL: 795-4555 E-MAIL: iaska@tohoku.ac.jp TEL: 795-6861 E-MAIL: masataka.yanagawa.b6@tohoku.ac.jp TEL: 795-6861
In addition	

Subject	Pharmacology 1					
Course Numbering	YAL-PHA251J	Categories	Elective			
Preferable Participants	2nd	Semester	3	Credits	2	
Instructor	Sasaki Takuya, Arimura Nariko					
Practical business						
Objectives and summary of class	Pharmacology is a discipline which explores an interaction between drugs and a human body. To better understand the action of clinically available drugs, students need to acquire abundant knowledge about not only the machinery of human body but also the mechanism of disease development. In human body, many chemical transmitter and intracellular signaling molecules work to keep the body healthy. In this course, students first acquire the elementary knowledge to understand the action of drugs. Students also understand the clinical application and effectiveness of drugs and identify a clinical issue through the understanding the extracellular chemical transmitter and intracellular signal transduction.					
Goal of study	The purpose of this course is to help students learn the basic knowledge and the point of view of the pharmacotherapy. Also, students understand the elementary chemical transmitter and intracellular signal transduction and develop the ability to consider the mechanism of drug action.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Sasaki	Introduction (1)	In this course, students will learn about basic matters to understand the action of drugs such as the history of the pharmacology, a mode of drug action and dose-responsibility. Students will also understand the regulation system of biological functions such as neural system and endocrine system.
2	Sasaki	Introduction (2)	In this course, students will understand the factors that influence the effectiveness of drugs. Also, this course will offer the opportunity to learn the change of drug effectiveness or appearance of side effect by coadministration of several drugs and repeated administration.
3	Sasaki	Cellular signal transduction:seven-pass transmembrane receptor	In this course, students will understand the intracellular signal transduction via seven-pass transmembrane receptors, many of which are molecular targets of clinically available drugs.
4	Sasaki	Cellular signal transduction: heterotrimeric G protein	In this course, students will learn about a class, functions and activation/inactivation mechanisms of heterotrimeric G protein which is coupled to seven-pass transmembrane receptors.
5	Sasaki	Cellular signal transduction: small G protein/growth factor receptor/intracellular receptor	In this course, students will learn about a class, functions and activation/inactivation mechanisms of small G protein, growth factor receptor and intracellular receptor.
6	Sasaki	Quantitative analysis of receptors	This course offers an opportunity to learn about the dose-responsibility of drugs and to understand a concept of agonist and antagonist and its quantitative analysis. The students will also understand the principle and methods of the receptor binding assay and will be able to do the quantitative analysis.

7	Sasaki	Cellular signal transduction: ion channels and transporter	In this course, students will learn about several ion channels and transporters as molecular targets of clinically available drugs.
8	Sasaki	Chronopharmacology and Midterm Exam	This course offers an opportunity to learn about a molecular mechanism of the circadian clock which govern the biological rhythm with 24 hr periodicity and to understand the mechanisms underlying the daily variation of action/side effect of drugs and chronopharmacology.
9	Arimura	Bioactive substance: vitamin	In this course, students will learn about a class and physiological roles of vitamin and their significance in the regulation of biological functions.
10	Arimura	Bioactive substance: acetylcholine	This course offers an opportunity to learn about a biosynthesis/metabolism, receptors and related-drugs of acetylcholine, which acts as an important neurotransmitter in the central nervous system and peripheral tissue.
11	Arimura	Bioactive substance: catecholamine	This course offers an opportunity to learn about a biosynthesis/metabolism, receptors and related-drugs of catecholamine, which acts as an important neurotransmitter in the central nervous system and peripheral tissue.
12	Arimura	Bioactive substance: bioactive peptides	This course offers an opportunity to learn about an outline of bioactive peptides and to understand their functions and clinical application of typical bioactive peptides such as angiotensin and orexin.
13	Arimura	Bioactive substance: serotonin	This course offers an opportunity to learn about a biosynthesis/metabolism, receptors and related-drugs of serotonin, which acts as an important bioactive substance in the central nervous system and peripheral tissue.
14	Arimura	Bioactive substance: histamine/amino acid	This course offers an opportunity to learn about a biosynthesis/metabolism, receptors and related-drugs of histamine and amino acids such as glutamate and GABA, which act as an important bioactive substance in the central nervous system and peripheral tissue.
15	Arimura	Bioactive substance: eicosanoid	This course offers an opportunity to learn about a biosynthesis and physiological/patho-physiological roles of eicosanoids such as prostaglandin and leukotrien and to understand the action of related-drugs.

Record and evaluation method	Students are evaluated based on the midterm examination (45%), term-end examination (45%), and class performance (10%).
Textbook	
Reference	Tanaka, Chikako and Kato, Ryuichi eds., *New Pharmacology (6th Edition)*. Nankodo Nabeshima, Toshitaka and Inoue, Kazuhide eds., *Mitewakaru Yakugaku Zukai Yakurigaku (1st Edition)*. Nanzando Sato, Susumu ed., *Shin-yakurigaku text (3rd Edition)*. Hirokawa Publishing Co. Yanagisawa, Teruyuki ed., *Shin-yakurigaku nyuumon (3rd Edition)*. Nanzando, Laurence Brunton, Bruce Chabner and Brorn Knollman eds., *Goodman & Gilman's The Pharmacological basis of Therapeutics* (Translation supervised by Takaori, Syuzo, Keitaro Hashimoto, Akaike, Akinori and Ishii, Kunio). Hirokawa Publishing Co.
Preparation and Review	Students can previously download the slide files and prepare the contents with the above textbook.
Language	Japanese
Office hours	Make an advance appointment via e-mail or other means. （Sasaki） E-MAIL : takuya.sasaki.b4@tohoku.ac.jp　TEL : 022-795-5503
In addition	Materials are provided via Google Classroom.

Subject	Pharmacology 2					
Course Numbering	YAL-PHA252J	Categories	Elective			
Preferable Participants	2nd	Semester	3	Credits	2	
Instructor	Associate Professor Moriguchi Shigeki					
Practical business						
Objectives and summary of class	Pharmacology is summarized in the interactions between medicines and biological functions. Students lean the clinical application, therapeutic and side effects of medicines through those biological actions. Pharmacology 2 focuses on medicines acting on peripheral and central nervous systems, and respiratory and digestive organs.					
Goal of study	Students understand the molecular basis in drug actions of therapeutics. In addition, students deepen their understanding of the pharmacological mechanisms underlying the main and side effects of medicine.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Moriguchi	Pharmacology of peripheral nervous system	Students learn the role of autonomic or somatic nervous system, neurotransmitter receptor, agonists and antagonists acting on these nervous systems.
2	Moriguchi	Autonomic nervous system therapeutics (1)	Students learn the regulation of organ function through the sympathetic nervous system and clinical application of agents acting on the sympathetic nervous system.
3	Moriguchi	Autonomic nervous system therapeutics (2)	Students learn the regulation of organ function through the parasympathetic nervous system, and clinical application of agents acting on the parasympathetic nervous system the autonomic ganglion.
4	Moriguchi	Somatic nervous system therapeutics	Students learn the therapeutics acting on the sensory and motor neurons. Students also learn the local anesthetic agents and muscle relaxants.
5	Moriguchi	Pharmacology of central nervous system	The biological homeostasis is regulated by interaction of nervous, endocrine and immune systems. Students learn the pharmacological interaction nervous, endocrine and immune systems.
6	Moriguchi	Mid-term examination and drug evaluation in central nervous system	Students learn the principle methods to evaluate the pharmacological actions of central nervous system agents.
7	Moriguchi	Central nervous system therapeutics (1)	Students learn the interactions of synaptic transmission, receptor and ion channel. Especially, students understand the basic mechanism of agents acting on the central nervous system.
8	Moriguchi	Central nervous system therapeutics (2)	Students learn the pharmacology of general anesthetic, hypnotic, antianxiety agents and antidepressants.
9	Moriguchi	Central nervous system therapeutics (3)	Students learn the pharmacology of muscle relaxants, antiepileptics, narcotic or non-narcotic analgesics. Students also learn therapeutics for migraine and for drug and alcoholic dependence.
10	Moriguchi	Central nervous system therapeutics (4)	Students learn the pharmacology of therapeutics for psychosis, schizophrenia, Parkinson's disease and narcolepsy.
11	Moriguchi	Neurodegenerative disorder therapeutics	Students learn the therapeutics for stroke, Alzheimer's disease, Huntington's disease and amyotrophic lateral sclerosis.

12	Moriguchi	Respiratory therapeutics	Students learn the pharmacology of antitussive, expectorants, antiasthmatic agents and respiratory stimulants. Students also learn therapeutics for chronic obstructive pulmonary disease, smoking disease and pneumonitis.
13	Moriguchi	Gastrointestinal therapeutics (1)	Students learn the regulation of gastric acid secretion by nervous system and gastrointestinal hormone. Students also learn the agents of gastritis, gastroesophageal reflux disease, gastroduodenal ulcer and bowel disease.
14	Moriguchi	Gastrointestinal therapeutics (2)	Students learn the regulation of gastrointestinal function by gastrointestinal hormone. Students also learn the therapeutics for liver, bile duct and pancreatic diseases.
15	Moriguchi	Gastrointestinal therapeutics (3)	Students learn the therapeutics acting on the intestinal immunity and intestinal flora.

Record and evaluation method	Mid-term examination (45%), examination (45%), class performance (10%) and so on.
Textbook	「Zukai Yakurigaku」 Ed. T Nabeshima and K Inoue, Nanzando
Reference	References will be provided as necessary.
Preparation and Review	Students are required to prepare knowledge of target organs for drugs and pathology related to content of the class using internet and books.
Language Used in Course	Japanese
Office hours	Make an appointment via e-mail before visiting the office. The contact information for the lecturers will be announced in the lecture. E-MAIL: shigeki.moriguchi.a3@tohoku.ac.jp TEL: 022-795-4562
In addition	

Subject	Pharmaceutics 1				
Course Numbering	YAL-PHA261J	Categories	Elective		
Preferable Participants	2nd	Semester	3	Credits	2
Instructor	Professor Akita Hidetaka, Lecturer Sakurai Yu, Assistant Professo Hiroki Tanaka				
Practical business					
Objectives and summary of class	The purpose of this class is to understand the basis of pharmaceutics including physical pharmaceutics and pharmacokinetics in a comprehensive manner. This course will also explore the relationship between the drug formulations and the biological properties of absorption, distribution, metabolism and elimination (ADME). Small test will be given in each lecture to evaluate the achievement of understandings.				
Goal of study	Upon completion of this course, a student should be able to: ·Explain characteristics, production methods, and quality test of drug formulations ·Explain drug delivery system ·Explain the fate of drugs and various factors affecting absorption, distribution, metabolism, and excretion in the body				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Akita	Introduction to Pharmaceutics	Overview of pharmaceutics including the development of drug formulations, their administration pathways, and the absorption processes of various drug preparations Process of drug development from the viewpoints of pharmaceutics
2	Akita	Biomembrane transport	Mechanisms of biomebrane transport as a rate-limiting process of the fate of drugs in the body
3	Akita	Drug absorption	Mechanisms of drug absorption in the small intestine
4	Akita	Protein binding	Classification of drug-protein bindings and the analyzing methods
5	Akita	Tissue distribution	Factors affecting the drug distribution in the targeted organs/tissues
6	Akita	Drug metabolism and First pass effect	Factors affecting the drug metabolizing rate, e.g., membrane permeability, protein binding, blood flow rate, and administration pathway
7	Akita	Renal and biliary excretion	Mechanisms of renal and biliary excretion as the main routs of drug elimination from the body
8	Sakurai	Solid formulation	Characteristics, production methods, and advantages of solid formulation
9	Sakurai	Semi-solid formulation	Characteristics and production methods of semi-solid formulation
10	Sakurai	Liquid formulation	Characteristics and production methods of liquid formulation
11	Sakurai	Sterile formulation	Characteristics, production methods, and administration pathway of the formulation for injection, ophthalmic solution, and ophthalmic ointments
12	Tanaka	Quality control, pharmaceutical test, stability	Quality tests of drug formulations for quality control in Japanese Pharmacopoeia (JP) and the stability of drug formulations
13	Sakurai	Solubility and kinetics	Factors affecting the solubility and pharmacokinetics of drug formulations

14	Sakurai	Drug delivery system 1	Basics of drug design and formulation of drug delivery system
15	Sakurai	Drug delivery system 2	Application of drug design and formulation of drug delivery system
Record and evaluation method		Students are evaluated on their points from all the small tests (15%), and the midterm and regular examinations (85%).	
Textbook		(Japanese) Partner Pharmaceutics, Fourth edition (2022) (ISBN:9784524403875) パートナー薬剤学 改訂第 4 版 原島秀吉ら編集、南江堂（2022）	
Reference		1. (English) Clinical Pharmacokinetics and Pharmacodynamics: concepts and applications Fourth Edition Malcolm Rowland and Thomas N. Tozer, Lippincott Williams and Wilkins (2009) (ISBN:9780781750097) 2. (Japanese) Biopharmaceutics (ISBN:9784567482349) わかりやすい生物薬剤学 第 5 版 荻原琢男執筆者代表、廣川書店（2014） 3. (Japanese) Physical Pharmaceutics (ISBN:9784567482653) わかりやすい物理薬剤学 第 5 版 辻　彰・河島　進　編、廣川書店（2015） 4. (Japanese) Clinical pharmacokinetics (ISBN: 9784524250554) 臨床薬物動態学 第 4 版 加藤隆一著、南江堂 (2009) 5. (Japanese) Tsuji's pharmacokinetics Episode Pharmacokinetics (ISBN:9784901789998) エピソード薬物動態学―薬物動態学の解明、京都廣川書店（2012） 6. (Japanese) Basic science of drug formulation (ISBN:9784860342890) 基礎から学ぶ製剤化のサイエンス第 3 版山本恵司監修、エルゼビア・ジャパン（2016）	
Preparation and Review		Getting basic knowledge on each topic using the text books and references above as a pre-study and Trying several practice problems as a review	
Language Used in Course		Japanese	
Office hours		Please make an advance appointment via e-mail or other means. The contact information for the lecturers will be given in the class.	
In addition			

Subject	Organic Chemistry 4					
Course Numbering	YAL-PHA224J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Professor Yoshiharu Iwabuchi and Lecturer Yusuke Sasano					
Practical business						
Objectives and summary of class	Carbonyl groups are regarded as one of the most important functional groups to understand organic chemistry from the viewpoints of the general existence and diverse reactivities. The principle of the reactions can be understood by basic reaction patterns. Organic chemistry 4 focuses on carbonyl group chemistry.					
Goal of study	To understand the basic character, reactivity and synthetic methods and to become to explain basic reaction mechanisms.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Iwabuchi Sasano	Carboxylic acid 1	Nomenclature, structure, physical property, hydrogen bonding, synthetic method and reactions of carboxylic acid
2	Iwabuchi Sasano	Carboxylic acid 2	Acidity and pKa value of carboxylic acid, separation using extraction, amino acid.
3	Iwabuchi Sasano	Carbonyl compound 1	General reactions of carbonyl compounds. Reduction of aldehyde and ketone.
4	Iwabuchi Sasano	Carbonyl compound 2	Stereochemistry in the reduction of carbonyl groups. Reduction of carboxylic acid and derivatives. Oxidation of aldehyde.
5	Iwabuchi Sasano	Carbonyl compound 3	Basic concept of organometallic reagents and reaction with aldehyde and ketone.
6	Iwabuchi Sasano	Carbonyl compound 4	Reaction of organometallic reagents with carboxylic acid derivatives. a,b-Unsaturated carbonyl compounds and protecting groups.
7	Iwabuchi Sasano	Aldehyde & ketone 1	Nomenclature, structure, physical property, synthetic method of aldehyde and ketone.
8	Iwabuchi Sasano	Aldehyde & ketone 2	General reactions of aldehyde and ketones with hydride, carbon nucleophiles, cyanide.
9	Iwabuchi Sasano	Aldehyde & ketone 3	Conversion of carbonyl groups to alkenes using Wittig reaction. Imine, enamine formation by the reaction with nitrogen nuclephiles.
10	Iwabuchi Sasano	Aldehyde & ketone 4	Acetal formation by the reaction with oxygen nucleophiles and the use as protecting groups. Cyclic acetal formation and introductory sugar chemistry.
11	Iwabuchi Sasano	Carboxylic acid derivative 1	Nomenclature, structure, physical property of ester, amide, carboxylic acide anhydride.
12	Iwabuchi Sasano	Carboxylic acid derivative 2	Reaction of carboxylic acid halide and anhydride.
13	Iwabuchi Sasano	Carboxylic acid derivative 3	Conversion of carboxylic acid to ester, amide, anhydride. Reaction of ester and hydrolysis of lipid.
14	Iwabuchi Sasano	Carboxylic acid derivative 4	Reaction of amides and biological activity of b-lactam. Natural and synthetic fibers with amide and ester linkages.
15	Iwabuchi Sasano	Carboxylic acid derivative 5	Acylation in metabolism. Basic reactions of nitrile.

Record and evaluation method	Evaluated by final examination (80%) and class performance including exercise (20%).
Textbook	'Organic Chemistry — 5th edition' J. G. Smith

Reference	
Preparation and Review	Students should read above contents in the textbook before lecture and solve problems in the textbook to deepen their understanding after the lecture.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: y-iwabuchi@tohoku.ac.jp TEL: 795-6846 E-MAIL: ysasano@tohoku.ac.jp TEL: 795-6848
In addition	

Subject	Organic Chemistry 5					
Course Numbering	YAL-PHA225J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Associate Professor Masanori Shigeno					
Objectives and summary of class	In this course, students will learn chemistry of carbonyl compounds, amines, pericyclic reactions, and heterocycles.					
Goal of study	· Students will understand chemical property and reactivity of carbonyl compounds, amines, and heterocycles, and synthetic methods for them. · Students will understand pericyclic reactions to illustrate the basic mechanism of them.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Shigeno	Basics of Enolates	Students will understand the acidity of the α-proton of carbonyl compounds.
2	Shigeno	Enolate Chemistry (1)	Students will understand the enolate formation and the α-alkylation of carbonyl compounds.
3	Shigeno	Enolate Chemistry (2)	Students will understand the alkylation of activated esters, β-keto esters and malonates
4	Shigeno	Condensation of Carbonyl Compounds (1)	Students will understand aldol reactions
5	Shigeno	Condensation of Carbonyl Compounds (2)	Students will understand the Claisen condensation, cross condensation, and intramolecular condensation.
6	Shigeno	Amines (1)	Students will understand the chemistry of amines and formation of amines.
7	Shigeno	Amines (2)	Students will understand the reactions of amines.
8	Shigeno	Carbon−Carbon Bond Formation (1)	Students will understand carbon−carbon bond forming reactions.
9	Shigeno	Carbon−Carbon Bond Formation (2)	Students will understand the synthetic methods for cyclopropane formation and metathesis.
10	Shigeno	Pericyclic Reactions (1)	Students will understand the molecular orbital theory and conservation of orbital symmetric theory
11	Shigeno	Pericyclic Reactions (2)	Students will understand cycloaddition reactions.
12	Shigeno	Pericyclic Reactions (3)	Students will understand electrocyclic reactions.
13	Shigeno	Heterocycles (1)	Students will understand the chemistry of five-membered heterocycles.
14	Shigeno	Heterocycles (2)	Students will understand the chemistry of six-membered heterocycles.
15	Shigeno	Amino Acids and Proteins	Students will understand the chemistry of amino acids, peptides, and proteins.

Record and evaluation method	Students are evaluated on examination (ca.80%) and class performance (ca.20%).
Textbook	'Organic Chemistry — 5th ed.' J. G. Smith
Reference	The chemistry of heterocycles: structure, reactions, synthesis, and applications, 3rd

	edition/ T. Eicher, S. Hauptmann, A. Speicher, Wiley-VCH (2012). Pericyclic reactions/ Ian Fleming, Oxford University Press (1999)
Preparation and Review	Students are required to read the relevant part of the textbook. After the lecture, students should review the contents of the lecture and solve problems of the textbook to deepen their understanding.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: masanori.shigeno.e5@tohoku.ac.jp TEL: 795-5917
In addition	Practice every time

Subject	Pharmacognosy 2				
Course Numbering	YAL-PHA227J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Professor Asai Teigo , Professor Sasaki Takuya				
Practical business					
Objectives and summary of class	In this course, students understand basic important points of pharmacognosy, including the origin, bioactive constituents, efficacy and application of the crude drugs listed in Japanese Pharmacopoeia, and learn about the actions of these natural drugs on gene expression in mammalian cells, the basic concepts necessary for understanding the diagnosis and treatment in Kampo medicine, and the importance of plant biotechnology in securement of medicinal plant resources. This course also offers the opportunity to deepen the understanding of therapeutic natural medicines for neurodegenerative disorders.				
Goal of study	The purpose of this course is to help students explain the importance of natural drugs in modern medicine and drug discovery research.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others(Papers)				

Term	Lecturer	Theme	Contents
1	Asai	Introduction	Overview of the history and the importance of pharmacognosy, and learn about the origins, properties, and clinical applications of representative crude drugs as well as crude drug classification.
2	Asai	Plant morphology Medicinal plants, animals, and minerals 1	Learn about plant morphology and organs. Additionally, learn about the basics of typical medicinal plants, active ingredients, structural formulas, pharmacological actions, and uses.
3	Asai	Medicinal plants, animals, and minerals 2	Learn about the basics of typical medicinal plants, active ingredients. Also, learn about their structural formulas, pharmacological actions, and uses.
4	Asai	Medicinal plants, animals, and minerals 3	Learn about the basics of typical medicinal plants, animals, minerals, active ingredients, and structural formulas, as well as pharmacological actions and uses.
5	Asai	Crude drug identification	Learn about the methods for identification of crude drugs and understand the importance.
6	Asai	Plant biotechnology 1	Understand the applications of plant biotechnology for the production of useful bioactive constituents of crude drugs.
7	Asai	Plant biotechnology 2	Understand the applications of plant biotechnology for the production of useful bioactive constituents of crude drugs.
8	Asai	Summary of the first half of this course	Review the contents in the first half part of this course.
9	Sasaki	Kampo medicine	Learn about the differences between Kampo medicine and western medicine, and understand an important position of Kampo medicine in modern medicine in Japan.
10	Sasaki	Evaluation of the efficacy of natural drugs	Understand how to evaluate the efficacy of crude drugs, Kampo medicines, and their constituents.

11	Sasaki	Natural drugs for treatment of neural disorders	Understand mechanisms underlying actions of natural drugs in the nervous system, and learn about the clinical potential and benefits.
12	Sasaki	Natural drugs for treatment of inflammation and allergy	Understand the mechanisms of anti-inflammatory and anti-allergic actions of crude drugs and natural compounds, and learn about the clinical potential and benefits.
13	Sasaki	Natural drugs acting on aspiratory and cardiovascular system	Learn about the history of discovery and isolation of natural drugs that act on the aspiratory and cardiovascular system, and understand their action mechanisms and clinical applications.
14	Sasaki	Natural drugs acting on digestive system	Understand the importance of natural drugs employed as digestants, stomachics, peptic ulcer agents, antidiarrheal drugs, cathartic drugs, emetics, and antiemetics.
15	Sasaki	Summary of this course	Confirm the contents in the last half part of this course.

Record and evaluation method	Students are evaluated on the final examination (90%) as well as class performance (10%).
Textbook	Basic Pharmaceutical Sciences Textbook Series: Pharmacognosy & Natural Products Chemistry (2nd ed.), edited by Masayuki Yoshikawa (KAGAKUDOJIN)
Reference	Medicinal Resources (2nd ed.), edited by Mikio Yamazaki & Kazuki Saito (MARUZEN); Pharmacognosy (7th ed.), edited by Isao Kitagawa (Hirokawa-Shoten); Signal Transduction, edited by Tetsu Akiyama (YODOSHA)
Preparation and Review	Preparation and submission of papers on the original plant (or animal) source, medicinal part, bioactive constituents, efficacy and application of the crude drugs listed in Japanese Pharmacopoeia four times.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail. （Kawahata） E-MAIL : kawahata@tohoku.ac.jp　TEL : 022-795-6838
In addition	

Subject	Analytical Chemistry 2					
Course Numbering	YAL-PHA212J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Professor Oe Tomoyuki, Associate professor Lee Seon Hwa					
Practical business						
Objectives and summary of class	Analytical chemistry in pharmaceutical sciences is an essential basic science in drug discovery and ADME researches (pharmacokinetics and pharmacology for "absorption, distribution, metabolism, and excretion). This course covers the basic knowledge and applications of spectroscopy, chromatography, and mass spectrometry. The aim is to help students understand basic instrumental analyses. Qualitative analyses and purity tests for organic/inorganic compounds in Japanese Pharmacopoeia, 17th Ed. (JP17) are also introduced.					
Goal of study	Better understanding of ultraviolet–visible spectroscopy, fluorescence spectroscopy, chromatography, and mass spectrometry to make it possible to explain each theory, to interpret the spectra/data, and to apply to use practically. Better understanding of each confirmatory test and purity test in Japanese Pharmacopoeia (JP) to make it possible to explain.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Oe	Introduction: qualitative analysis of drugs	Overviewing qualitative analysis of drugs
2	Oe	Ultraviolet–visible spectroscopy	Learning about the principle, instrumentation, Beer-Lambert law, and applications for biomolecules
3	Oe	Fluorescence spectroscopy	Learning about the principle of fluorescence, instrumentation, and the applications (including chemiluminescence)
4	Oe	Basics of chromatography I	Watching two Videos to image chromatography, followed by overviewing chromatographic methods
5	Oe	Basics of chromatography II	Learning about two typical chromatographic modes, absorption chromatography and partition chromatography, in terms of the separation behavior, the role of stationary phase and mobile phase
6	Oe	Basics of chromatography III	Learning about other chromatography: Ion exchange chromatography, size exclusion chromatography, affinity chromatography
7	Oe	Basics of chromatography IV	Learning about the instrumentation and structures of LC system (pump, detector)
8	Oe	Basics of chromatography V	Learning about gas chromatography and thin layer chromatography
9	Oe	Validation test for organic compounds I	Learning about technical terms of chromatography and, quantitative applications using calibration curve
10	Oe	Validation test for organic compounds II	Learning about derivatization methods for HPLC and GC
11	Oe	Validation test for organic compounds III	Learning about confirmatory tests for specific functional groups found in JP17
12	Oe	Qualitative inorganic analysis	Learning about systematic separation and identifications of metal cations (Separation scheme by precipitation and each confirmatory test)
13	Lee	Basics of mass spectrometry I	Watching a Video to image mass spectrometry followed by learning about the difference between mass and weight, definition of relative molecular mass, monoisotopic mass, and most abundant mass
14	Lee	Basics of mass spectrometry II	Overviewing MS and learning about typical ionization methods and mass analyzers

15	Lee	Basics of mass spectrometry III	Learning about typical mass analyzers, each significance, and the applications
Record and evaluation method		Based on the written exam	
Textbook		Analytical Chemistry I (パートナー分析化学 I), 4th Ed., Ed. J. Haginaka, K. Katoh, Nankodo Co., Ltd., 2021 (ISBN 978-4-524-40384-4) Analytical Chemistry II (パートナー分析化学 II), 4th Ed., Ed. J. Haginaka, K. Katoh, Nankodo Co., Ltd., 2021 (ISBN 978-4-524-40385-1)	
Reference		「イメージから学ぶ分光分析法とクロマトグラフィー～基礎原理から定量計算まで」Y. Sadakane, Kyoto Hirokawa Publishing Inc., 2009 (ISBN 978-4-901789-19-6) Separation science supports high-technology (分離の科学　ハイテクを支えるセパレーション・サイエンス), Blue Backs B723, K. Ueno, Kohdansha Inc., 1988 (ISBN 4-06-132723-1) What can we know using mass spectrometry (物質の質量から何がわかるか), S. Tajima, S. Tobita, Shokabo, 1991 (ISBN 4-7853-8547-2) Diagnostic using Novel prize awarded-mass spectrometry (ノーベル賞の質量分析法で病気を診る), Iwanami Science Library 94, A. Shimizu, Iwanami Shoten, Publishers, 2003 (ISBN 4-00-006594-7) Standard Pharmaceutical Sciences, Series II 2, Physical Pharmaceutical Sciences III, Instrumental analysis & determination of chemical structure (スタンダード薬学シリーズ II 2　物理系薬学 III. 機器分析・構造決定), Ed. The Pharmaceutical Society of Japan, Tokyo Kagaku（2016）(ISBN 978-4-8079-1704-4)	
Preparation and Review			
Language Used in Course		Japanese	
Office hours		An appointment required by E-mail (t-oe@mail.pharm.tohoku.ac.jp) or phone (795-6817).	
In addition			

Subject	Radiochemistry				
Course Numbering	YAL-PHA217J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Professor Furumoto Shozo, Senior Lecturer Funaki Yoshihito				
Practical business					
Objectives and summary of class	Radioisotopes are used as an essential tool for life science research and clinical diagnosis. In this course, students will understand the basic knowledge of radiation and radioisotope correctly and learn a method for dealing with them properly. Additionally, students will learn about radiopharmaceuticals for nuclear medicine with respect to their properties and methods for preparation, management, and usage.				
Goal of study	Student will understand nature of radiation and deepen their knowledge about usage of radioisotopes beneficial for life-science studies to have an ability to use radio tracer for a research. Then, Students will learn actual clinical application of radiopharmaceuticals.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Furumoto	Atomic nucleus and radioactivity	Students learn the importance of studying the utility of radioisotope. This class will provide basic knowledges of radiation chemistry such as concept of radiation, nuclear structure, types and properties of radiation, nuclear disintegration, radioactive decay and half-life, and so on.
2	Furumoto	Interaction between radiation and materials (I)	This class is designed to help students understand interactions of radiation with materials with respect to a relationship between radiation types and their energy.
3	Furumoto	Interaction between radiation and materials (II)	This class is designed to help students understand interactions of radiation with materials with respect to the physiological changes and the process of energy absorption of radiation.
4	Furumoto	Measurement of radiation (I)	Students learn the principle of all kinds of measuring instruments and measuring methods according to nuclides, and then understand how the radiation interaction with material is applied to the measuring technology.
5	Furumoto	Measurement of radiation (II)	Students learn the usage of a liquid scintillation counter and an imaging plate technique that are necessary to life science researches.
6	Furumoto	Production of radionuclides and radiolabeled compounds	This class helps students understand the principles of nuclear reactors and accelerators and their use for producing radionuclides. Then, students learn the principle and properties of chemical synthesis of radiolabeled compounds used as a tracer.
7	Furumoto	Radiopharmaceuticals (I)	Students learn the properties, measuring principle, and measuring instruments with respect to diagnostic imaging with radiopharmaceuticals. Additionally, understanding characteristics of radioisotopes, students learn radiosynthesis methods of radiopharmaceuticals used for PET and SPECT.
8	Funaki	Radiopharmaceuticals (II)	Students learn about a principle of radiopharmaceuticals for diagnosis.
9	Funaki	Radiopharmaceuticals (III)	Students learn about a principle of radiopharmaceuticals for therapy.
10	Funaki	Radiopharmaceuticals (IV)	Students learn about quality control of radiopharmaceuticals for PET used as hospital preparation.

11	Funaki	The applicability to the pharmaceutical territory of the radioactive materials (I)	Students learn about an isotope dilution method and an activation analysis as examples using radioactive tracers.
12	Funaki	The applicability to the pharmaceutical territory of the radioactive materials (II)	Students learn about a radio receptor assay and an autoradiography as examples using radioactive tracers.
13	Furumoto	The effect of the radiation on human body (I)	This class is designed to help students understand biological effects of radiation, acute effects, and late effects.
14	Furumoto	The effect of the radiation on human body (II)	This class is designed to help students understand effects from external and internal exposure and biological effects depending on the dose received
15	Furumoto	Radiation protection and safety control	Students learn basic rules and practical methods of safety handling when conducting tracer experiments using unsealed radioisotopes, safety control in accordance with the Radiation Hazard Prevention Act, and reagents used to prevent radiation hazard.

Record and evaluation method	Students are evaluated on a written examination (100%).
Textbook	"Radiochemistry and Radiopharmaceuticals, the 5th edition" Publisher: Nankodo Co., Ltd. This textbook is available for purchase at the University Co-op.
Reference	No reference will be used.
Preparation and Review	Preparation and review using textbooks and handouts.
Language Used in Course	Japanese
Office hours	Students can contact Prof Furumoto by email or telephone. Email: shozo.furumoto.b6@tohoku.ac.jp TEL: 022-795-7801
In addition	

Subject	Structural Chemstry				
Course Numbering	YAL-PHA218J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Professor Nakabayashi Takakazu and Assistant Professor Tahara Shinya				
Practical business					
Objectives and summary of class	This course provides students with basic knowledge of intermolecular interactions forming structures of biomolecules and the principles and concepts of a variety of spectroscopic methods for measuring biomolecular structures. The spectroscopic methods treated are X-ray diffraction, UV-Vis absorption, fluorescence, circular dichroism, IR, Raman, NMR, and ESR. Students are recommended to have finished "Physical Chemistry 1" and "Chemistry-A" before taking this course.				
Goal of study	This course is designed to help students explain (i) the basic properties of intermolecular interactions and their relationships with the formation of biomolecular structures, (ii) the principles of a variety of spectroscopic methods from the point of view of light-matter interactions, (iii) the structural information obtained from each spectroscopic method, and (iv) the application of spectroscopic methods to analyze structures of biological and functional molecules.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Nakabayashi	UV-Vis Absorption Spectroscopy I	Properties of Light, Concepts of Structural Analysis Using Interactions of Molecules with Light (Electromagnetic Wave), Lambert-Beer Law, Boltzmann Distribution
2	Nakabayashi	UV-Vis Absorption Spectroscopy II	Transition Dipole Moment, Franck-Condon Factor, Selection Rules
3	Nakabayashi	UV-Vis Absorption Spectroscopy III. Fluorescence Spectroscopy I	Structural Analysis of Proteins and Nucleic Acids Using UV-Vis Absorption, Jablonski diagram
4	Nakabayashi	Fluorescence Spectroscopy II	Fluorescence Lifetime, Fluorescence Quantum Yield, Radiative and Non-Radiative Rate Constants
5	Nakabayashi	Fluorescence Spectroscopy III	Application of Fluorescent Molecules and Proteins to Biological Science
6	Tahara	Vibrational Spectroscopy I	Basic Concepts of Energy Levels and Wave Functions of Molecular Vibrations
7	Tahara	Vibrational Spectroscopy II	Principles and Applications of IR and Raman Spectroscopy
8	Tahara	Midterm Examination, Circular Dichroism	Optical Rotatory Dispersion, Structural Analysis of Biomolecules Using Circular Dichroism
9	Tahara	X-Ray Crystallography I	Classification of Crystal Structures, Miller Indices, Bragg's Law, Fundamentals of Crystal Structure Analysis Using X-Ray Diffraction Pattern
10	Tahara	X-Ray Crystallography II	Application of Powder and Single Crystal X-Ray Diffraction, Structure and Properties of Inorganic Compounds
11	Nakabayashi	Intermolecular Interactions I	Permanent Dipole Moment, Ionic Bond, Molecular Polarizability, Induced Dipole Moment
12	Nakabayashi	Intermolecular Interactions II	Hydrogen Bond, Van der Waals Interaction, Lennard-Jones Potential, Hydrophobic Interaction
13	Nakabayashi	NMR I	Magnetic Moments Arising from Electron Orbital Motion, Electron Spin, and Nuclear Spin, Shielding Constant, Chemical Shift.
14	Nakabayashi	NMR II	Splitting of NMR Peaks Arising from Spin-Spin Coupling, Mechanism of Nuclear Overhauser Effect

15	Nakabayashi	NMR III, ESR	Investigation of Biomolecular Structures Using NMR, Basic Concepts of ESR
Record and evaluation method		Students are evaluated on their points from the midterm examination (~30%), the term examination (~60%), and mini tests (~10%).	
Textbook			
Reference		"Physical Chemistry for the Chemical and Biological Sciences" R. Chang, University Science Books（2000） "Physical Chemistry: A Molecular Approach" D. A. McQuarrie、J. D. Simon, University Science Books（1997）	
Preparation and Review		Students are required to prepare and review for each class using handouts and references.	
Language Used in Course		Japanese	
Office hours		Make an advance appointment via e-mail or other means. MAIL: takakazu.nakabayashi.e7@tohoku.ac.jp TEL: 795-6855	
In addition			

Subject	Biochemistry 4				
Course Numbering	YAL-PHA236J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Inoue Asuka				
Practical business					
Objectives and summary of class	Biochemistry is a molecular understanding of chemical processes in cells. In this class, students will learn how cells degrade nutrients such as glucose and fatty acids and produce ATP, an energy currency in cells. Students will also learn importance of these energetic pathway from genetic diseases and compounds to inhibit the pathway.				
Goal of study	The purpose of this course is to help students learn how energy is obtained from foods (sugar, lipid and proteins) in cells. Students will understand synthesis, conversion and degradation of key metabolic pathways including glycolysis, citrate cycle and ATP synthesis in mitochondria. Student will also learn genetics and diseases related to dysregulation of metabolism.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Inoue	Basics of metabolism, Glycolysis	To understand basic knowledge of energy metabolisms through food digestion and catabolism. To understand glycolysis and its enzymatic reactions as well as aerobic and anaerobic glycolysis.
2	Inoue	Citrate cycle	To understand citrate cycle and its roles in ATP synthesis, supply to amino acids and anaplerosis.
3	Inoue	Electron and ATP synthesis (I)	To understand electron transport chain and oxidized phosphorylation.
4	Inoue	Electron and ATP synthesis (II)	To understand ATP generation in mitochondria. To learn molecules to inhibit ATP synthesis and their mechanism of action.
5	Inoue	Glycogen metabolism	To understand the structure and the function of glycogen and the regulation by hormone. To learn pentose phosphate cycle.
6	Inoue	Photo-synthesis	To understand the mechanism of photosynthesis in plants.
7	Inoue	Fatty acid metabolism	To understand the synthesis and the degradation (via ß oxidation) of fatty acids.
8	Inoue	Lipid metabolism	To understand the synthesis and the degradation of cholesterol, phospholipids and triacylglycerol.
9	Inoue	Functional lipid (I)	To understand the function of lipid mediators.
10	Inoue	Functional lipid (II)	To understand the function of PI turnover and lysophospholipid mediators.
11	Inoue	Basics of genetics	To learn the basics of genetics.
12	Inoue	Methods of genetics	To understand model animals and mutants. To understand forward and reverse genetics.
13	Inoue	Human genetics	To understand human genetics and genetic disease. To learn how to identify a gene responsible for a genetic disorder.
14	Inoue	Bioinformatics	To understand the concept of bioinformatics and methods to obtain information from online database.
15	Inoue	Summary of the course	To review the course and understand the biochemistry of metabolism and genetics.

Record and evaluation	Evaluation is performed based on class performance including the final (80%) examination and the class performance (20%).

method	
Textbook	Biochemistry, Editors: Masakazu Maeda, Shinji Asano, Nankodo Co., Ltd., Essential Cell Biology, Fifth Edition, Editor: Bruce Alberts et al.
Reference	Molecular Biology of the Cell, Sixth Edition, Bruce Alberts et al.
Preparation and Review	Understanding of each theme by textbook and reference book.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: iaska@tohoku.ac.jp　TEL: 795-6861
In addition	

Subject	Molecular biology					
Course Numbering	YAL-PHA237J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Professor Inada Toshifumi					
Practical business						
Objectives and summary of class	The purpose of this course is to learn the functions and structure of the cell, the principle of gene expression.					
Goal of study	Students will understand the molecular basis of DNA replication, repair, transcription, RNA processing, translation.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Inada	Sex and genetics I	Principal of Mendelian inheritance
2	Inada	Sex and genetics II	Mechanism of meiosis and recombination
3	Inada	DNA and chromosome	Structure of DNA and chromosome
.4	Inada	DNA replication	Mechanism of DNA replication, a process of producing two identical replicas from one original DNA molecule
5	Inada	DNA damage and repair	DNA is damaged by metabolic activities and environmental factors and corrected by the specific mechanisms.
6	Inada	Gene expression	A process by which genetic information in DNA is converted into a functional gene product
7	Inada	Transcription	In transcription, a particular segment of DNA is copied into RNA by RNA polymerase.
8	Inada	Chromatin structure	Chromatin structure and histone proteins
9	Inada	Transcriptional regulation	Transcription is regulated by protein binding to regulatory DNA sequences.
10	Inada	RNA processing	An important process to provide mature mRNA, a template for protein synthesis
11	Inada	Translation initiation	Mechanism of initiation step of protein synthesis
12	Inada	Translation elongation	Mechanism of translation elongation
13	Inada	Analyzing gene and genome I	Methods to analyze gene products (Western blotting and Northern blotting)
14	Inada	Analyzing gene and genome II	Methods to analyze gene and genome (PCR, DNA sequence)
15	Inada	Quality control for gene expression	Quality controls that recognize and eliminate aberrant mRNA and proteins to ensure the fidelity of gene expression.

Record and evaluation method	Valuation is performed based on short tests (about 10%) and the final examination (about 90%).
Textbook	Essential Biology IV
Reference	

Preparation and Review	Preparation: Reading the textbook for the next lecture Review: Answer of the small test and commentary by the lecture
Language Used in Course	Japanese
Office hours	E-MAIL: toshifumi.inada.a3@tohoku.ac.jp TEL: 795-6874
In addition	

Subject	Pharmacology 3					
Course Numbering	YAL-PHA253J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Sasaki Takuya					
Practical business						
Objectives and summary of class	Pharmacology is summarized in the interactions between medicines and biological functions. Students lean the clinical application, therapeutic and side effects of medicines through those biological actions. Pharmacology 3 focuses on medicines and its clinical application acting on cardiovascular system, kidney, urinary, genital organs. Pharmacology 3 also focused on therapeutics for metabolic diseases and cancer.					
Goal of study	Students understand the molecular basis in drug actions of therapeutics. In addition, students deepen their understanding of the pharmacological mechanisms underlying the main and side effects of medicines.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Sasaki	Introduction of cardiovascular pharmacology	Students learn the pathology of cardiovascular and kidney diseases and pharmacology of therapeutics acting on circulatory organs.
2	Sasaki	Cardiovascular therapeutics (1)	Students learn the heart failure and its therapeutics including cardiac glycoside, beta adrenergic agents and angiotensin-converting enzyme inhibitors.
3	Sasaki	Cardiovascular therapeutics (2)	Students learn the therapeutics for angina including nitrate, calcium channel blockers, vasodilators and beta receptor inhibitors.
4	Sasaki	Cardiovascular therapeutics (3)	Students learn the antiarrhythmia agents such as sodium channel inhibitors.
5	Sasaki	Cardiovascular system therapeutics (4)	Students learn the agents of hypertension such as sympathetic nervous system modulator, renin-angiotensin inhibitors, calcium channel inhibitors and diuretic.
6	Sasaki	Coronary and cerebral thrombosis therapeutics	Coronary and cerebral thrombosis causes myocardial infarction and stroke. Students learn the thrombolytic agents and protectants for acute and subacute heart or brain infarction.
7	Sasaki	Mid-term examination, and renal therapeutics	Students learn the regulation of urine formation and the effects of diuretic agents on hypertension and heart failure.
8	Sasaki	Urinary organ therapeutics	Students learn the therapeutics for dysuria and prostatic hyperplasia.
9	Sasaki	Genital organ therapeutics	Students learn the agents of uterine construction, uterine relaxant and improving drugs for sexual cycle and functions.
10	Sasaki	Metabolic disease therapeutics (1)	Students learn the lipid and purine metabolism and the therapeutics for hyperlipidemia and gout.
11	Sasaki	Metabolic disease therapeutics (2)	Students learn the mechanism underlying autoimmune disease, and bone and calcium metabolism. Students also learn the therapeutics for rheumatoid arthritis, collagen disease, osteoporosis and osteoarthrosis.
12	Sasaki	Eye and skin disease therapeutics	Students learn the therapeutics for eye and skin diseases including glaucoma, atopic dermatitis and decubitus

13	Sasaki	Anticancer therapeutics (1)	Students learn the mechanism of anticancer regents and the application for typical cancers.
14	Sasaki	Anticancer therapeutics (2)	Students learn the mechanism for the resistance acquisition and the therapeutics for prevention of side effects of anticancer regents.
15	Sasaki	Drug-induced suffering	Students learn the cause of harmful side effects and skill for prevention of the drug-induced suffering.
Record and evaluation method		Mid-term examination (45%), examination (45%), class performance (10%) and so on.	
Textbook		「Zukai Yakurigaku」 Ed. T Nabeshima and K Inoue, Nanzando	
Reference		References will be provided as necessary.	
Preparation and Review		Students are required to prepare knowledge of target organs for drugs and pathology related to content of the class using internet and books.	
Language Used in Course		Japanese	
Office hours		Make an appointment via e-mail before visiting the office. The contact information for the lecturers will be on the textbook. E-MAIL: takuya.sasaki.b4@tohoku.ac.jp TEL: 022-795-5503	
In addition			

Subject	Health Chemistry 1					
Course Numbering	YAL-PHA241J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Professor Matsuzawa Atsushi, Associate Professor Noguchi Takuya					
Practical business						
Objectives and summary of class	Health Chemistry is the research field to understand the essential nutrients for human and to find the method by which protect human from various types of stress including environmental stress, chemicals, and drugs, leading to maintenance and increase of human health and prevention of human diseases. Therefore, the important theme is changed by the needs of the times. In this course, students can especially deepen their understanding of digestion and absorption of nutrients, energy metabolism, relationship between essential nutrients and human health, dynamics of nutrients and chemicals in internal body, toxicity of chemicals, safety evaluation method of chemicals.					
Goal of study	1. Understanding of various types of stress caused by environment, chemicals, drugs, and so on. 2. Understanding of digestion and absorption of nutrients, energy metabolism, relationship between essential nutrients and human health. 3. Understanding of dynamics of nutrients and chemicals in internal body, toxicity and safety evaluation method of chemicals.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Matsuzawa	Digestion and absorption of nutrients (1)	Students learn the three major nutrients such as carbohydrates, lipids, and proteins.
2	Matsuzawa	Digestion and absorption of nutrients (2)	Students understand the mechanisms of digestion and absorption of nutrients.
3	Matsuzawa	Delivery systems of nutrients	Understanding of delivery systems of the three major nutrients.
4	Matsuzawa	Storage, utilization, and interconversion of nutrients	Understanding of storage, utilization, and interconversion of the three major nutrients, and energy metabolism.
5	Matsuzawa	Vitamins (1)	Students learn water-soluble vitamins as important nutrients except for the three major nutrients.
6	Matsuzawa	Vitamins (2)	Students learn fat-soluble vitamins as important nutrients except for the three major nutrients.
7	Matsuzawa	Minerals	Students learn minerals required in trace or large amounts.
8	Matsuzawa	Dietary fibers and non-nutrients	Students learn dietary fibers and non-nutrients.
9	Matsuzawa	Effect of nutrients on human health and diseases (1)	Students understand the relationship of human diseases with deficiency and excess of nutrients or energy metabolism, and the change of dietary reference intakes, dietary life, and dietary habits.
10	Matsuzawa	Effect of nutrients on human health and diseases (2)	Students understand the relationship of food ingredient and nutrients with increase of human health and prevention of human diseases, and learn health food and food for specified health uses.
11	Matsuzawa	Metabolism of chemicals	Students deepen their understanding of metabolism of chemicals and drugs.

12	Noguchi	Toxicity of chemicals (1)	Understanding of the mechanisms of carcinogenesis induced by chemicals and drugs.
13	Noguchi	Toxicity of chemicals (2)	Understanding of the mechanisms of tissue damages induced by chemicals and drugs.
14	Noguchi	Toxicity of chemicals (3)	Students understand the effect of endocrine disruptors and inorganic or organic substance on human health, and learn their toxicity, methods of detoxification, and drug abuse.
15	Matsuzawa	Safety evaluation and restriction of chemicals	Understanding of safety evaluation, restriction, and toxicity testing methods of chemicals.
Record and evaluation method		Students are evaluated on the final examination (75%) and the class performance (25%).	
Textbook		"Eisei Yakugaku –Kenkou to Kankyou– " edited by Akira Naganuma, Seiichiro Himeno, Akira Hiratsuka (Maruzan).	
Reference			
Preparation and Review		Students are required to prepare and review for class according to the goal and contents of each class.	
Language Used in Course		Japanese	
Office hours		Students should make an advance appointment via E-mail or other means. E-mail: atsushi.matsuzawa.c6@tohoku.ac.jp TEL: 795-6827	
In addition		The most of lecture contents are included in pharmacist national examination guidelines.	

Subject	Pharmaceutics 2					
Course Numbering	YAL-PHA262J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Professor Akita Hidetaka, Lecturer Sakurai Yu, Assistant Professor Hiroki Tanaka					
Practical business						
Objectives and summary of class	The purpose of this course is to apply the physical pharmacy and basic pharmacokinetics given by Pharmaceutics 1 for the design of dosage regimen in human. This course will help students understand pharmacokinetic models, moment analysis, mechanisms and kinetics of drug-drug interaction, various factors affecting pathological changes in pharmacokinetics and individual differences, and therapeutic drug monitoring (TDM). Small test will be given in each lecture to evaluate the achievement of understandings.					
Goal of study	Upon completion of this class, a student should be able to: ·Explain the concept of pharmacokinetic models such as one-compartment model and physiologically based pharmacokinetic model ·Explain the mechanisms and kinetics of drug-drug interactions ·Explain the principle of clinical dosage regimen and apply for selecting a route of drug administration and determining the dose and frequency of administration. ·Explain moment analysis and therapeutic drug monitoring (TDM)					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Akita	Compartment models-1	Basic concept and principle of one-compartment model Application of one-compartment model for bolus intravenous administration
2	Akita	Compartment models-2	Application of one-compartment model for constant infusion and multiple dosage regimen
3	Akita	Design of dosage regimen-1	Formulation of pharmacokinetic models for constant infusion Design of bolus dose and constant infusion rate to achieve a desired steady state plasma concentration of drugs
4	Akita	Design of dosage regimen-2	Formulation of pharmacokinetic models for multiple dosing Design of multiple dosing regimen to achieve a desired steady state plasma concentration of drugs
5	Akita	Moment analysis	Principle of moment analysis as a models-independent analysis Application of moment analysis for analyzing the release and absorption of drug delivery system formulations which have the difficulty in describing models.
6	Tanaka	Population pharmacokinetics	Basic concepts of population pharmacokinetics
7	Tanaka	Practice: PK models-1	Practice of one-compartment model for the basic 1-compartment model
8	Akita Tanaka	Practice: PK models-2	Practice of one-compartment model for the actual cases of dosage regimen
9	Akita	Physiologically based pharmaco-kinetic models	The values of volume of distribution and rate constant obtained by the compartment model are conceptual. We outline physiological drug kinetics that express pharmacokinetics in more detail based on physiological and anatomical findings.
10	Akita	Clearance theory	Clearance theory to formulate the elimination process of drugs Definitions of total body clearance, organ clearance, intrinsic clearance and their relationships
11	Akita	Nonlinear	Processes the show saturation characteristics, e.g., metabolism,

		pharmacokinetics	membrane transport, and plasma protein binding Principle of nonlinear pharmacokinetics
12	Sakurai	Pathological changes and inter-individual differences	Pharmacokinetic factors affecting the pathological changes in the rate-limiting processes of absorption, distribution, metabolism and elimination (ADME) and the inter-individual differences
13	Sakurai	Special population	Children therapy
14	Akita	Drug-drug interaction-1	Basic principle of drug-drug interactions Changes in the pharmacological effect of drugs by the other concomitantly administrated drugs
15	Akita	Drug-drug interaction-2	Mechanisms and kinetics of drug-drug interactions

Record and evaluation method	Students are evaluated on their points from all the small tests (15%), and the midterm and regular examinations (85%).
Textbook	(Japanese) Partner Pharmaceutics, Fourth edition (2022) (ISBN:9784524403875) パートナー薬剤学 改訂第 4 版 原島秀吉ら編集、南江堂（2022）
Reference	1. (English) Clinical Pharmacokinetics and Pharmacodynamics: concepts and applications Fourth Edition Malcolm Rowland and Thomas N. Tozer, Lippincott Williams and Wilkins (2009) (ISBN:9780781750097) 2. (Japanese) Biopharmaceutics (ISBN:9784567482349) わかりやすい生物薬剤学 第 5 版 荻原琢男執筆者代表、廣川書店（2014） 3. (Japanese) Clinical pharmacokinetics (ISBN: 9784524250554) 臨床薬物動態学 第 4 版 加藤隆一著、南江堂 (2009) 4. (Japanese) Tsuji's pharmacokinetics Episode Pharmacokinetics (ISBN:9784901789998) エピソード薬物動態学―薬物動態学の解明、京都廣川書店（2012）
Preparation and Review	Getting basic knowledge on each topic using the text book and references above as a pre-study and Trying several practice problems as a review
Language Used in Course	Japanese
Office hours	Please make an advance appointment via e-mail or other means. The contact information for the lecturer will be given in the class.
In addition	

Subject	Medicinal Chemistry 1					
Course Numbering	YAL-PHA228J	Categories	Elective			
Preferable Participants	3rd	Semester	5	Credits	1	
Instructor	Doi Takayuki, Miyata Kazuhiko					
Practical business						
Objectives and summary of class	In this class, students learn history of drug discovery and the current advanced drug discovery research represented by genomic drug discovery, a patent, and the norms for developing a marketing drug. Students learn the basic knowledge of drug research and development.					
Goal of study	· Students can explain the flow of drug development and the research methods used. · Students can explain the significance of intellectual property rights and patents, and the norms related to new drug development research. · Students can explain about genome-based drug discovery. · Students can explain drug targets, screening, drug design, and drug discovery modalities.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Doi	Drug discovery process (1)	The history of pharmaceuticals, the current status of drug discovery, and the drug discovery process from the early stages of drug discovery
2	Doi	Drug discovery process (2)	The flow of drug discovery from the early stages of discovery to the determination of development compounds (non-clinical studies), clinical studies, application for approval, approval, marketing, and post-marketing surveillance.
3	Doi	Drug discovery research (1)	Genomic drug discovery, antibody drugs, drug discovery modalities and AI drug discovery and therapy
4	Doi	Drug discovery research (2)	Molecular target discovery by elucidating disease-related genes and its application to drug discovery such as IT, big data analysis, robotics, etc., as well as genome editing and chemical knockdown
5	Doi	Drug discovery research (3)	Basic knowledge and ethical attitudes toward biopharmaceuticals, gene therapy, and cell therapy.
6	Miyata	Fundamentals of drug development (1)	Intellectual property rights and the significance of the patent system
7	Doi	Fundamentals of drug development (2)	Generic drugs, drug hazards, and the norms for research and development of new drugs.
8	Doi	Summary and Examination	Summary of the flow of drug development

Record and evaluation method	Evaluation is performed comprehensively based on the class performance (20%) and the final examination (80%).
Textbook	Basic Pharmaceutical Textbook Series 6, Pharmaceutical Science and Medicinal Chemistry 2nd edition, Kagakudojin (2022)

Reference	The Practice of Medicinal Chemistry, second edition/ C. G. Wermuth, ELSEVIER LIMITED (2011)
Preparation and Review	Before this course, students are required to read a textbook. After lectures, students are required to read the story of drug discovery development under own investigation.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: doi_taka@mail.pharm.tohoku.ac.jp
In addition	

Subject	Organic Reaction				
Course Numbering	YAL-PHA229J	Categories	Elective		
Preferable Participants	3rd	Semester	5	Credits	2
Instructor	Professor Naohiko Yoshikai, Associate Professor Masanori Shigeno, Assistant Professor Kazuya Kanemoto				
Practical business					
Objectives and summary of class	Biologically active compounds often contain nitrogen, oxygen, and sulfur atoms, and students will understand the property and synthesis of such organoheteroatom compounds along with their application to drugs. In addition, students learn organometallic, Brønsted base, and radical chemistry to synthesize these compounds.				
Goal of study	To be able to understand and explain the chemical property, synthesis of nitrogen, oxygen, and sulfur containing organic molecules and organometallic chemistry				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Shigeno	Introduction to heteroatom chemistry	Outline of organic sulfur and organic phosphorous chemistry
2	Shigeno	Carbon-heteroatom bond	Nature of carbon-heteroatom bonds
3	Shigeno	Synthesis of organosulfur compounds	Synthesis of organosulfur compounds
4	Shigeno	Reaction of organosulfur compounds 1	Transformation of organosulfur compounds
5	Shigeno	Reaction of organosulfur compounds 2	Synthetic reactions using organosulfur compounds
6	Shigeno	Reaction of Brønsted base	Transformation of deprotonative functionalizations
7	Shigeno	Reaction of radicals	Transformation of radical reactions
8	Shigeno	Summary and middle examination	Summary of organoheteroatom chemistry
9	Yoshikai Kanemoto	Introduction to organometallic chemistry	History and importance of organometallic chemistry
10	Yoshikai Kanemoto	Structure, bonding, and properties 1	Types of ligands, basics of ligand-field theory, electron counting
11	Yoshikai Kanemoto	Structure, bonding, and properties 2	Nature of different metals and metal-ligand bondings
12	Yoshikai Kanemoto	Elementary reactions 1	Elementary reactions of transition metal complexes and their mechanisms
13	Yoshikai Kanemoto	Elementary reactions 2	Elementary reactions of transition metal complexes and their mechanisms
14	Yoshikai Kanemoto	Transition metal-catalyzed organic reactions	Principles and applications of transition metal-catalyzed organic reactions
15	Yoshikai Kanemoto	Main group organometallics	Synthesis and reactions of main group organometallic compounds

Record and evaluation method	Evaluated mainly by first examination (40%) and second examination (40%) with partial consideration of attendance (20%)
Textbook	none
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: naohiko.yoshikai.c5@tohoku.ac.jp（吉戒教授） masanori.shigeno.e5@tohoku.ac.jp（重野准教授）
In addition	

Subject	Analytical Chemistry 3					
Course Numbering	YAL-PHA213J	Categories	Elective			
Preferable Participants	3rd	Semester	5	Credits	2	
Instructor	Professor Oe Tomoyuki					
Practical business						
Objectives and summary of class	Drug analyses for ADME (absorption, distribution, metabolism, and excretion) research are essential to keep the safety and proper use of drugs. Protein analyses in biomarker discovery are also essential for drug discovery and diagonosis. This course covers recent practical strategies for advanced separation technologies and highly sensitive analytical technologies for above purposes.					
Goal of study	Better understanding of recent analytical approaches in drug research, basic research, and clinical research to make it possible to explain practical analytical strategies for biomolecules including handling/clean-up of biological samples, qualitative/quantitative use of chromatography/mass spectrometry.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Oe	Introduction: clinical analytical chemistry	Overviewing clinical analytical chemistry and learning about the methodology, significance, difficulties in analyses of drug and bioactive molecules in biological samples
2	Oe	Handling of biological specimens	Learning about biological samples in terms of categorization, sampling, handling, and storage.
3	Oe	Reliable analytical data	Learning about validation of analytical methods and standardization of clinical data in order to keep the reliability
4	Oe	Clean-up for biological specimens	Learning about the clean-up strategies: principle and the characteristics
5	Oe	High performance liquid chromatography I	Learning about the retention on HPLC and related chromatographic conditions (mobile phase, pH, stationary phase, etc.)
6	Oe	High performance liquid chromatography II	Learning about the relationship between the chemical structures and the retention behavior on HPLC
7	Oe	Affinity chromatography	Learning about the basic theories and the significance of affinity chromatography
8	Oe	Electrophoresis I	Learning about the basic theory and the characteristics of gel electrophoresis for bio-macromolecules
9	Oe	Electrophoresis II	Learning about the basic theory and the characteristics of capillary electrophoresis
10	Oe	Mass spectrometry I (advanced)	Learning about the basic of LC/MS for small molecules
11	Oe	Mass spectrometry II (advanced)	Learning about the combination use of stable isotope labeling and mass spectrometry for pharmacokinetics study
12	Oe	Proteomics I	Learning about the ionization/fragmentation of proteins/peptides in mass spectrometry and how to interpret the data
13	Oe	Proteomics II	Learning about protein identification strategies by mass spectrometry
14	Oe	Immunoassay I	Learning about the basic theory and the relationship between designing hapten immunogen and acquired antibodies in terms of the selectivity
15	Oe	Immunoassay II	Learning about the basic theories and the significance in the use of competitive assays for small molecules and non-competitive assays for macromolecules

Record and evaluation method	Based on the written exam
Textbook	Handouts of the power point slides are provided.

Reference	Analytical Chemistry I (パートナー分析化学 I), 3rd Ed., Ed. J. Haginaka, H. Nohta, M. Yamaguchi, Nankodo Co., Ltd., 2017 (ISBN 978-4-524-40343-1) Analytical Chemistry II (パートナー分析化学 II), 4th Ed., Ed. H. J. Haginaka, K. Katoh, Nankodo Co., Ltd., 2021 (ISBN 978-4-524-40385-1) Clinical Chemistry（薬学生のための臨床化学), 3rd Ed., Ed. J. Goto, Y. Katayama, Nankodo Co., Ltd., 2010 (ISBN 978-4-524-40262-5) 「イメージから学ぶ分光分析法とクロマトグラフィー～基礎原理から定量計算まで」. Sadakane, Kyoto Hirokawa Publishing Inc., 2009 (ISBN 978-4-901789-19-6)
Preparation and Review	
Language Used in Course	Japanese
Office hours	An appointment required by E-mail (t-oe@mail.pharm.tohoku.ac.jp) or phone (795-6817)
In addition	

Subject	Physical chemistry 3					
Course Numbering	YAL-PHA216J	Categories	Elective			
Preferable Participants	3rd	Semester	5	Credits	2	
Instructor	Professor Konno Tomohiro, and Assistant Professor Yoshizaki Yuta					
Practical business						
Objectives and summary of class	The purpose of this course is to learn polymeric biomaterials containing polymeric aggregates and micelles, colloids, hydrogels, thin films, liposomes, emulsions, microspheres and microcapsules, rheology, and powders.					
Goal of study	This course is designated to help students understand the basics and applications of colloid biomaterials, polymer biomaterials for pharmaceutical sciences and engineering.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Konno	Thermal physics of condensed matter	Basics of thermal physics of condensed matter
2	Konno	Colloids 1	Characteristic features of colloids
3	Konno	Colloids 2	Stability of colloids
4	Konno	Detergents 1	Structure and properties of detergents
5	Konno	Detergents 2	Thermodynamics of detergents
6	Konno	Polymers and hydrogels 1	Characteristic features of polymers and hydrogels
7	Konno	Polymers and hydrogels 2	Characteristic features and applications of polymers and hydrogels
8	Konno	Polymers and hydrogels 3	Biomedical and chemical applications of polymers and hydrogels
9	Konno	Rheology 1	Basic principle of rheology
10	Konno	Rheology 2	Biomedical application of ideas of rheology
11	Yoshizaki	Powders	Characteristic features of powders and applications in drug preparation
12	Yoshizaki	Thin films 1	Monomolecular and multilayer films
13	Yoshizaki	Thin films 2	Langmuir-Blodgett films and bioanalytical applications of thin films
14	Yoshizaki	Liposomes and emulsions	Preparation and use of liposomes and emulsions
15	Yoshizaki	Microsphere and microcapsule	Preparation and use of microspheres and microcapsules

Record and evaluation method	Students are evaluated on the small quizzes (20%) and final test (80%).
Textbook	
Reference	“Physical Chemistry 2nd Edition.”, Publisher: Kagaku-Dojin Publishing Company, (2018) (ISBN: 978-4-7598-1628-0) “Biomaterials Science 2nd Edition.”, Publisher: Tokyo-Kagaku-Dojin Publishing Company, (2018) (ISBM: 978-4-8079-0906-3)

Preparation and Review	Students are required to read the textbook for the next class.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-mail: t-konno@tohoku.ac.jp　Phone: 795-6841
In addition	

Subject	Pharmacology 4				
Course Numbering	YAL-PHA254J	Categories	Elective		
Preferable Participants	3rd	Semester	5	Credits	2
Instructor	Professor Hirasawa Noriyasu, Accistant Professor Segawa Ryosuke, and Professor Moriya Takahiro				
Practical business					
Objectives and summary of class	Pharmacology is a discipline which explores an interaction between drugs and a human body. It also explores the mechanism of a wide variety of human body functions through the analysis of drug action. The main objective of this course is to better understand an interaction between drugs and a human body which is great necessary for considering the actions, adverse effects and contraindication for any given drug. In this Pharmacology 4, students learn about the physiological/pathophysiological roles of various hormones, blood, inflammation and immuno-system and understand the mechanism of the actions, adverse effects and contraindication for related drugs. Students also learn about the classification, morphology and structure of pathogenic microbe and understand the mechanism of the actions, adverse effects and contraindication for several agents to treat infectious diseases such as antibiotics, synthetic antimicrobial agents, anti-tuberculosis drugs, antifungals and antivirals.				
Goal of study	The purpose of this course is to help students learn the basic knowledge and the point of view of the pharmacotherapy. Also, students understand the mechanism of actions and adverse effects of drugs that act on endocrine, blood, hemotogenesis and inflammation/immuno-system. Students also understand the pathogenic microbe and infection and develop the ability to consider and to explain the mechanism of agents to treat infectious diseases.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Hirasawa・Segawa	Hormone and drugs (1)	In this course, students will understand the physiological/pathophysiological roles of hypothalamic hormones, pituitary hormones and mineralocorticoids and learn about related drugs.
2	Hirasawa・Segawa	Hormone and drugs (2)	In this course, students will understand the physiological/pathophysiological roles of thyroid hormone, sex hormones and parathyroid hormone and learn about related drugs.
3	Hirasawa・Segawa	Hormone and drugs (3)	In this course, students will understand the physiological/pathophysiological roles of insulin and learn about drugs for Diabetes Mellitus.
4	Hirasawa・Segawa	Anti-inflammatory drugs (1)	In this course, students will learn about steroidal anti-inflammatory drugs.
5	Hirasawa・Segawa	Anti-inflammatory drugs (2)	In this course, students will learn about Nonsteroidal Anti-inflammatory Drugs (NSAIDs) and antipyretic analgesics.
6	Moriya	Hematology and drugs (1)	In this course, students will understand the physiological/pathophysiological roles of blood and the mechanism of hemostasis and thrombolysis and learn about agents to treat anemias.
7	Moriya	Hematology and drugs (2)	In this course, students will learn about antithrombotic drugs.
8	Moriya	Hematology and drugs (3)	In this course, students will learn about hemostatic drugs.

9	Moriya	Treatment of infectious diseases (1)	This course offers an opportunity to learn about infectious diseases and pathogenic microbe. Students also learn about the history of the development of agents to treat infectious diseases.
10	Moriya	Treatment of infectious diseases (2)	In this course, students will learn about the classification, morphology and structure of pathogenic microbe.
11	Moriya	Treatment of infectious diseases (3)	In this course, students will understand the principle of the action of chemotherapeutic agent to treat infectious diseases and learn the reason why many chemotherapeutic agents exhibit a selective toxicity.
12	Moriya	Treatment of infectious diseases (4)	This course offers an opportunity to learn about the elementary matters of action of chemotherapeutic agents. Students also understand the molecular mechanism and clinical application of cell wall synthesis inhibitors such as penicillins, most popular antibiotics.
13	Moriya	Treatment of infectious diseases (5)	In this course, students will learn about the molecular mechanism and clinical application of protein synthesis inhibitors such as aminoglycosides and tetracyclines.
14	Moriya	Treatment of infectious diseases (6)	In this course, students will learn about the molecular mechanism and clinical application of synthetic antimicrobial agents, anti-tuberculosis drugs and antifungals.
15	Moriya	Treatment of infectious diseases (7)	In this course, students will learn about the molecular mechanism and clinical application of antivirals.

Record and evaluation method	Students are evaluated on the midterm (50%) and final (50%) examination.
Textbook	Nabeshima, Toshitaka and Inoue, Kazuhide eds., *Mitewakaru Yakugaku Zukai Yakurigaku (1st Edition)*. Nanzando, 2015.
Reference	Tanaka, Chikako and Kato, Ryuichi eds., *New Pharmacology (6th Edition)*. Nankodo, 2011. Azuma, Masanobu and Oguma, Keiji eds., *Simple Biseibutsugaku (5th Edition)*. Nankodo, 2011. Yanagisawa, Teruyuki ed., *Shin-yakurigaku nyuumon (3rd Edition)*. Nanzando, 2008. Sato, Susumu ed., *Shin-yakurigaku text (3rd Edition)*. Hirokawa Publishing Co., 2011. Yanagisawa, Teruyuki ed., *Shin-yakurigaku nyuumon (3rd Edition)*. Nanzando, 2008. Laurence Brunton, Bruce Chabner and Brorn Knollman eds., *Goodman & Gilman's The Pharmacological basis of Therapeutics* (Translation supervised by Takaori, Syuzo, Keitaro Hashimoto, Akaike, Akinori and Ishii, Kunio). Hirokawa Publishing Co., 2013.
Preparation and Review	Hirasawa: Students are required to prepare knowledge of target organs for drugs and pathology related to content of the class using internet and books. Moriya: Students can previously download the slide files and prepare the contents with the above textbook.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. The contact information for the lecturer: Hirasawa: E-MAIL: noriyasu.hirasawa.c7@ tohoku.ac.jp TEL: 022-795-6809 Moriya: E-MAIL: t-moriya@pha.ohu-u.ac.jp TEL: 024-932-9156
In addition	Materials are provided via ISTU (Moriya).

Subject	Environmental Health Science					
Course Numbering	YAL-PHA242J	Categories	Elective			
Preferable Participants	3rd	Semester	5	Credits	2	
Instructor	Professor Saito Yoshiro and Assistant Professor Toyama Takashi					
Practical business						
Objectives and summary of class	Environmental health science is a discipline which explores methods for maintenance of the human health and prevention of disease caused by environmental pollutants. In this course, students will understand methods to grasp the human health condition and the actual situation of the disease, the investigation method of the primary cause (mainly environmental risk) of the illness and actual methods for the disease prevention. Students also learn about pollution and purification treatment of water and air which are the most important factors in maintaining health.					
Goal of study	The purpose of this course is to help students better understand the methods for maintenance of the human health and prevention of disease.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Saito	Overview	History of public health and social significance
2	Saito	Environmental factors	Relation with environmental parameters and the human health
3	Saito	Health statistics	Significance of health statistics and method of its evaluation
4	Saito	Epidemiology	Method and significance of epidemiology
5	Saito	Prevention	Significance and effect of disease prevention care
6	Saito	Pollutants 1	Human exposure to environmental pollutants
7	Toyama	Pollutants 2	Health effects of inorganic pollutants
8	Toyama	Pollutants 3	Health effects of organic pollutants
9	Saito	Global environment	Changes in global environment and human life
10	Saito	Water 1	Purification system of drinking water
11	Saito	Water 2	Water pollution and its evaluation
12	Saito	Air	Air and health
13	Saito	Air pollution	Significance and evaluation of air pollution
14	Saito	Occupational health	Cause of the occupational illness and its prevention
15	Saito	Health administration	Law in conjunction with the environmental pollution

Record and evaluation method	Evaluation is performed comprehensively based on the midterm examination (40%), the final examination (40%) and class performance (20%).
Textbook	Pharmaceutical Health Sciences, eds by A. Naganuma et al., Maruzen Publishing Co. Ltd. (ISBN: 978-4-621-08627-8)

Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means.
In addition	

Subject	General Training in Analytical Chemistry				
Course Numbering	YAL-PHA210J	Categories	Required		
Preferable Participants	2nd	Semester	4	Credits	2 (including General Training in Physical Chemistry)
Instructor	Staff and graduate students of Bio-analytical Chemistry Lab (Professor Oe Tomoyuki)				
Practical business					
Objectives and summary of class	The purity of drugs not only affects the pharmacological activity, but also could cause adverse effects. Therefore, accurate and reliable analytical approach is necessary to keep better patients' QOL. In this training, students can experience typical volumetric analyses based on chemical equilibrium in order to acquire basic theories and skills of typical quantitative analyses. For this training, comprehensive knowledge (including physical, inorganic, and organic chemistries) is required. Through this course, students are expected to learn not only for concept of analytical chemistry, but also the scientific way of thinking.				
Goal of study	The principles and operation procedures of volumetric analyses in Japanese Pharmacopoeia, 16th Ed (JP16) are studied in order to perform the analyses practically.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents

This training aims to help students learn basic knowledges on chemical equilibrium and covers: preparation of standard solutions, standardization of the solutions by primary or secondary standard reagents, quantification of drugs by standardized standard solutions, judgement of equivalent point/titration end-point by indicator's color-change, and calculation of the contents/concentrations.

（1） Acid-base titration

Learning about acid-base reactions in aqueous solution, the titration curves, difference between equivalent point and titration end-point, and color-changing mechanism of indicator. Also, performing quantification of aspirin (analgesic) for better understanding of the theory and procedure.

1） Preparation and standardization of 0.1 mol/L NaOH solution

Learning about the procedure for the preparation of NaOH solution and the standardization using sulfamic acid and HCl solution as the primary standard reagent and secondary standard reagent, respectivery.

2） Quantification of aspirin

To understand back titration in acid-base titration, aspirin is analyzed.

（2） Chelatometric titration

Learning about chelation between metal ion/multidentate ligand and color-changing mechanism of metal indicator. Also, performing quantification of calcium pantothenate (vitamin B_5, Ca salt) for better understanding of the theory and procedure..

1） Preparation and standardization of 0.01 mol/L EDTA solution

Learning about the procedure for the preparation of EDTA solution and the standardization using zinc as the primary standard reagent

2） Preparation and standardization of 0.01 mol/L $MgCl_2$ solution

Learning about the procedure for the preparation of $MgCl_2$ solution and the standardization using EDTA solution as the secondary standard reagent.

3） Quantification of calcium pantothenate

To understand chelatometric titration, calcium pantothenate is analyzed as calcium ion.

Record and evaluation method	Based on the attendance, attitude/activity in the laboratory, and the final report. Submitting report is mandatory.
Textbook	

Reference	Japanese Pharmacopoeia, 18th Ed (JP18) Manual (第１８改正日本薬局方解説書), Editing Committee of Japanese Pharmacopoeia Manual, Hirokawa-Shoten Ltd., 2016 (ISBN 978-4-567-01532-5) Analytical Chemistry I (パートナー分析化学 I), 4th Ed., Ed. J. Haginaka, K. Katoh, Nankodo Co., Ltd., 2021 (ISBN 978-4-524-40384-4) Quantitative analysis（図解とフローチャートによる定量分析), Ed. S. Asada, S. Uchide, M. Kobayashi, Gihodo Shuppan Co., Ltd., 1987 (ISBN 4-7655-0342-9)
Preparation and Review	
Language Used in Course	Japanese
Office hours	An appointment required by E-mail (t-oe@mail.pharm.tohoku.ac.jp) or phone (795-6817)
In addition	

Subject	General Training in Physical Chemistry				
Course Numbering	YAL-PHA210J	Categories	Required		
Preferable Participants	2nd	Semester	4	Credits	2 (including General Training in Analytical Chemistry)
Instructor	Teaching staff of Laboratory of Biointerface Chemistry and Laboratory of Bio-Structural Chemistry. Contact: Nakabayashi Takakazu				
Practical business					
Objectives and summary of class	Physical chemistry serves as an important base for various methods which are utilized in pharmaceutical research studies. In this course, students will learn about the principles and measurements of several spectroscopic and electrochemical techniques. This course trains students to be able to determine various kinetic and equilibrium parameters such as the rate of a chemical reaction, and analyze the molecular structure.				
Goal of study	(1) The purpose of this course is to help students understand the principles and operations of instrumental analysis methods. (2) Students will be able to find an appropriate method for solving their own specific analytical problem.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents

General training in physical chemistry consists of 6 courses described below. An instructor of each course works with a small group of students up to 15. Students make an original project based on the general training courses and perform it at the final stage of the training.

(1) Ion selective electrode

Students will learn about the constitution and principle of ion selective electrodes. Students can deepen their understanding of the properties and operations of electrodes through determining solute concentration in a test sample.

(2) Buffer

Students will learn about the theory and preparation of a pH-meter and buffer solutions. Students perform neutralization titration, and understand the buffer capacity and the working pH range by analyzing the obtained titration curve.

(3) Acid dissociation constant

Students will learn about the principles and operations of a UV-visible spectrophotometer. Students will be able to determine the acid dissociation constant of dye molecules from the pH dependence of the absorption spectrum.

(4) Fluorescence spectroscopy

Students will learn about the principles and operations of a fluorescence spectrofluorometer. Fluorescence spectrum of a protein is applied for estimation of the environment of tryptophan residues in protein molecule.

(5) Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) of proteins

Students will learn about the methods for determinations of molecular weight and concentration of proteins using SDS-PAGE and UV absorption, respectively.

(6) Infrared absorption spectroscopy

Students will learn about the operations of an infrared spectrometer, and the preparation of samples for the spectral measurements. In order to obtain information on the molecular structure from the infrared spectrum, students understand why the frequency of a molecular vibration is altered by the isotope substitution or hydrogen bonding.

Record and evaluation method	Evaluation is performed comprehensively based on submitted report, attendance and so on.
Textbook	
Reference	Atkins' Physical Chemistry (10th edition), Peter Atkins and Julio de Paula, Oxford University Press, ISBN: 978-0199697403.
Preparation and Review	Students are required to prepare for each training session using the training manual.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means.
In addition	

Subject	General Training in Organic Chemistry 1				
Course Numbering	YAL-PHA220J	Categories	Required		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Faculty staff of Organometallic Chemistry Laboratory, Medicinal Chemistry Laboratory, Synthetic Chemistry Laboratory, Heterocyclic Chemistry Laboratory, Molecular Transformation Laboratory, Natural Products Chemistry Laboratory, and Botanical Garden for Pharmacological Herbs. Contact: Yoshiharu Iwabuchi (Synthetic Chemistry Laboratory), Teigo Asai (Natural Products Chemistry Laboratory)				
Practical business					
Objectives and summary of class	This course provides practical training in the basic techniques of the standard organic chemistry laboratory, such as separation and characterization techniques. Experiments involving the synthesis and reaction of simple organic compounds are introduced. Fieldwork in the Experimental Station for Medicinal Plant Studies is also included in this course.				
Goal of study	Students will develop their skills in the organic chemistry laboratory and their abilities necessary to interpret spectra of organic molecules.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents

Lecture:
Introduction to organic chemistry experiments and structure analysis of organic compounds

Laboratory training:
1. Introduction of basic techniques
(1) Extraction and drying, (2) Distillation and recrystallization, (3) Melting point determination, (4) Qualitative analysis, (5) Glasswork techniques, (6) Spectroscopic analysis

2. Reaction and structure determination of organic compounds
(1) Electrophilic aromatic substitution reaction
(2) Functional group transformation
(3) Reactivity of organometallic reagents
(4) Identification of organic molecules

3. Fieldwork in the Experimental Station for Medicinal Plant Studies
(1) Observation of medicinal plants
(2) Component of medicinal plants
(3) Intended purpose, pharmacological action, and used part of medicinal plants

Record and evaluation method	Evaluation is performed comprehensively based on their level of class participation (60%), the final examination (20%), the submitted report (i.e., the submitted laboratory notebook) (10%), and fieldwork in the experimental station for medicinal plant studies (10%).
Textbook	令和４年度–令和５年度 創薬化学実習（Soyaku Kagaku Jissyu）

Reference	Handbook of Experimental Organic Chemistry 1. Sample Handling and Purification Techniques (Japanese), Ed. by T. Goto et al. Kagaku Dojin (1988) Handbook of Experimental Organic Chemistry 3. Organic Reactions [1] (Japanese), Ed. by T. Goto et al. Kagaku Dojin (1990) Basic Heterocyclic Compounds, New Edition (Japanese), written by H. Yamanaka, T. Hino, M. Nakagawa, and T. Sakamoto, Kodansya (2004) Advanced Heterocyclic Compounds, New Edition (Japanese), written by H. Yamanaka, T. Hino, M. Nakagawa, and T. Sakamoto, Kodansya (2004) The Organic Chem Lab Survival Manual -A Student's Guide to Technique- Sixth Edition, written by J. W. Zubrick, John Wiley & Sons (2004) Reactions and Syntheses: in the Organic Chemistry Laboratory, Second, Completely Revised and Updated Edition, written by L. F. Tietze, T. Eicher, U. Diederichsen, A. Speicher, and N. Schützenmeister, Wiley-VCH (2007) Spectrometric Identification of Organic Compound, 8th Edition, written by R. M. Silverstein, F. X. Webster, D. J. Kiemle, and D. L. Bryce Wiley (2016)
Preparation and Review	Students must read the relevant sections in the textbook and Classroom and understand the contents in advance.
Language Used in Course	Japanese
Office hours	Make an appointment in advance. E-mail: y-iwabuchi@tohoku.ac.jp, Phone: 022-795-6846 E-mail: teigo.asai.c8@tohoku.ac.jp, Phone: 022-795-6822
In addition	

Subject	General Training in Organic Chemistry 2				
Course Numbering	YAL-PHA320J	Categories	Required		
Preferable Participants	3rd	Semester	5	Credits	1
Instructor	Faculty staff of Organometallic Chemistry Laboratory, Medicinal Chemistry Laboratory, Synthetic Chemistry Laboratory, Heterocyclic Chemistry Laboratory, Molecular Transformation Laboratory, Natural Products Chemistry Laboratory, and Botanical Garden for Pharmacological Herbs. Contact: Asai Teigo (Natural Products Chemistry Laboratory), Masanori Shigeno (Molecular Transformation Laboratory)				
Practical business					
Objectives and summary of class	In continuation of General Training in Organic Chemistry 1, the first half of this course continues to provide practical training in the basic techniques of the standard synthetic organic chemistry laboratory. The second part of this course provides practical training in the basic techniques of the isolation, derivative synthesis and characterization of natural products. Fieldwork in the Experimental Station for Medicinal Plant Studies is also included in the second part.				
Goal of study	Students will develop basic skills in the organic chemistry laboratory and natural product chemistry, and their abilities necessary to interpret spectra of organic molecules.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents

Lecture:
Introduction to organic chemistry experiments and structure analysis of organic compounds

Laboratory training and fieldwork:
1. Introduction of basic techniques
(1) Extraction and drying, (2) Distillation and recrystallization, (3) Melting point determination, (4) Qualitative analysis, (5) Optical resolution, (6) Spectroscopic analysis

2. Reaction and structure determination of organic compounds
(1) Reaction of aromatic compounds
(2) Synthesis and reaction of organometallic compounds
(3) Pericyclic reaction

3. Multi-step synthesis of protoberberine alkaloids

4. Isolation of natural products, Synthesis of their derivatives, and Structure determination
(1) Isolation of rutin
(2) Synthesis of rutin derivatives
(3) Structure analysis of rutin

5. Fieldwork in the Experimental Station for Medicinal Plant Studies
(1) Observation of medicinal plants
(2) Component of medicinal plants
(3) Intended purpose, pharmacological action, and used part of medicinal plants

Record and evaluation method	Evaluation is performed comprehensively based on their level of class participation, the submitted report (i.e., the submitted laboratory notebook), and the final examination.
Textbook	令和３年度−令和４年度 創薬化学実習（Soyaku Kagaku Jissyu）

Reference	Handbook of Experimental Organic Chemistry 1. Sample Handling and Purification Techniques (Japanese), Ed. by T. Goto et al. Kagaku Dojin (1988) Handbook of Experimental Organic Chemistry 3. Organic Reactions [1] (Japanese), Ed. by T. Goto et al. Kagaku Dojin (1990) Basic Heterocyclic Compounds, New Edition (Japanese) written by H. Yamanaka, T. Hino, M. Nakagawa, and T. Sakamoto, Kodansya (2004) Advanced Heterocyclic Compounds, New Edition (Japanese), written by H. Yamanaka, T. Hino, M. Nakagawa, and T. Sakamoto, Kodansya (2004) The Organic Chem Lab Survival Manual -A Student's Guide to Technique- Sixth Edition, written by J. W. Zubrick, John Wiley & Sons (2004) Reactions and Syntheses: in the Organic Chemistry Laboratory, Second, Completely Revised and Updated Edition, written by L. F. Tietze, T. Eicher, U. Diederichsen, A. Speicher, and N. Schützenmeister, Wiley-VCH (2007) Spectrometric Identification of Organic Compound, 8th Edition, written by R. M. Silverstein, F. X. Webster, D. J. Kiemle, and D. L. Bryce Wiley (2016)
Preparation and Review	Students must read the relevant sections in the textbook and understand the contents in advance.
Language Used in Course	Japanese
Office hours	Make an appointment in advance. E-mail: yoshinori.kondo.a7@tohoku.ac.jp, Phone: 022-795-6804 E-mail: teigoasai@gmail.com, Phone: 022-795-6822
In addition	

Subject	General Training in Life Sciences				
Course Numbering	YAL-PHA230J	Categories	Required		
Preferable Participants	3rd	Semester	5	Credits	3
Instructor	Molecular and Cellular Biochemistry, Molecular Genetics, Molecular Biology and Metabolism				
Practical business					
Objectives and summary of class	This course aims to improve students' ability to handle biological materials including tissues, cells, and bacteria, in biochemical and molecular biological methods, to learn methodologies for analyzing physiology and pharmacology of organisms: i.e., students learn how to analyze structure of organs and tissues, how to measure enzymatic activities, and gene expression, and methods for protein purification, bacterial isolation, DNA amplification, and restriction enzyme mapping.				
Goal of study	- Understanding the structure of organs and tissues - Learning the fundamental biochemical procedures through the experiments with protein and enzymes - Developing the ability of cell culture and assays using cultured cells. - Understanding the principals of enzymatic reaction and learn methods for measuring the enzyme activity. - Understanding the principle of the gene expression and developing the methodological skills for the detection of gene expression. - Developing the experimental technique including instrument sterilization, aseptic manipulation and bacteria handling, and understanding the basic knowledge about microorganisms.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents

【Microorganisms and chemotherapeutic agent】

1) Handling of microorganisms
This practical training performs the sterilization, disinfection, aseptic manipulation, pipetting, and medium preparation.
2) Culture and identification of microorganisms
This practical training observes the colonization of bacteria on solid medium and growth of bacteria in liquid medium after inoculating the bacteria into the medium. Furthermore, this practical training performs the identification of bacteria by PCR.
3) Antibacterial spectrum
This practical training performs the antibacterial spectrum and biological assay of various antibiotics.
4) Gene transfer
This practical training aims to understand the plasmid purification from E Coli. Furthermore, this practical training performs the introduction of gene into the *E. coli* (transformation).

【 Gene expression and Enzymatic reactions】

1) Principles of Gene Expression
Analyzing the induction of *lacZ* gene expression in *E. coli via* measuring the enzymatic activity of the products. Analyzing tissue-specific expression of reporter genes by substrate staining of the enzymatic reaction.
2) Principles of enzyme reaction and protein purification
Purification of ß-galactosidase by affinity chromatography. Analyses of protein expression and purification by SDS-PAGE and the enzyme activity.
3) Analyses of gene expression using reporter genes
Detecting the expression genes using reporter genes in tissues and whole bodies.

【Observation of organs and tissues, and fundamental biochemical procedures】

1) Observation of rat organs and tissues
Anatomy of rat and observation of its organs and tissues
2) Separation and quantification of proteins/enzymes
Separation of proteins by gel electrophoresis, determination of protein concentration and enzyme activities
3) Handling of animal cells
Preparation of rat peritoneal mast cells, evaluation of mast cell activation and quantification of histamine
4) Gene transfer to cultured cells
Lipofection of plasmid DNA into a human cell line
5) Ligand activity toward G-protein-coupled receptors
Measurement of agonistic and antagonistic activities of ligands for histamine receptors

Record and evaluation method	Evaluate submitted report (50%) and class performance (50%). Details will be explained in the first lecture session.
Textbook	A textbook for the course (Seimei-yakugaku Jisshusho) is provided in the class.
Reference	
Preparation and Review	Students are required to read relevant sections of the textbook and understand details of training sessions in advance.
Language Used in Course	Japanese
Office hours	An advance appointment *via* e-mail is required.
In addition	

Subject	General Training in Biopharmacy and Pharmacy Practice				
Course Numbering	YAL-PHA250J	Categories	Required		
Preferable Participants	3rd	Semester	5	Credits	2
Instructor	Lab. of Pharmacology, Lab. of Health Chemistry, Lab. of Membrane Transport and Drug Targeting				
Practical business					
Objectives and summary of class	In this course, students deepen their understanding of Biopharmacy and Pharmacy Practice, and learn analytical methods commonly used in the field. In the first section, students learn the principle and technique on pharmacological actions of central, peripheral and cardiovascular systems. Especially, students will understand the five practical exercise themes of cardiac function, blood pressure, ilea function, convulsion, and anatomy of animal. In the second section, students work on two practical exercises; one is biochemical analysis of antioxidant responses mediated by biomolecules, and the other one is polymorphism analysis of detoxification enzymes. The exercises will provide insight into the detoxification mechanisms and the individual differences derived from diverse genetic backgrounds. In the last section, students will study on the pharmacokinetic analysis affecting pharmacological and toxicological effects of drug after the administration. Several simulation works will be performed to understand the clinical pharmacokinetics for the design of dosage regimen.				
Goal of study	The purpose of this course is to learn and understand the following subjects: the mechanism of pharmaceutical regent, the method of drug evaluation, the detoxification responses for drug toxicity and the analytical methods for genetic polymorphisms, the pharmacokinetic analysis, the design of dosage regimen.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents

1. Mechanism of drug actions and evaluation of drug efficacy
   (1) Anatomy of target organs for drugs (brain, intestine, heart and vessels)
   (2) Pharmacology of sympathetic and parasympathetic nervous and cardiac systems with isolated intestine and heart. Measurement of blood pressure under anesthesia
   (3) Pharmacology of central nervous system (anti-epileptic drugs etc.)
2. Drug toxicity and detoxification responses
   (1) Biochemical analysis of antioxidant responses mediated by biomolecules
   (2) Analysis of a genetic polymorphism of metabolic detoxification enzymes
3. Pharmacokinetics, design of dosage regimen, and general tests, processes and apparatus
   (1) Estimation of pharmacokinetic parameters, calculation of the constant infusion rate and the frequency of oral drug administration for the effective drug therapy
   (2) Therapeutic Drug Monitoring (TDM) and moment analysis
   (3) Dissolution test of drug

Record and evaluation method	Evaluate class performance (40%) and submitted report (60%).
Textbook	Textbooks will be provided.
Reference	References will be provided as necessary.
Preparation and Review	Students should read the relevant sections in the textbook and understand the contents in advance.
Language Used in Course	Japanese
Office hours	Make an appointment via e-mail before visiting the office. The contact information for the lecturers will be on the textbook.

In addition	

Subject	Natural Products Chemistry					
Course Numbering	YPS-PHA321J	Categories	Elective			
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2	
Instructor	Professor Asai Teigo, Associate professor Taro Ozaki					
Practical business						
Objectives and summary of class	Natural products are very important for developing drugs. This course aims to learn about biosynthesis of natural products as well as their structures, chemical properties and biological activities.					
Goal of study	The aim of this course is to help student understand the importance of natural products in drug discovery and pharmaceutical sciences.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Asai	Introduction of Natural products biosynthesis	This lecture aims to introduce the study of natural products biosynthesis.
2	Asai	Fatty acid biosynthesis	This lecture aims to learn about fatty acid biosynthesis.
3	Asai	Fatty acid synthase	This lecture aims to learn about fatty acid synthase based on domain function.
4	Asai	Introduction of polyketide synthase (PKS)	This lecture aims to introduce polyketide biosynthesis.
5	Asai	Biosynthetic machinery of PKS 1	This lecture aims to learn about biosynthetic machinery of PKS.
6	Asai	Biosynthetic machinery of PKS 2	This lecture aims to learn about biosynthetic machinery of PKS.
7	Asai	Biosynthetic machinery non-ribosomal peptide synthase (NRPS)	This lecture aims to learn about biosynthetic machinery of NRPS.
8	Asai	Biosynthetic machinery of terpene cyclase	This lecture aims to learn about biosynthetic machinery of terpene cyclase.
9	Ozaki	Modification enzyme 1	This lecture aims to learn about biosynthesis of natural product.
10	Ozaki	Modification enzyme 2	This lecture aims to learn about enzymes responsible for modification step in natural product biosynthesis.
11	Ozaki	Modification enzyme 3	This lecture aims to learn about enzymes responsible for modification step in natural product biosynthesis.
12	Ozaki	Natural product biosynthesis 1	This lecture aims to learn about enzymes responsible for modification step in natural product biosynthesis.
13	Ozaki	Natural product biosynthesis 2	This lecture aims to learn about frontier research on natural product chemistry.
14	Ozaki	Natural product biosynthesis 3	This lecture aims to learn about frontier research on natural product chemistry.
15	Asai	Frontier research on natural product chemistry 3.	This lecture aims to learn about frontier research on natural product chemistry.

Record and evaluation method	Evaluated by examination (50%) and submitting report (50%).
Textbook	
Reference	「医薬品天然物化学」　海老塚豊 監訳、南江堂（2004） 「天然物化学」菅原二三男、浅見忠男、葛山智久、倉持幸司、新家一男、永田晋治、コロナ社（2019）
Preparation and Review	Review frequently using textbooks and handouts distributed during lectures.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means before students will visit office. E-mail: teigo.asai.c8@tohoku.ac.jp　Tel: +81-795-6822
In addition	

Subject	Organic Synthesis				
Course Numbering	YPS-PHA322J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2
Instructor	Iwabuchi Yoshiharu, Tokuyama Hidetoshi, Ueda Hirofumi, Hiroyuki Yamakoshi				
Practical business					
Objectives and summary of class	The purpose of this course is to help students deepen their understanding of synthetic organic chemistry and improve their ability to plan tactics for synthesizing complex small organic molecules.				
Goal of study	Students will develop their ability to design and analyze synthetic strategy of complex small organic molecules.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Iwabuchi/ Yamakoshi	Introduction to the Total Synthesis	Introduction to the retrosynthetic analysis, What is total synthesis, What is convergence and linearity in total synthesis
2	Iwabuchi/ Yamakoshi	C-C disconnections	Disconnections next to the alkyne group, Synthetic design using the reactivity of carbonyl group
3	Iwabuchi/ Yamakoshi	Two-group disconnections	1,2-Disconnections and 1,3-disconnections next to heteroatoms, Functional group interconversion between alcohols and ketones
4	Iwabuchi/ Yamakoshi	1,3-Dicarbonyl compounds	Disconnections of β-hydroxycarbonyl compounds, α,β-unsaturated carbonyl compounds, and 1,3-dicarbonyl compounds
5	Iwabuchi/ Yamakoshi	1,5-Dicarbonyl compounds	Disconnections of 1,5-dicarbonyl compounds using a retro-Claisen reaction, Synthetic utilities of Robinson annulation and Mannich reaction
6	Iwabuchi/ Yamakoshi	Umpolung	Natural reactivity and umpolung, Disconnections of 1,2-difunctional compounds
7	Iwabuchi/ Yamakoshi	Chemoselectivity	Chemoselective transformation, Protective group in organic synthesis
8	Iwabuchi/ Yamakoshi	Regioselectivity	Regioselective transformations and their reaction mechanisms
9	Tokuyama/ Ueda	Stereoselectivity	Stereoselective transformations and their reaction mechanisms
10	Tokuyama/ Ueda	Asymmetric synthesis	Optical resolution, Enantioselective reaction, Chiral pool, Enzymatic reaction
11	Tokuyama/ Ueda	Terpene	Selected total synthesis of terpenes
12	Tokuyama/ Ueda	Steroid	Selected total synthesis of steroids
13	Tokuyama/ Ueda	Prostaglandin	Selected total synthesis of prostaglandins
14	Tokuyama/ Ueda	Macrolide	Selected total synthesis of macrolides
15	Tokuyama/ Ueda	Alkaloid	Selected total synthesis of alkaloids

Record and evaluation method	Term 1–8: Students are evaluated on their points from the final examination (90%) and the level of class participation (10%) Term 9–15: Class performance including presentation and discussion (40%), the final examinations (60%)
Textbook	

Reference	Organic Synthesis (Oxford Chemistry Primers, 31), written by C. L. Willis and M. Willis, Oxford University Press (1996) Organic Chemistry, Second Edition, written by J. Clayden, N. Greeves, and S. Warren, Oxford University Press (2012) Classics in Total Synthesis, written by K. C. Nicolaou, and E. J. Sorensen, VCH (1996) Classics in Total Synthesis II, written by K. C. Nicolaou and S. A. Snyder, Wiley-VCH (2003) Classics in Total Synthesis III, written by K. C. Nicolaou and J. S. Chen, Wiley-VCH (2011)
Preparation and Review	Before class, it is important for students to review fundamental knowledge of organic transformations, which have been learned in Organic Chemistry 1~5. After lecture, students are required to review reaction mechanisms and rational of stereoselectivities involved in each total synthesis.
Language Used in Course	Japanese
Office hours	Make an appointment in advance via e-mail. y-iwabuchi@tohoku.ac.jp (Iwabuchi) tokuyama@mail.pharm.tohoku.ac.jp (Tokuyama) hirofumi.ueda.d8@tohoku.ac.jp (Ueda) hiroyuki.yamakoshi.e1@tohoku.ac.jp (Yamakoshi)
In addition	

Subject	Medicinal Chemistry 2				
Course Numbering	YPS-PHA323J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	1
Instructor	Professor Hidetoshi Tokuyama and Lecturer Hirofumi Ueda				
Practical business					
Objectives and summary of class	In this class, students learn about the biological mechanisms and the structures of drugs and targets. Students learn about the fundamental knowledge required for drug discovery.				
Goal of study	· Students can explain about drug discovery, pharmacophore, biological equivalence, and structure-activity relationships. · Students can illustrate and explain the biological mechanisms based on the structures of drugs and targets.				
Method of class	[Lecture] · Practice · Training · On-site training · [SGD] · PBL · Roleplay · e-learning · Others( )				

Term	Lecturer	Theme	Contents
1	Tokuyama Ueda	Target Molecules DNA and RNA	Historical drug discovery, Structures of cells, and Molecular-level interactions between DNA and RNA and drugs.
2	Tokuyama Ueda	Enzymes Receptor	Molecular-level interactions between enzymes or receptors and drugs
3	Tokuyama Ueda	Ion Channel Transporter	Molecular-level interactions between ion channel or transporter and drugs
4	Tokuyama Ueda	Protein-Protein Interaction	Molecular-level interactions of drugs associated with protein-protein interaction.
5	Tokuyama Ueda	Structure of Drug	Pharmacophore and biological equivalence in the structures of drugs
6	Tokuyama Ueda	Typical Drug (1)	Biological mechanisms based on the structures of drugs and targets
7	Tokuyama Ueda	Typical Drug (2)	Presentation of drug development (1)
8	Tokuyama Ueda	Typical Drug (3)	Presentation of drug development (2)

Record and evaluation method	Students are evaluated by examination (70%) and class performance (30%).
Textbook	Basic Pharmaceutical Textbook Series 6, Pharmaceutical Science and Medicinal Chemistry 2nd edition, Atsushi Kittaka Ed., Kagakudojin (2022)
Reference	MEDICINAL CHEMISTRY/ N. Dunlap and D. M. Huryn, Garland Science (2018) The Practice of Medicinal Chemistry, second edition/ C. G. Wermuth, ELSEVIER LIMITED (2011)
Preparation and Review	Read the story of drug discovery development under own investigation
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: tokuyama@mail.pharm.tohoku.ac.jp, hirofumi.ueda.d8@tohoku.ac.jp
In addition	SGD:7th and 8th

Subject	Structure Analysis of Organic Compound					
Course Numbering	YPS-PHA324J		Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2	
Instructor	Iwabuchi Yoshiharu, Doi Takayuki, Tokuyama Hidetoshi, Asai Teigo, Yoshikai Naohiko, Shigeno Masanori, Ozaki Taro, Ueda Hirofumi, Sugawara Akihiro, Yamakoshi Hiroyuki, Ohsawa Kosuke, Sakata Juri, Nagasawa Shota, Tahara Atsushi, Kohyama Aki, Kikuchi Jun, and Kanemoto Kazuya					
Practical business						
Objectives and summary of class	This course aims to improve students' ability to interpret different types of spectra (MS, IR, NMR, and UV-vis) of simple organic compounds and to identify their molecular structures through the spectral analysis. After general introduction to these spectroscopic methods, each class will be conducted in the form of problem-solving exercise, in which the students should expect to actively participate.					
Goal of study	After successfully completing this course, the students will gain basic skills for the interpretation of spectra of organic compounds and the determination of their molecular structures through the spectral analysis.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Tokuyama/ Ueda	NMR, MS, IR and UV-vis spectroscopy	Principles of nuclear magnetic resonance (NMR) spectrometry, ultraviolet (UV)-visible (vis) spectroscopy, mass spectrometry (MS) and infrared (IR) spectroscopy
2	Iwabuchi/ Sugawara	Aliphatic compounds-1	Spectrometric identification of aliphatic compounds
3	Doi/ Kanemoto	Aliphatic compounds-2	Spectrometric identification of aliphatic compounds
4	Asai/ Yamakoshi	Aliphatic compounds-3	Spectrometric identification of aliphatic compounds
5	Yoshikai/ Sakata	Aromatic compounds-1	Spectrometric identification of aromatic compounds
6	Shigeno/ Tahara	Aromatic compounds-2	Spectrometric identification of aromatic compounds
7	Ozaki/ Kikuchi	Aromatic compounds-3	Spectrometric identification of aromatic compounds
8	Ueda/ Nagasawa	Alcohols	Spectrometric identification of alcohols
9	Shigeno/ Ohsawa	Aldehydes	Spectrometric identification of aldehydes
10	Ozaki/ Kanemoto	Ketones	Spectrometric identification of ketones
11	Shigeno/ Nagasawa	Carboxylic acids	Spectrometric identification of carboxylic acids
12	Ohsawa /Sugawara	Esters	Spectrometric identification of esters
13	Shigeno/ Kikuchi	Amines	Spectrometric identification of amines
14	Tahara/ Kohyama	Phenols	Spectrometric identification of phenols
15	Tokuyama/ Ueda	Summary	Summary of spectrometric identification of organic molecules
Record and	Class performance including presentation (25%), the midterm and final examinations (75%)		

evaluation method	
Textbook	
Reference	Spectrometric identification of organic compound, 8th edition (translated in Japanese), written by R. M. Silverstein, F. X. Webster, D. J. Kiemle and D. L. Bryce, translated by N. Iwasawa, S. Toyota, S. Murata, Tokyo Kagaku Dojin (2016)
Preparation and Review	
Language Used in Course	Japanese
Office hours	Make an appointment in advance via e-mail. tokuyama@mail.pharm.tohoku.ac.jp (Tokuyama) hirofumi.ueda.d8@tohoku.ac.jp (Ueda)
In addition	

Subject	Principles of Clinical Medicine				
Course Numbering	YPS-PHA301J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2
Instructor	Takahashi Nobuyuki, Komatsu Hiroshi, Kameoka Jun-ichi, Okazaki Tatsuma, Ohnuma Shinobu, Sawada Shojiro, Ichikawa Tomohiro, Ishii Tomonori, Tachibana Masahito, Ashino Yugo, Ishikawa Makoto, Katori Yukio, Inoue Akira, Shiga Hisashi				
Practical business	○				
Objectives and summary of class	This course provides students with basic knowledge necessary for diagnosis, pathogenesis, pathophysiology, and pharmacotherapy on various diseases. Faculty staff members of the Graduate School of Medicine provide lectures, in an "omnibus" style.				
Goal of study	The purpose of this course is to help students better understand practical medication based on pathophysiology of each disease, and updated diagnostic approach for various diseased states.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Takahashi	General Internal Medicine	Students learn about diagnostic processes for various diseases including medical interviews, physical examinations, clinical laboratory tests, and so on. This course also covers concept, diagnosis, and treatments of various kidney diseases.
2	Komatsu	Clinical Psychopharmacology	In recent years, with the COVID-19 epidemic, depression and other psychiatric disorders have become more prevalent. This course provide evidence-based pharmacotherapy for major psychiatric disorders such as schizophrenia and bipolar disorder as well as depression, and will deepen their understanding of the appropriate use of psychotropic drugs.
3	Kameoka	General Hematology	This course covers recent advance in the diagnosis and treatment for hematological disorders including anemia, thrombocytopenia, leukemia, malignant lymphoma, and so on.
4	Okazaki	General Geriatrics	In this course, students will understand the characteristics of diseases developed in the aged people by learning about the pneumonia in aged people and the pathogenesis of sarcopenia (age related decline in the skeletal muscle power, mass, and physical function)
5	Ohnuma	General Surgery	This course covers recent advance in endoscopic surgery including colorectal surgery and bariatric surgery.
6	Takahashi	Kidney and Hypertension	Hypertension is a common disease, and is important as a factor of the metabolic syndrome. However, its mechanisms are still unclear. Students learn about the role of the kidney and humoral factors on developing hypertension, and understand diagnosis and treatments of hypertension.
7	Sawada	Principles of metabolic disorders: visceral fat obesity and diabetes mellitus	The changes of lifestyle in recent years induced several metabolic disorders for instance visceral fat obesity and diabetes mellitus in Japanese people. These disorders give hardly uncomfortable symptoms to the body, therefore reconsideration of the lifestyle i.e. diet and exercise and effective treatment should be postponed, so that the patients lapse into myocardial infarction, stroke, uremia and

			the other severe complications. In this lecture, the basic approach to pathophysiology , prevention, therapeutic strategy and pharmacotherapy for the metabolic disorders will be presented.
8	Ichikawa	Respiratory Disease	This course covers recent advance in the diagnosis and treatment for respiratory diseases.
9	Ishii	Rheumatism and Collagen Diseases	This course covers recent advance in the diagnosis and treatment for collagen diseases including rheumatoid arthritis.
10	Tachibana	General Reproductive Medicine	This course covers general aspects of reproductive medicine. In addition, students learn about the precautions in a medication of pregnant female.
11	Ashino	Infectious Diseases	This course covers recent advance in the diagnosis and treatment for various infectious diseases including HIV infection.
12	Ishikawa	General Ophthalmology	Students learn about the ophthalmologic information-processing system, and about the recent advance in ophthalmic treatment including gene-based therapy and regenerative medicine.
13	Katori	Otorhinolaryngology, from the General to the Particular	This course covers clinical characteristics of disease in otolaryngology and influences for functions of hearing, smell, taste, phonation and swallowing.
14	Inoue	Palliative Medicine, from the General to the Particular	Students learn about assessment and treatment using opioids NSAIDs and adjuvant analgesics, etc. for cancer-related pain.
15	Shiga	Gastroenterology, from the General to the Particular	This course covers the recent medical treatments for some important gastroenterological diseases, such as H. pylori infection, inflammatory bowel diseases, viral hepatitis and acute pancreatitis.

Record and evaluation method	Students are evaluated based on submitted reports.
Textbook	The textbook will be designated at the beginning of the course.
Reference	References are handed out at every class.
Preparation and Review	
Language Used in Course	Japanese
Office hours	The office hours are from 14:00 to 16:00 on Tuesdays. Make an appointment in advance via e-mail: nobuyuki.takahashi.a8@tohoku.ac.jp (Nobuyuki Takahashi).
In addition	This class is an omnibus lecture series.

Subject	Drug Design and Development				
Course Numbering	YPS-PHA302J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2
Instructor	Ikeda Koji, Nakagawa Atsuhiro, Yoshinari Koichi, Kamiyama Yoshiteru, Kumakura Seiichiro, Yamada Shohei, Hashimoto Tomohiro, Nakamura Ryuta, Nakabayashi Tetsuo, Arakawa Noriaki, Saito Yoshiro, Takeda Masahiro, Taniguchi Nobuaki, Doi Katsuyo				
Practical business	○				
Objectives and summary of class	In order to find and select some drug candidate compounds by some drug efficacy screening tests or a non-clinical test using an experimental animal, it is important to understand the pharmacokinetics and toxicity of candidate compounds for use as a safe and effective drug in humans. Even after launch, it is necessary to pay attention to the information of adverse reactions through post-marketing surveys. In this class, students will learn the basics of pharmacokinetics and toxicity related to drug discovery and development, also learn the outline of new drug development in actual companies. In addition, students will also learn about drug approval and application, including regulatory science and systems for post-marketing surveillance.				
Goal of study	Understand the pharmacokinetics and side effects (toxicity) mechanisms of drugs, and explain the importance of pharmacokinetic and safety research to develop effective and safe novel medicines. In addition, understand the mechanism from drug discovery and development to post-marketing surveillance, and explain the outline of new drug development				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Kumakura	Drug discovery and development at Pharmaceutical companies (1)	Outline: Outline how pharmaceutical companies proceed with drug development. Understand internationalization and translational research in drug development research at pharmaceutical companies
2	Kamiyama	Drug discovery and development at Pharmaceutical companies (2)	Role of pharmacokinetic and safety research: Understand how pharmacokinetic and safety research is conducted in drug development in pharmaceutical companies and its significance.
3	Yamada	Drug discovery and development at Pharmaceutical companies (3)	Factory: Learn the flow of process research from drug development research to launch in pharmaceutical companies. (Case 1)
4	Hashimoto	Drug discovery and development at Pharmaceutical companies (4)	CRO: Learn the flow of process research from drug development research to launch in pharmaceutical companies. (Case 2)
5	Doi	Drug discovery and development at Pharmaceutical companies (5)	Development new medicine in pharmaceutical companies. Understand how to proceed New Drug Application of Allery immunotherapy (sublingual tablet) for Japanese cedar pollinosis in Japan.
6	Ikeda	Development of drugs and medical devices at universities	Understand how to support development of basic research, bridging research, and clinical research, and their significance.
7	Nakamura	Pharmaceutical reviews.	Understand how PMDA conducts screening of drugs, medical devices, and its significance.
8	Nakabayashi	Drug Safety and Health Damage Relief	Understand how PMDA implements safety measures for drugs, medical devices, and how to rescue health damage and its significance
9	Yoshinari	Safety (1)	Earn the importance of safety research in drug discovery. Learn about the major general toxicities (genotoxicity, carcinogenicity, developmental toxicity) of pharmaceuticals.
10	Yoshinari	Safety (2)	Learn the importance of safety research in drug discovery. Learn about the major organ toxicities (liver, kidney, cardiovascular) of

			drugs.
11	Arakawa	Drug Development and biomarker	The current status of biomarker research will be reviewed, and risks and benefits of drug development will be discussed.
12	Saito	Safety evaluation using post-marketing medical information database	Learn about administrative policy and measures related to post-marketing safety of pharmaceuticals and the current state of research using related medical information.
13	Nakagawa	Development of human resources for medical engineering	How to create innovation in the medical and healthcare domain will be presented, ranging from finding needs to distribution and sales. In this process, understanding, and making stories, or delivering context to specific customer segments is important, yet how to make appropriate approaches is not often understood by entrepreneurs. Design thinking is a step by step approach to tackle this problem. We will be discussing some of the Stanford Biodesign and Academic Science Unit cases at Tohoku University Hospital and expecting you to have perspectives in this field.
14	Takeda	Drug discovery through open innovation	The purpose of this lecture is to understand the outline of new drug research and development, and learn the importance of new drug basic research and the fun of developing new drugs, through learning new drug discovery research and development activities in actual pharmaceutical companies.
15	Taniguchi	Patent strategy in drug development	In this lecture, students will learn about the basics of the patent system and understand the importance of patents in corporate activities and patent strategies for the effective protection of inventions in drug development.

Record and evaluation method	Evaluate based on each report (100%)
Textbook	Not specified
Reference	Not specified
Preparation and Review	Preparation: Read related items in the reference book specified by the lecture time. Work on assignments that are designated as preparations before SGD. Review: Summarize the outline of the lecture content. Learn the parts of the lack of understanding in the reference book related items to deepen your understanding.
Language Used in Course	Japanese
Office hours	E-MAIL appointments: ytomioka@tohoku.ac.jp、noriyasu.hirasawa.c7@tohoku.ac.jp
In addition	

Subject	Imaging Diagnosis				
Course Numbering	YPS-PHA303J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	1
Instructor	Professor Furumoto Shozo, Professor Zhang Ming-Rong, Associate Professor Kotaro Nagatsu				
Practical business	○				
Objectives and summary of class	This course provides an overview of radiopharmaceuticals used in medical imaging, from their preparation methods to the principles of diagnostic imaging using in vivo kinetics. Imaging techniques using radiopharmaceuticals play an important role in elucidating the mechanism of drug efficacy and evaluating therapeutic effects in the development of new drugs. In the lecture, the application and utilization of radiopharmaceuticals will be outlined.				
Goal of study	Students will learn about imaging diagnosis in nuclear medicine and relationship between biofunctions and tracer distribution in vivo, and then understand their principle and mechanism of action. Students will learn the relationships between PET imaging and drug development researches, too.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Furumoto	Introductions	Students learn radiochemistry of compounds labeled with a positron emitter and imaging principles and instruments of PET and SPECT.
2	Furumoto	Tumor imaging (I)	Students learn tumor uptake mechanisms and diagnostic utilities of typical tumor imaging agents such as derivatives of glucose and amino acids labeled with a positron emitter.
3	Furumoto	Tumor imaging (II)	This class provides state-of-the-art knowledge of PET probes for imaging tumor specific enzymes or receptors and evaluating the efficacy of radiation therapy.
4	Furumoto	Cardiovascular disease imaging	Students learn basics and application of radiopharmaceuticals for cardiovascular disease.
5	Zhang	Imaging agents for neurotransmission	Students learn development and application of PET probes for imaging neuro receptors, enzymes, transporters, and other proteins in relation to Parkinson's disease and Alzheimer's disease.
6	Zhang	PET radiopharmaceuticals for clinical use	In this class, students learn the production, quality control and safety evaluation of PET radiopharmaceuticals for clinical usefulness.
7	Zhang	PET imaging for drug development	In this class, students learn the usefulness of PET and molecular probes in microdosing clinical study and developmental study of new drugs.
8	Nagatsu	Radiotherapy with RI	In this class, students will learn about the production and utilization of radioisotopes (RIs) for cancer therapy and their relationship to diagnostic imaging.

Record and evaluation method	Students are evaluated on their reports. (100%)
Textbook	Handouts of the lecture will be given at each class.
Reference	No reference will be used.
Preparation and Review	Review with materials distributed at the lecture.
Language Used in Course	Japanese

Office hours	Students can contact Prof Furumoto by email or telephone. Email: shozo.furumoto.b6@tohoku.ac.jp　TEL: 022-795-7801
In addition	

Subject	Pharmaceutic Laws 1					
Course Numbering	YPS-PHA381J YPH-PHA381J	Categories	Elective[Pharmaceutical Sciences] Required[Pharmacy]			
Preferable Participants	3rd	Semester	6	Credits	1	
Instructor	Kimura Takahiro, Ishibashi Tsuyoshi					
Practical business	○					
Objectives and summary of class	In this course, students will learn the system from development to marketing about medicine and medical device, understanding "Pharmaceutical and Medical Device Act" to play a key role and the rule of its ordinance to become the approval permission requirement.					
Goal of study	Students will understand the importance of pharmaceutical related laws in the development of medicine and medical device, and touch it to watch the basic thought that can support problems, classifying the global expansion into the field of vision in the future.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others(Report)					

Term	Lecturer	Theme	Contents
1	Kimura	Medicine development related laws (1)	Learning the system about the new medicine development and the investigational significance, and understanding the rule of GLP, GCP. Learning the difference in system with the generic medicine.
2	Kimura	Medicine development related laws (2)	Learning the pharmaceutical system of production sale, product, and measures after the marketing, and understanding the rule of GMP, GQP, GVP, and GPSP.
3	Kimura Ishibashi	Medical device development related laws (1)	Learning the system about the medical device from development to marketing, and understanding the difference with the medicine development.
4	Ishibashi	Medical device development related laws (2)	Learning ISO13485 concerned international rule in medical device product, and understanding the attempt to international consistency.
5	"Pharmaceutical products company"	Medicine development and pharmaceutical related laws in the company	Learning the concrete processes from development to marketing in a pharmaceutical company, and understanding the action to pharmaceutical related laws.
6	"Medical device company"	Medical device development and pharmaceutical related laws in the company	Learning the concrete processes from development to marketing in a medical device product company, and understanding the action to pharmaceutical related laws.
7	Kimura Ishibashi	Quality assurance against pharmaceutical development and global expansion	Understanding the importance of the pharmaceutical related laws through the action of the quality assurance against the development of pharmaceuticals, medical devices, regenerative medicine products. Learning the problem on global expansion.
8	Kimura Ishibashi	Medical device development by industry-academia-government collaboration	Learning the concrete process of medical device development by industry-academia-government collaboration, and understanding the importance of pharmaceutical related laws.

Record and evaluation method	Evaluation is performed based on the final examination (80%) and reports (20%).
Textbook	

Reference	“The introduction to pharmaceutical products development,” Jihou “The commentary of pharmaceutical laws, system, and ethic, 2020-21 version,” Yakujinippou Corporation “The pharmaceutical related laws, revision 4th version,” Nankodo Corporation “The commentary of Pharmaceutical and Medical Device Act, Pharmacist Act, and Poisonous and Deleterious Substances Control Act,” Yakujinippou Corporation
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	Lectures pharmacist national examination questions criteria (http://www.jshp.or.jp/cont/10/1015-1.pdf ') It will be mainly carried out the items that have been published in.

Subject	Advance Training in Pharmaceutical Sciences				
Course Numbering	YPS-PHA300J	Categories	Required		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	6
Instructor	Supervisor of the laboratory				
Practical business					
Objectives and summary of class	Students will develop skills to solve research themes by organic association of the practical knowledge and basic experiment skills studied in basic pharmaceutical trainings. This training are located to develop skills that are necessary for Research Training held in 4th grade.				
Goal of study	The purpose of this course is to understand research themes and do experiments thinking the purpose to achieve themes logically.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents
Students do trainings based on the theme given by the supervisor of the laboratory. Moreover, students are required to participate in the seminar held in the laboratory.

Record and evaluation method	Evaluated by the supervisor of the laboratory.
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	

Subject	Research Training				
Course Numbering	YPS-PHA400J	Categories	Required		
Preferable Participants	4th [Pharmaceutical Sciences]	Semester	7・8	Credits	20
Instructor	Supervisor of the laboratory				
Practical business					
Objectives and summary of class	Research Training is the most important subject scheduled in the last grade as a general decision of undergraduate education. Students belonging in each laboratories are given their research theme by their supervisor and do the research along the objective plan made by themselves. Students also make a summary of their research results as a graduation thesis and make a presentation of achievement and question-and-answer session in front of the research staff, undergraduate students and graduate students. Therefore, this subject is expected not only the basic preparation education for students to be a researcher but also useful for their career.				
Goal of study	・To help students seek and evaluate research achievements by for now related to their theme. ・To help students extract some problems to solve to achieve their theme. ・To help students make a research plan. ・To help students develop their observation eyes to grasp phenomena exactly through their theme. ・To help students summarize their research results. ・To help students consider and evaluate their research results. ・To help students presence their research achievement and question-and-answer exactly.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Training Contents					
Students do their research given the theme obey to each specialized field by their supervisor of the laboratory. Research will be going obey to each laboratory's program; for example, participation in the seminar held in the laboratory, to audit some lectures.					
Record and evaluation method	Evaluated by the supervisor of the laboratory.				
Textbook					
Reference					
Office hours					
In addition					

Subject	General Introduction to Various Forms of Illness				
Course Numbering	YPS-PHA371J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2
Instructor	Takahashi Nobuyuki, Komatsu Hiroshi, Kameoka Jun-ichi, Okazaki Tatsuma, Ohnuma Shinobu, Sawada Shojiro, Ichikawa Tomohiro, Ishii Tomonori, Tachibana Masahito, Ashino Yugo, Ishikawa Makoto, Katori Yukio, Inoue Akira, Shiga Hisashi				
Practical business	○				
Objectives and summary of class	This course provides students with basic knowledge necessary for diagnosis, pathogenesis, pathophysiology, and pharmacotherapy on various diseases. Faculty staff members of the Graduate School of Medicine provide lectures, in an "omnibus" style.				
Goal of study	The purpose of this course is to help students better understand practical medication based on pathophysiology of each disease, and updated diagnostic approach for various diseased states.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Takahashi	General Internal Medicine	Students learn about diagnostic processes for various diseases including medical interviews, physical examinations, clinical laboratory tests, and so on. This course also covers concept, diagnosis, and treatments of various kidney diseases.
2	Komatsu	Clinical Psychopharmacology	In recent years, with the COVID-19 epidemic, depression and other psychiatric disorders have become more prevalent. This course provide evidence-based pharmacotherapy for major psychiatric disorders such as schizophrenia and bipolar disorder as well as depression, and will deepen their understanding of the appropriate use of psychotropic drugs.
3	Kameoka	General Hematology	This course covers recent advance in the diagnosis and treatment for hematological disorders including anemia, thrombocytopenia, leukemia, malignant lymphoma, and so on.
4	Okazaki	General Geriatrics	In this course, students will understand the characteristics of diseases developed in the aged people by learning about the pneumonia in aged people and the pathogenesis of sarcopenia (age related decline in the skeletal muscle power, mass, and physical function)
5	Ohnuma	General Surgery	This course covers recent advance in endoscopic surgery including colorectal surgery and bariatric surgery.
6	Takahashi	Kidney and Hypertension	Hypertension is a common disease, and is important as a factor of the metabolic syndrome. However, its mechanisms are still unclear. Students learn about the role of the kidney and humoral factors on developing hypertension, and understand diagnosis and treatments of hypertension.
7	Sawada	Principles of metabolic disorders: visceral fat obesity and diabetes mellitus	The changes of lifestyle in recent years induced several metabolic disorders for instance visceral fat obesity and diabetes mellitus in Japanese people. These disorders give hardly uncomfortable symptoms to the body, therefore reconsideration of the lifestyle i.e. diet and exercise and effective treatment should be postponed, so that the patients lapse into myocardial infarction, stroke, uremia and

			the other severe complications. In this lecture, the basic approach to pathophysiology , prevention, therapeutic strategy and pharmacotherapy for the metabolic disorders will be presented.
8	Ichikawa	Respiratory Disease	This course covers recent advance in the diagnosis and treatment for respiratory diseases.
9	Ishii	Rheumatism and Collagen Diseases	This course covers recent advance in the diagnosis and treatment for collagen diseases including rheumatoid arthritis.
10	Tachibana	General Reproductive Medicine	This course covers general aspects of reproductive medicine. In addition, students learn about the precautions in a medication of pregnant female.
11	Ashino	Infectious Diseases	This course covers recent advance in the diagnosis and treatment for various infectious diseases including HIV infection.
12	Ishikawa	General Ophthalmology	Students learn about the ophthalmologic information-processing system, and about the recent advance in ophthalmic treatment including gene-based therapy and regenerative medicine.
13	Katori	Otorhinolaryngology, from the General to the Particular	This course covers clinical characteristics of disease in otolaryngology and influences for functions of hearing, smell, taste, phonation and swallowing.
14	Inoue	Palliative Medicine, from the General to the Particular	Students learn about assessment and treatment using opioids NSAIDs and adjuvant analgesics, etc. for cancer-related pain.
15	Shiga	Gastroenterology, from the General to the Particular	This course covers the recent medical treatments for some important gastroenterological diseases, such as H. pylori infection, inflammatory bowel diseases, viral hepatitis and acute pancreatitis.

Record and evaluation method	Students are evaluated based on submitted reports.
Textbook	The textbook will be designated at the beginning of the course.
Reference	References are handed out at every class.
Preparation and Review	
Language Used in Course	Japanese
Office hours	The office hours are from 14:00 to 16:00 on Tuesdays. Make an appointment in advance via e-mail: nobuyuki.takahashi.a8@tohoku.ac.jp (Nobuyuki Takahashi).
In addition	This class is an omnibus lecture series.

Subject	Pharmacostatistics					
Course Numbering	YPH-PHA351J	Categories	Required			
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	1	
Instructor	Takahashi Nobuyuki, Matsuura Masaki, Nakamura Hironori, not fixed, Yamaguchi Takuhiro, not fixed, Satoh Michihiro, Kurokawa Naoyuki,					
Practical business	○					
Objectives and summary of class	Statistics is an important discipline which supports an objective and accurate evaluation of the efficacy of medical treatment. This course offers an opportunity to study practical knowledge and skill on pharmacostatistics associated with drug development process, clinical research, and pharmacy operation.					
Goal of study	This course is designed to help students explain (1) for what purpose the pharmacostatistics is applied, (2) how to use the pharmacostatistics, (3) what kind of statistical tools should be used for a specified matter, and (4) in what way the results of clinical researches should be evaluated.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Matsuura	Statistics of Pharmacy Operation	Students learn about practical pharmacy operation using pharmacostatistics
2	Nakamura	Statistics Application to Healthcare	Students learn about practical application of statistics to health and medical field, and about the attitude to epidemiological study.
3	not fixed	Basic Statistics	Students learn about principal statistical tools used in the field of pharmacostatistics.
4	Yamaguchi	Statistics of Drug Development	Students learn about the necessity of statistics in the clinical research, and about its crucial role on the drug development.
5	not fixed	Statistics of EBM	Students learn about the concept of evidence-based medicine, and about the related statistical methods.
6	Satoh	Statistics of Investigative Research	Students learn about investigative research such as pharmacoepidemiology associated with pharmacist activity, and learn about the related statistical methods.
7	Kurokawa	Introduction to Meta-analysis	Students learn about the concept of meta-analysis, and about the related statistical methods.
8	Takahashi	Summary of Pharmacostatistics	Students exchange diverse opinions and discuss about pharmacostatistics learned in this class.

Record and evaluation method	Students are evaluated based on submitted reports.
Textbook	The textbook will be designated at the beginning of the course.
Reference	References are handed out at every class.
Preparation and Review	
Language Used in Course	Japanese
Office hours	The office hours are from 14:00 to 16:00 on Tuesdays. Make an appointment in advance via e-mail: nobuyuki.takahashi.a8@tohoku.ac.jp (Nobuyuki Takahashi).
In addition	This class is an omnibus lecture series.

Subject	Immunology					
Course Numbering	YPH-PHA331J	Categories	Elective			
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	2	
Instructor	Associate Professor Yano Tamaki					
Practical business						
Objectives and summary of class	Beyond the importance of the immune reaction as the defense system against microbes, the essential concept of Immunology is the recognition of the self and non-self. With tremendous studies on the mechanism of self and non-self recognition, and repertoire making of immunoglobulins, Immunology has given a great contribution on Biology.					
Goal of study	This course provides students the basic knowledge and deeper understanding of immune system, and diseases caused by immune disorder.					
Method of class	[Lecture] ・ Practice ・ Training ・ On-site training ・ [SGD] ・ [PBL] ・ Roleplay ・ e-learning ・ Others( )					

Term	Lecturer	Theme	Contents
1	Yano	History and concept of immunology	To understand the concepts of the immune system though reviewing history and results of immunological studies.
2	Yano	Generation of immunoglobulin diversity	To learn the molecular mechanism of gene rearrangement and to understand how diversity of immunoglobulin is generated.
3	Yano	Antigen presentation to T lymphocytes	To learn about MHCs and their functions, antigen presentation to T lymphocytes.
4	Yano	Development and survival of lymphocytes	To learn the generation of lymphocytes in bone marrow and thymus.
5	Yano	Signaling though immune system receptors	To learn signaling pathways though antigen receptors, and other pathways that contribute to lymphocyte behavior.
6	Yano	T-cell mediated immunity	To understand the mechanism of the production of effector T cells and their functions.
7	Yano	Humoral immune responses	To learn about the B-cell activation, functions of immunoglobulin isotypes, and Fc receptors.
8	Yano	Summary of the first half of this course	To confirm the contents that are handled in the first half of this course.
9	Yano	Innate immunity	To understand the importance of innate immunity as a frontline of host defense, and learn about the innate immune system.
10	Yano	Complement system	To learn complement pathways and the functions of complement in immunity.
11	Yano	Mucosal immune system	To understand the characteristic properties of mucosal immune system, especially intestinal immunity.
12	Yano	Disorder of host defense mechanism	To understand the host-pathogen interactions and learn about immune-deficiency syndrome.
13	Yano	Allergy	To learn effector mechanisms in allergic reactions.
14	Yano	Autoimmunity	To understand that autoimmune responses are directed against self-antigens, and learn the mechanism under the autoimmune disease.
15	Yano	Immunologists' toolbox	To learn techniques using antibodies and lymphocytes as research and diagnostic tools.

Record and evaluation method	Evaluation is based on the midterm examination (50%) and the final examination (50%).

Textbook	No textbook will be designated. References are handed out at every class.
Reference	Immunobiology Charles A. Janeway *et al*. ISBN: 978-081534-1239
Preparation and Review	Review based on reference textbook and handout is expected.
Language Used in Course	Japanese
Office hours	Make an advance appointment *via* e-mail or other means. E-MAIL: tamaki.yano.e7@tohoku.ac.jp TEL: 795-4555
In addition	

Subject	Food Hygiene and Safety					
Course Numbering	YPH-PHA342J	Categories	Required			
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	2	
Instructor	Saito Yoshiro, Toyama Takashi, and Arisawa Kotoko					
Practical business						
Objectives and summary of class	This course provides the classification and nature of food contaminants such as the food additive, microorganism and chemical. In this course, students will understand the effects of food contaminants on human health.					
Goal of study	The purposes of this course are to help students better understand the following items. 1) Food and human health 2) Infection disease (including food poisoning) and its prevention 3) Cause of health damage by food contaminants including microorganisms and chemicals, and its prevention 4) Type, nature, functional mechanism and ingestion pathway of food contaminants that affect human health 5) Method of safety assessment of chemicals					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Saito	Overview	System and law relating to food hygiene administration, food poisoning occurrence and food contaminants
2	Arisawa	Food and human health	Social significance which relates to consider human health from eating habits Novel type food with health function
3	Saito	Food safety	Diversified food contamination Basic measures to ensure the food safety General food safety evaluation method
4	Saito	Oral infections and food poisoning	Difference of between food poisoning and oral infection Characteristic of pathogens involving food poisoning and oral infection
5	Saito	Microorganisms	Distribution of microorganisms involving food poisoning Food poisoning occurrence and poisoning symptoms Characteristic and function of toxins involving food poisoning Problem and preventive measure on food hygiene
6	Saito	Natural toxin	Plant toxin and animal toxin Mycotoxin
7	Toyama	Mutagen and carcinogen	Initiation and promotion in carcinogenesis Oncogene and tumor suppressor gene
8	Saito	Food spoilage	Food spoilage and its prevention
9	Saito	Food contamination 1	Organic halogen compounds and metal remaining in the food
10	Saito	Food contamination 2	Endocrine disrupting substances and radioactive substances remaining in the food
11	Saito	Pesticide residues	Pesticide residues and its safety
12	Saito	Food additive	Food additive and its safety
13	Saito	Genetically modified organism	Genetically modified organism and its safety

14	Toyama	Safety assessment of chemicals	Chemical substances control law Guidelines for the testing of chemicals
15	Saito	Group discussion	In this class, students discuss a recent food safety issue.
Record and evaluation method		Evaluation is performed comprehensively based on the midterm examination (40%), the final examination (40%) and class performance (20%).	
Textbook		Food Hygienic Sciences, eds by M. Nasu and K. Wada, Nankodo Publishing Co. Ltd. (ISBN: 978-4-524-40272-4)	
Reference			
Preparation and Review			
Language Used in Course		Japanese	
Office hours		Make an advance appointment via e-mail or other means.	
In addition			

Subject	Infectious Diseases				
Course Numbering	YPH-PHA332J	Categories	Elective		
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	2
Instructor	Tomioka Yoshihisa, Akiyama Yasutoshi, Aoki Yoshiko, Koike Satoshi, Nishikawa Kiyotaka, Nishimura Shuichi				
Practical business	○				
Objectives and summary of class	In this study for infectious diseases, students learn fundamental knowledge of the classification, structure, and growth mechanism of pathogenic microorganisms such as viruses, and understand the etiology and pathology of infectious diseases. In addition, understand the routes of transmission, treatment, pharmacotherapy, and prophylaxis of typical infectious diseases, and understand their advantages and problems.				
Goal of study	Acquire fundamental knowledge about pathogenic microorganisms, list the main infectious diseases, and explain the pathophysiology and causes, routes of infection, medical treatment, pharmacotherapy, and prevention.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Tomioka	Prevention / Protection (1)	Outline the management of infectious disease outbreaks. Understand and explain concretely the sterilization and disinfection methods. Outline the relationship between medical devices and infection risk.
2	Tomioka	Prevention / Protection (2)	Explain hand hygiene. Explain the type of personal protective equipment and precautions for use. Explain cough etiquette. Explain the handling of medical waste.
3	Tomioka	Prevention / Protection (3)	Outline community-acquired and hospital-acquired infection factors, outbreak factors, infection routes, causative microorganisms, and preventive measures. Understand standard precautions for infectious diseases.
4	Akiyama	Therapy (1)	Classify antibacterial drugs, antiprotozoal and parasite drugs, antifungal drugs and antiviral drugs, and explain the mechanism of action and clinical application of typical drugs. Understand antimicrobial use guidelines.
5	Tomioka	Microorganisms (1)	Finding out "questions" from the pathological conditions, infection patterns, and treatment methods caused by various pathogens. Search for answers to questions through research and analysis. Deepen understanding through group discussions, presentations, and questions and answers.
6	Tomioka	Microorganisms (2)	Finding out "questions" from the pathological conditions, infection patterns, and treatment methods caused by various pathogens. Search for answers to questions through research and analysis. Deepen understanding through group discussions, presentations, and questions and answers.
7	Tomioka	Microorganisms (3)	Finding out "questions" from the pathological conditions, infection patterns, and treatment methods caused by various pathogens. Search for answers to questions through research and analysis. Deepen understanding through group discussions, presentations, and questions and answers.
8	Tomioka	Microorganisms (4)	Finding out "questions" from the pathological conditions, infection patterns, and treatment methods caused by various pathogens. Search for answers to questions through research and analysis. Deepen understanding through group discussions, presentations, and questions and answers.
9	Tomioka	Microorganisms (5)	Finding out "questions" from the pathological conditions, infection patterns, and treatment methods caused by various pathogens. Search for answers to questions through research and analysis. Deepen understanding through group discussions, presentations, and questions

			and answers.
10	Tomioka	Side effects	Understand how to obtain and use information on side effects of infectious drugs.
11	Nishikawa	Research (1)	Understand the methods and concepts of research by having researchers conducting infectious disease research introduce the most advanced infectious disease research.
12	Koike	Research (2)	Understand the methods and concepts of research by having researchers conducting infectious disease research introduce the most advanced infectious disease research.
13	Nishimura	Research (3)	Understand the methods and concepts of research by having researchers conducting infectious disease research introduce the most advanced infectious disease research.
14	Tomioka	Therapy (2)	Explain the mechanism of acquiring resistance of major chemotherapeutic drugs. Explain the measures against major multidrug-resistant bacteria. List the major side effects of major chemotherapeutic drugs and explain their symptoms. Through PBL / SGD, we can propose prescription drugs for infectious diseases.
15	Tomioka	Therapy (3)	Clarify the problems of scenario issues that imitate the clinical setting, then promote further information gathering and information organization through group discussions (materialization, visualization, simplification, etc.), and propose practical action plans and preventive measures.

Record and evaluation method	Evaluate based on submitted reports (100%).
Textbook	
Reference	
Preparation and Review	Preparation: Read related items in the specified textbook / reference book by the lecture time. Review: Summarize the outline of the lecture content. For the part with insufficient understanding, learn with related items in textbooks and reference books to deepen understanding.
Language Used in Course	Japanese
Office hours	E-MAIL: ytomioka@tohoku.ac.jp
In addition	

Subject	Pathology				
Course Numbering	YPH-PHA375J	Categories	Elective		
Preferable Participants	3rd	Semester	6	Credits	2
Instructor	Suzuki Takashi, Miki Yasuhiro, Inoue Chihiro, Yamazaki Yuto, Takagi Kiyoshi, Takaki Takashi, Shibahara Yukiko, Nakamura Yasuhiro, Endo Mareyuki, Takeyama Junji, Sasaki Masaru, Akahira Junichi, and Sato Ikuro				
Practical business	○				
Objectives and summary of class	An understanding of pathology is a fundamental requirement for fully understanding various human disorders and their corresponding treatments, including the pharmacological targeting of the underlying causes of disease. In addition, basic knowledge of pathology is also required for understanding the side effects or toxicology of medications. Coursework will focus on teaching the fundamentals of pathology and in parallel, how these apply to various human diseases. Experts in relevant fields provide comprehensive and thought provoking lectures in an "omnibus" fashion in various diseases including the potential toxicological aspects of medical treatment.				
Goal of study	Students are expected to acquire the minimum knowledge of pathological aspects of human disorders.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Suzuki	Pathology in therapeutic efficacy	The basic concept of diseases and how diseases afflict humans. In addition, as relevant to pharmaceutical science, how histopathology could contribute to select which patients to be treated in oncology.
2	Suzuki	Pathology of cancer	Antineoplastic therapy has become one of the most important topics in the field of pharmaceutical science. Therefore, in this course, students will learn the basic concept of cancer.
3	Miki	Toxicology and Pathology	In drug development, clinical and molecular pathology plays important roles in the evaluation of toxicology studies. These lectures will cover the toxicological pathology, drug-induced injury and experimental pathology.
4			
5	Takagi	Processing of pathological specimens	Pathological examination is done by light microscopic observation of tissues or cells from body. This lecture covers how specimens are processed for pathological examination (fixation, staining etc).
6	Takaki	Basics and significance of microscopy in morphology	These lectures will focus on the following four contents. 1) Microscope basics : Difference between optical microscope and electron microscope 2) Points to keep in mind when observing morphology using a microscope 3) Trends in worldwide research on electron microscopes 4) Tips for research using a microscope
7	Shibahara	Histopathology of Skin	The histology of the skin is closely related to drug metabolism and its adverse effects. This lecture will cover the basic structure and metabolism of the skin, general skin pathology, including psoriasis, dermatitis including drug eruption, infectious and tumorous lesions.
8	Inoue	Respiratory pathology	The respiratory system including lungs exhibits a variety of histological changes in response to external antigens and/or drugs. In this lecture, we will review histology of the lung tissue and its changes in response to external stimuli, pathology of pulmonary tumor, and the relationship between histopathology

			and drug therapy.
9	Nakamura	Pathology of Endocrinology, Metabolism and Reproduction	These lectures will focus on the basic pathology of endocrinology, metabolism and reproduction associated with pharmacokinetics and clinical diseases
10	Endo	Pathology of Liver, Gastrointestinal tract, and Kidney	These lectures will focus on the pathology of liver and kidney disorders. Particularly relevant to students of pharmacology, the lectures will also include a focus on pathological changes associated with the side effects of medicines. As a learning tool case studies of the latter will be covered in this lecture
11	Takeyama	Prenatal pathology	This component focuses on the physiology and histology of placenta. Placental pathologies related with fetal development are also covered.
12	Sasaki	Oral pathology	The oral cavity is an important organ with a variety of functions. Of particular interest to pharmacists is the barrier system of the oral mucosa. In this lecture, the etiology of lesions of the oral cavity and salivary glands will be discussed.
13	Akahira	Pathology and cytology of gynecological field	These lectures will explain the pathology of gynecologic normal to neoplastic lesions, mainly focus on endometrial hormonal changes. At the same time, the uterine cervical cytology will be lectured.
14	Sato	Molecular diagnosis of cancer	1. molecular pathology of carcinogenesis Chromosomal instability, Abnormality of transcription and translation, Abnormality of DNA repair, Cell cycle checkpoint, Immune checkpoint, etc. 2. molecular target of cancer therapy Growth factor receptor Signal transduction, etc. 3. molecular diagnosis of cancer ISH, PCR, IHC etc.
15	Yamazaki	Practical application of histopathological sections for translational research	The application of histology sections is not only for practical medicine as well as divergent spectrums of translational research, including genomic analysis for precision medicine. Many sophisticated approaches for research application which everybody will experience in close future will be introduced in this lecture.

Record and evaluation method	Students are evaluated on the results of final report (50%) as well as performance of individual class attendance (50%)
Textbook	Simple Pathology Revised 8 Edition NANKODO
Reference	None
Preparation and Review	None
Language Used in Course	Japanese
Office hours	Make an appointment in advance via email or other means. Mizuki Kato, Administrative assistant Department of Pathology Tohoku University School of Medicine 2-1 Seiryo-machi Aoba-ku Sendai Miyagi Japan 980-8575 Tel+81-22-717-8050 mizuki@patholo2.med.tohoku.ac.jp
In addition	

Subject	Human Genomics				
Course Numbering	YPH-PHA333J	Categories	Required		
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	1
Instructor	Inada Toshifumi				
Practical business					
Objectives and summary of class	This course covers the treatment mutation and its pathology of the gene. In particular, students will understand about the quality control mechanism to abnormal mRNA recognizes the exclusion to hold a major cause mutation nonsense mutation of the genetic disease. Students will learn about the molecular basis of the genetic disease treatment due to modification of the translation reaction, and the association between abnormal and disease expression control at the RNA levels.				
Goal of study	Students learn about the mutation and repair mechanisms of gene, and quality control mechanism of gene expression. This course also covers the treatment by the modification of-gene expression, and genetic disease cased by abnormality at the RNA level.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Inada	Basis of heredity	Basics of genes and genetics.
2	Inada	Basis of heredity	Meiosis, recombination and sex-linked inheritance.
3	Inada	Mutation and repair	The causes of inducing human mutations and its repair mechanisms.
4	Inada	Recombinant protein drugs and gene therapy	The features and usefulness of the safety of recombinant pharmaceutical products. The principles of ethical problems of gene therapy.
5	Inada	Quality control for gene expression	Quality control mechanisms to guarantee the accuracy of gene expression.
6	Inada	Modification of gene expression and drug discovery I	Drug therapy by the modification of the translation.
7	Inada	Modification of gene expression and drug discovery II	Current state of drug discovery by the modification of protein synthesis system.
8	Inada	Modification of gene expression and drug discovery III	Drug therapy by the modification of RNA processing reactions.

Record and evaluation method	Valuation is performed based on short tests (about 10%) and the final examination (about 90%).
Textbook	
Reference	
Preparation and Review	Preparation: Reading the textbook for the next lecture Review: Answer of the small test and commentary by the lecture
Language Used in Course	Japanese
Office hours	E-MAIL: toshifumi.inada.a3@tohoku.ac.jp TEL: 795-6874
In addition	

Subject	Bioorganic Chemistry					
Course Numbering	YPH-PHA321J	Categories	Required			
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	2	
Instructor	Asai Teigo, Sugawara Akihiro, Masanori Shigeno					
Practical business						
Objectives and summary of class	This course aims to learn about sugars, lipids, proteins (amino acids), nucleic acids (nucleoside, nucleotide) to understand chemical principle of life. In addition, this course will provide the method of structural analysis of these compounds.					
Goal of study	The aim of this course is to help student understand the chemical structures and physiological activities of sugars, lipids, proteins (amino acids), and nucleic acids (nucleoside, nucleotide). The aim of this course is to help student acquire the method of structural analysis of biofunctional molecules by using NMR spectroscopy, infrared spectroscopy, and mass spectrometry.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Asai	The chemistry of sugars (1)	This lecture aims to understand about monosaccharides, polysaccharides, and glycosides.
2	Asai	The chemistry of sugars (2)	This lecture aims to understand about physiological activities of polysaccharide.
3	Asai	The chemistry of lipids (1)	This lecture aims to understand about chemical structures of lipids.
4	Asai	The chemistry of lipids (2)	This lecture aims to understand about chemical structures and physiological activities of lipid derivatives.
5	Shigeno	The chemistry of amino acids and peptides	This lecture aims to understand about chemical structures and physiological activities of amino acids and peptides.
6	Shigeno	The chemistry of proteins	This lecture aims to understand about secondary and tertiary structures and physiological activities of proteins.
7	Shigeno	The chemistry of nucleic acids (1)	This lecture aims to understand about chemical structures and physiological activities of nucleic acids, RNA and DNA.
8	Shigeno	The chemistry of nucleic acids (2)	The same as above
9	Asai, Sugawara	Structure analysis (1)	This lecture aims to learn about principle of NMR spectroscopy, infrared spectroscopy, and mass spectrometry and understand structure analysis by the use of these methods.
10	Asai, Sugawara	Structure analysis (2)	The same as above
11	Asai, Sugawara	Structure analysis (3)	The same as above
12	Asai, Sugawara	Structure analysis (4)	The same as above
13	Shigeno	Structure analysis (5)	The same as above
14	Shigeno	Structure analysis (6)	The same as above
15	Shigeno	Structure analysis (7)	The same as above

Record and evaluation method	Evaluated by examination (100%).
Textbook	「生体分子の化学」相本三郎、赤路健一著、化学同人
Reference	「有機化合物のスペクトルによる同定法-MS, IR, NMR の併用　第 7 版」R .M . Silverstein, F. X. Webster, D. J. Kiemle 著　荒木峻ら訳、東京化学同人 (2006) 「ヴォート 生化学　第 3 版（上)」; D. Voet、J. G. Voet 著、田宮信雄ら訳、東京化学同人 (2005)「スミス 基礎有機化学　第 3 版（下)」 J. G. Smith 著、山本尚ら監訳、化学同人 (2012) 「ブルース 有機化学　第 5 版（下)」 P. Y. Bruice 著、大船泰史ら訳、化学同人 (2009)
Preparation and Review	Problem-solving sessions will be in terms 10-15. Prepare problems of structural analysis in each term.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means before students will visit office. The contact informations for the lecturers are referred at the end of the student handbook.
In addition	

Subject	Health Chemistry 2					
Course Numbering	YPH-PHA341J	Categories	Required			
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2	
Instructor	Professor Matsuzawa Atsushi, Associate Professor Noguchi Takuya					
Practical business						
Objectives and summary of class	Health Chemistry is the research field to find the method by which protect human from various types of stress including environmental stress, emerging infectious diseases, and drugs, leading to maintenance and increase of human health and prevention of human diseases. Therefore, the important theme is changed by the needs of the times. In this course, students can especially deepen their understanding of infection by microorganisms and their prophylaxis, immunity and food allergy, epidemiology and prophylaxis of life style-related diseases such as cancer, cardiovascular disease, and diabetes.					
Goal of study	1. Understanding of infection by microorganisms and their prophylaxis, immunity and food allergy. 2. Understanding of epidemiology and prophylaxis of life style-related diseases. 3. Understanding of relationship between various type of stress and diseases.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Matsuzawa	Mechanisms of infection	Students understand mechanisms of infection, types of infectious diseases, infection routes, and their factors.
2	Matsuzawa	Prophylaxis of infectious diseases (1)	Students understand recent trends of infectious diseases, and learn methods for prophylaxis of infectious diseases.
3	Matsuzawa	Prophylaxis of infectious diseases (2)	Students understand related laws for prophylaxis of infectious diseases, especially infectious diseases control law, their classification, and their transition.
4	Matsuzawa	Prophylaxis of infectious diseases (3)	Students understand the prophylactic vaccination against infectious diseases and their recent problems.
5	Matsuzawa	Toxicity of pathogens (1)	Students learn types and classification of pathogens, understand specific toxicity of each pathogen.
6	Matsuzawa	Toxicity of pathogens (2)	Students learn types and factors of food poisoning caused by pathogens.
7	Matsuzawa	Food contamination	Students learn food contamination by chemicals, pathogens, and natural toxin, and understand the effect on human health.
8	Noguchi	Immune system	Understanding of basic immune system.
9	Noguchi	Immunity and food allergy	Students learn the mechanisms of allergy by immunity, and especially understand the factors of food allergy.
10	Noguchi	Maternal and child health	Understanding of infection of infant from mother and neonatal mass screening.
11	Matsuzawa	Mechanisms of life style-related diseases	Students learn types and characteristics of life style-related diseases such as cancer, cardiovascular disease, and diabetes, and understand their factors, their mechanisms, and past and recent trends of these diseases.

12	Matsuzawa	Epidemiology and prophylaxis of life style-related diseases (1)	Understanding of epidemiology and prophylaxis of cancer.
13	Matsuzawa	Epidemiology and prophylaxis of life style-related diseases (2)	Understanding of epidemiology and prophylaxis of cardiovascular disease.
14	Matsuzawa	Epidemiology and prophylaxis of life style-related diseases (3)	Understanding of epidemiology and prophylaxis of diabetes.
15	Matsuzawa	Epidemiology and prophylaxis of life style-related diseases (4)	Students deepen their understanding of the relationship of various diseases with life style such as dietary life and smoking.
Record and evaluation method		Students are evaluated on the final examination (75%) and the class performance (25%).	
Textbook		"Eisei Yakugaku –Kenkou to Kankyou– " edited by Akira Naganuma, Seiichiro Himeno, and Akira Hiratsuka (Maruzen).	
Reference			
Preparation and Review		Students are required to prepare and review for class according to the goal and contents of each class.	
Language Used in Course		Japanese	
Office hours		Students should make an advance appointment via E-mail or other means. E-mail: atsushi.matsuzawa.c6@tohoku.ac.jp TEL: 795-6827	
In addition		The most of lecture contents are included in pharmacist national examination guidelines.	

Subject	Fundamentals of Practical Pharmacy					
Course Numbering	YPH-PHA361J	Categories	Elective			
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2	
Instructor	Tomioka Yoshihisa, Naoe Kiyotaka, Toyama Akira, ~~Hayakari Makoto, Suzuki Naoto,~~ Yamaguchi Hiroaki, Shimanuki Eiji, Kaori Ohmukai					
Practical business	○					
Objectives and summary of class	The environment surrounding medical treatment in recent years is facing a rapid decline in medical resources as the birthrate and aging population ages. Efficient and effective use of medical expenses, which are medical resources, especially pharmaceutical expenditure accounting for a large proportion of them, has become a national policy, and since 2003 the diagnostic group classification comprehensive evaluation (DPC / PDPS: Diagnosis Procedure Combination / Per-Diem Payment System) was started to a specific function hospital such as a university hospital. At the same time, however, the medical field is also required to improve the quality of medical care, including medical safety that originated from medical accidents caused by misdiagnosed patients. A wide range of measures including medical safety, infection control, measures against high-risk medicine, clinical trials and medical management are indispensable, as well as proper use of medicines. In the clinical pharmacy pay, we introduce fundamental tasks such as dispensing and pharmaceutical product management, which are mainly performed in the hospital pharmacy department, and also provide pharmaceutical care such as drug management guidance practice (including patient education) Based on the practice, as well as the addition of 'ward drug work execution addition' introduced by revision of medical treatment fee 2012 and its work, even hospital management work including advanced clinical research work and hospital management, university hospital pharmacy department Learn by giving examples in practice.					
Goal of study	· Explain changes in the environment surrounding pharmaceuticals and changes in the role of pharmacists. · Understand basic pharmacist's work based on proper use of medicines. · Understand the transition of team medical care and the qualities, skills and knowledge required of pharmacists. · Understand the new role of pharmacists in hospitals. · Understand medical ethics, medical system, medical treatment remuneration system in using pharmaceutical products. · Understand the role of pharmacists in hospital management operations including hospital management. · To understand the importance of learning a wide range of specialized subjects by forecasting a broad academic field to be learned from the faculty of pharmacy in the future.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Toyama	Dispensing practice	To understand the health care system and national health insurance system. Based on these, understand the transition of the concept and work contents accompanying the change of the medical environment, the medical safety and the medical system concerning dispensing practice (in the narrow sense).
2	Toyama	Pharmaceutical product management	To understand the importance and significance of supply management for requiring special attention such as narcotics / psychotropics and blood derived products. To explain pharmacist's role and responsibility.
3	Toyama	Hospital pharmacy compounding	We also understand the existence of medical institutional, economic and ethical issues for in-hospital formulations and special hospital formulations that have benefited patients in advanced medical care

		products	and rare disease.
4	Toyama	Drug information service	Information necessary for proper use of pharmaceuticals is indispensable for better medication treatment. The drug information management service (hereinafter referred to as DI service) handles this drug information (Drug Information) extensively. Understand the contents of information collection, arrangement, evaluation, storage, processing, provision etc. of DI operations and knowledge and technical ability necessary for carrying out their work.
5	Yamaguchi	Infection control	In the acute phase hospital, after the introduction of DPC, the medical treatment system has changed dramatically, and accordingly the hospital infection is a serious problem for the hospital, and in severe cases of the basic disease, the treatment of infectious diseases is It connects directly. Understand administration practices of nosocomial infection prevention measures and administration method based on PK / PD theory in antimicrobial therapy.
6	Yamaguchi	Emergency and drug abuse	In emergency medicine such as drug addiction, information provision of drugs and drugs of abuse, analysis of drugs, measurement of blood concentration, administration of antidotes, etc. are required. Regarding prevention of drug abuse, educational activities for schoolchildren and students by pharmacists are required. Understand the role of pharmacists in these poisoning medicine
7	Toyama	Team medical and pharmacist	Each medical field has developed to a high degree, and a pharmacist specialized and certified pharmacist system was started to raise expertise. Understand the pharmacist's involvement as a member of the ICT, NST, cancer chemotherapy team, etc., as well as understand drug administration guidance work and "addition of ward drug service work addition" and outline of its work.
8	Toyama	Risk management and role of pharmacy	Recently, numerous medical incidents have been reported. In addition, there are many more incidents (adverse events that are not medical accidents) in the hospital. Among them, the proportion of adverse events related to medicine is high. Understand how the pharmacist / medicine department is involved in improving these events. Also understand the role of the medical safety manager who is set up in the hospital.
9	Toyama	TDM	TDM serves as a means of improving the efficacy and safety of drug therapy. Factors affecting drug dynamics, collection of patient information, clinical background, understanding pharmacokinetic analysis, drug interaction and administration design.
10	Toyama	Clinical trials and pharmacists	Understand how pharmacists are involved in clinical trials as clinical research coordinators (CRC) etc, along with problems such as elimination of drug lag and response to international joint clinical trials.
11	Tomioka Ohmukai	Science mind for clinical settings	Logically explain the change of prescription contents from the case where a small question felt in the medical field eventually leads to drug discovery and the result of TDM analysis in medication guidance From the above cases, the importance of scientific viewpoints will be mentioned, and further practical countermeasures will be proposed through group discussions.
12	Toyama	Pharmacy administration	Drugs expenses were sought in the pharmaceutical department. Understand the role of pharmacists necessary in comprehensive medical systems, such as clinical path management, generic drug countermeasures, pharmaceutical formula management, etc.
13	Shimanuki	Community Pharmacy Practice	Understand the changes in the environment surrounding pharmaceuticals and the role of pharmacists from the viewpoint of insurance pharmacies. In particular, understand the deepening and differentiation of insurance pharmacy functions required by the revision of the Pharmaceutical Machinery Act, etc., and how to cooperate with medical institutions (specific examples of drug-drug cooperation).

14	Toyama	Evaluation and development	Efficacy and safety of drugs are confirmed by clinical trials and others, and they are subject to manufacturing approval. However, right after marketing, proper use information is insufficient. Understand why it is insufficient (limits of clinical trial), understand how to select and select medicines in a situation where information is insufficient and understand how to accumulate information
15	Naoe	Clinical ethics and pharmacy	When advancing medical care, overview the ethical viewpoint to be learned and understand points to be noted in medicine work.
Record and evaluation method		Evaluation is performed based on examination (above 60 points)	
Textbook			
Reference			
Preparation and Review		Preparation: Read related items of reference book specified by lecture time. Review: Summarize the outline of lecture content. For the lack of understanding, learn from reference book related items and deepen their understanding.	
Language Used in Course		Japanese	
Office hours		Contact: ytomioka@tohoku.ac.jp	
In addition		SGD,PBL	

Subject	Pharmacotherapeutics 1				
Course Numbering	YPH-PHA372J	Categories	Elective		
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2
Instructor	Tomioka Yoshihisa, Matsumoto Yotaro, Tsukamoto Hiroki				
Practical business					
Objectives and summary of class	Pharmacotherapy learns basic knowledge on how to use medicines and how to select medicines based on individual patient information and medicinal information based on the understanding of the pathology and symptoms of typical diseases, and from the perspective of patient QOL and proper use of medicine Understand that contributing to drug treatment from. Pharmacotherapy 1 learns the outline of each disease regarding blood / hematopoietic disorders, nerve and muscle diseases, mental disorders, ear and nose and throat diseases, eye diseases, infectious diseases, and malignant tumors, Estimate etiology and disease name from laboratory findings and understand how to decide therapeutic policy and prescription. Learn the points of caution in using individual drugs. Classes, along with lectures, conduct surveys, presentations and discussions by small group.				
Goal of study	Based on the symptoms and laboratory tests, a treatment policy can be planed and specific prescription can be suggested.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Tomioka	Generals of Pharmacotherapy	To explain what treatment is, the position of drug treatment and non-drug treatment, and the role of pharmacist. Discuss the role of drug treatment in representative diseases. It can be explained based on medicinal pharmacology, pharmacokinetics, drug interaction for selection of an appropriate therapeutic agent. Discuss representative phytotoxicity and substance abuse.
2	Tomioka	Blood / hematopoietic disorders (I)	Representative diseases in blood / hematopoietic devices can be mentioned. It can explain the therapeutic agent against anemia and the attention on its use.
3	Tomioka	Blood / hematopoietic disorders (II)	Purpura, leucopenia, thrombus/embolism can be outlined for drug therapy. Can outline drugs, pathology, and treatment of malignant tumors.
4	Tomioka	Blood / hematopoietic disorders (III)	Explain the therapeutic agent against disseminated intravascular coagulation syndrome (DIC) and the attention on its use. It can explain the therapeutic agent for hemophilia and the attention on its use.
5	Tomioka	Oncology Pharmacy (I)	Leukemia, malignant lymphoma, osteosarcoma, and precautions on its use. Explain care plan against adverse events/side effects caused by antineoplastic drugs.
6	Tomioka	Oncology Pharmacy (II)	It can explain therapeutic agents for gastrointestinal malignancies (gastric cancer, esophageal cancer, liver cancer, colon cancer, gallbladder / bile duct cancer, pancreatic cancer, etc), and precautions on its use. Explain care plan against adverse events/side effects caused by antineoplastic drugs.
7	Tomioka	Oncology Pharmacy (III)	It can explain therapeutic agents for lung cancer, pancreatic cancer, head and neck cancer and malignant tumors of sensory organ (brain tumor, retinoblastoma, larynx, pharynx, nasal cavity / paranasal sinus, oral cavity malignant tumor etc.) and cautions on its use. Explain care plan against adverse events/side effects caused by antineoplastic drugs.

8	Tomioka	Oncology Pharmacy (IV)	It can explain therapeutic agents for reproductive malignancies (prostate cancer, uterine cancer, ovarian cancer etc.), malignant tumors of renal / urinary system (renal cancer, bladder cancer), breast cancer, and cautions on its use. Explain care plan against adverse events/side effects caused by antineoplastic drugs.
9	Tomioka	Oncology Pharmacy (V)	It can explain supportive care for cancer chemotherapy and terminal care and palliative care.
10	Tsukamoto	Otorhinolaryngology Eye disease	It can explain the remedy for dizziness (Meniere's disease, motion sickness, etc.) and typical eye diseases (glaucoma, cataract, age-related macular degeneration etc.) and attention on its use. Representative diseases related to otolaryngology and eyes (allergic rhinitis, hay fever, sinusitis, otitis media, stomatitis / pharyngitis / tonsillitis, pharyngitis, conjunctivitis, retinopathy, uveitis, retinitis pigmentosa etc.).
11	Tsukamoto	Infection	List the major infections and explain their condition and cause. Antibacterial drugs, antiprotozoa / parasitic drugs, antifungal drugs, antiviral drugs, and their usage attention can be explained.
12	Matsumoto	Neurological and muscle disease (I)	Representative diseases related to nerve and muscle can be cited. Therapeutic agents for cerebrovascular diseases, epilepsy, remedies for Parkinson's disease, and cautions on its use.
13	Matsumoto	Neurological and muscle disease (II)	Alzheimer's disease, cerebrovascular dementia, and precautions on its use. It can explain the therapeutic agent for headache (migraine, tension headache, cluster headache) and attention on its use. Medical therapy can be outlined about myasthenia gravis, encephalitis / meningitis, febrile convulsion, brain tumor, transient ischemic attack, Guillain-Barre syndrome.
14	Matsumoto	Neurological and muscle disease (III)	Representative mental illness can be cited. Can explain therapeutic agents against schizophrenia and cautions on its use. It can explain therapeutic agents for mood disorders (depression, manic depressive disorder) and attention on their use. About drug therapy about neurosis, psychosomatic disease, drug addiction, alcohol dependence can be outlined.
15	Matsumoto	Summary	About prescription cases for diseases covered in Pharmacotherapy 1, you can explain medication therapy from the viewpoint of patient QOL and proper use of medicine.

Record and evaluation method	Evaluate based on the normal point (15%) and the written test (85%).
Textbook	
Reference	
Preparation and Review	Preparation: Read related items of reference book specified by lecture time. Review: Summarize the outline of lecture content. For the lack of understanding, learn from reference book related items and deepen their understanding.
Language Used in Course	Japanese
Office hours	E-MAIL appointments: ytomioka@tohoku.ac.jp
In addition	

Subject	Medical Informatics					
Course Numbering	YPH-PHA362J	Categories	Elective			
Preferable Participants	4th	Semester	7	Credits	2	
Instructor	Mano Nariyasu, Maekawa Masamitsu, Fujimori Kenji, Obara Taku, Matsuura Masaki, Sato Mayumi, Akasaka Kazutoshi, Oyanagi Gen, Noda Aoi, Ishikawa Tomofumi, Tsuchiya Masami					
Practical business	○					
Objectives and summary of class	This course provides students with basic knowledge of medical information necessary for pharmaceutical care. Faculty and medical staff members in Tohoku University Hospital provide lectures, in an omnibus style.					
Goal of study	The purpose of this course is to help students explain the methods of collection, processing, and provision of medical information necessary for medical staffs and patients. Students will understand the utilization of medical information for the optimization of drug therapy.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Mano	Introduction: Related laws and rug information obtained in drug development research	In this course, students summarize the position of various kinds of medical information and the outline of the law related to pharmaceuticals and pharmacist works. And they will understand the flow of drug development and drug information obtained in the process.
2	Obara Ishikawa	Study design on efficacy of pharmaceutical products	In this course, students understand research design to evaluate data on the effectiveness of drugs produced by clinical research and epidemiological studies
3	Obara, Noda	Critical examination of clinical research thesis	Through critical examination on clinical research papers for investigating the effectiveness and safety of drugs, students practically understand statistical parameters, thinking about the interpretation and evaluation of information described in the papers to acquire reading comprehension and English language skills.
4	Obara	Pharmacovigilance and post marketing surveillance	In this course, students learn the pharmaceutical safety monitoring system in Japan, and understand the flow and utilization of information collected in the process of post marketing surveillance and the related pharmacy regulatory system.
5	Oyanagi	Types and features of drug information sources (1) Package insert	In this course, students understand the legal basis of drug package inserts, confirm the items listed, and understand how to read and read them. Also students understand the meanings of the terms used in the package insert, the degree of processing of the drug information source and how to use it.
6	Oyanagi	Types and features of drug information sources (2) Interview form	In this course, students understand how to read and use interview forms. Also students understand the position in the source of drug information, the degree of processing of drug information sources and how to use them.
7	Fujimori	Medical policy in Japan and DPC system	Students understand the structure of Diagnosis Procedure Combination (DPC) while looking over the overall health policy in Japan, and learn about the information of medical institutions that can be read from and the examples of their use.

8	Sato	Utilization of medical information in prescription inspection and risk management	Pharmacists should not dispense medication unless they solve doubts caused by verification with medication history information or examination value data in prescription examination. In this course, students understand patient information to be utilized in prescription examination and various medical information. Students also learn about medical safety information related to medicines.
9	Akasaka	Utilization of medical information and medical records in ward work	In this course, students learn through practical examples about the use of information on bringing medicine at the time of hospitalization, prescription in ward work, medication history, examination value data, electronic medical records and pathology used in general wards, ICUs, and advanced medical and emergency center, and understand the meaning of information sharing and description of medical records .
10	Obara	Medication therapy and information utilization in perinatal period	In medicine therapy in perinatal period (pregnant women, lactating women, neonates), the information obtained during the drug development stage is limited. In this course, students learn about the information to be aware of, in order to secure the safety of medication therapy in perinatal period.
11	Matsuura	Regional medical cooperation	In this course, students understand the cooperation between hospitals in the area - insurance pharmacies in the area and hospitals - hospitals, and make use of information such as treatment contents, prescription medicines, examination values and side effects to be provided to the family pharmacy etc learn. Students also understand the current state of information networks on regional medical care.
12	Mano	Pharmaceutical safety management	In this course, students understand the flow of information gathering related to the use of medicines such as unapproved and their utilization, and learn about the well-known way of information for promoting proper use.
13	Maekawa	Utilization of medical information in the promotion of personalized medicine	In this course, students are required to promote cancer genome medicine and combine information such as blood concentration and gene analysis results indispensable for precision medical treatment individually optimized, information such as electronic medical records, medical records, and interviews with patients Learn practical examples of prescription design utilizing medical information.
14	Maekawa	Healthcare transformation through AI and DX	In this course, students learn the shape of patient-centered team medical care in the near future created by AI and medical DX through national policies and current practice examples.
15	Obara Tsuchiya	Big data in medical care and its application	Students understand the nature of various big data generated by medical care and learn about its use.

Record and evaluation method	Evaluation is based on the written examination in principle, considering class performance.
Textbook	Do not specify textbooks. Each lecturer will introduce reference books, documents, etc. as necessary.
Reference	References will be handed out at every class.
Office hours	Please make an appointment by e-mail before visiting. E-MAIL: mano@hosp.tohoku.ac.jp
In addition	

Subject	Kampo Medicine					
Course Numbering	YPH-PHA376J	Categories	Elective			
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2	
Instructor	Professor Arai Makoto					
Practical business	○					
Objectives and summary of class	In this course, students will mainly understand the basic theories, characteristics, and adverse reactions of Kampo (Japanese traditional) medicine, and develop their abilities to apply it clinically. The course will be conducted in an intensive lecture format.					
Goal of study	The purpose of this course is to discuss the differences among Kampo, Traditional Chinese, Western and complementary and alternative medicine, and explain the Kampo basic theories, Sho, diagnostic explanation and adverse reactions.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Role-play・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Arai	Introduction	Students learn about the history, characteristics, application of Kampo medicine and relationship with modern medicine.
2	Arai	Basic theory 1	Students learn *yin and yang* and *deficiency and excess*, and explain them clinically.
3	Arai	Basic theory 2	Students learn *cold and heat*, *exterior and interior*, *qi, blood and fluid*, s*ix stages of disease transformation*, and explain them clinically.
4	Arai	Clinical theory	Students learn how to use Kampo medicine, for example, *Sho-based therapy* with the theory of clinical reasoning.
5	Arai	Formulation practice	Students are familiar with Kampo medicine through adjusting and tasting Kampo decoction, extract and powder.
6	Arai	Therapeutics 1/ respiratory diseases	Students learn the Kampo treatment of respiratory diseases and decide the appropriate Kampo prescriptions for the patient through exercises.
7	Arai	Therapeutics 2/ upper gastrointestinal diseases	Students learn the Kampo treatment of upper gastrointestinal diseases and decide the appropriate Kampo prescriptions for the patient through exercises.
8	Arai	Therapeutics 3/ lower gastrointestinal diseases	Students learn the Kampo treatment of lower gastrointestinal diseases and decide the appropriate Kampo prescriptions for the patient through exercises.
9	Arai	Therapeutics 4/ gynecological diseases	Students learn the Kampo treatment of gynecological diseases and decide the appropriate Kampo prescriptions for the patient through exercises.
10	Arai	Therapeutics 5/ geriatric diseases and pain disorders	Students learn the Kampo treatment of geriatric diseases and pain disorders, and decide the appropriate Kampo prescriptions for the patient through exercises.
11	Arai	Pharmacology	Students learn the pharmacokinetics of Kampo medicine.
12	Arai	Adverse reaction Medication instruction	Students learn the adverse reactions and clinical medication instruction.
13	Arai	Diagnostic exercise 1	Students practice exercises to decide appropriate Kampo prescriptions for the patient in small groups
14	Arai	Diagnostic exercise 2	Students discuss the results obtained from the exercise 1 by the workshop.

15	Arai	Special lecture	Students learn about practical Kampo medicine treatment
Record and evaluation method		Evaluated by class performance (50%) and report (50%)	
Textbook		A handout is distributed every time.	
Reference		Shorei de wakaru Kampo-yaku nyumon (Introduction to Kampo medicine) by Makoto Arai (Nichu shuppan)	
Preparation and Review		Review based on the handout texts and reference books.	
Language Used in Course		Japanese	
Office hours		Available anytime by e-mail; arai@tokai-u.jp.	
In addition			

Subject	Clinical Pharmacology				
Course Numbering	YPH-PHA352J	Categories	Elective		
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2
Instructor	Takahashi Nobuyuki, Fukudo Shin, Kawamorita Naoki, Sato Emiko, Hasegawa Takafumi, Miyagi Shigehito, Takahashi Jun Miyazaki Mariko, Nakagawa Atsuhiro, Takase Kei,, Yamagishi Toshio, Saito Masatoshi, Saijo Ken, Sugawara Akira				
Practical business	○				
Objectives and summary of class	This course provides students with basic knowledge on pharmacotherapy necessary for bed-side medication and drug development. Faculty staff members of the Graduate School of Medicine (including the Institute of Development, Aging and Cancer), experts in each field, provide lectures, in an "omnibus" style.				
Goal of study	The purpose of this course is to help students better understand (1) practical medication based on pathophysiology of each disease, (2) updated diagnostic approach for various diseased states, and (3) responsibility as a leading pharmacist having basic knowledge useful for clinical practice and drug development.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others)				

Term	Lecturer	Theme	Contents
1	Takahashi N	Etiology and Treatment of Renal Disease	Students learn about the etiology and treatment of renal disease.
2	Takahashi N	Etiology and Treatment of Hypertension and Metabolic Syndrome	Students learn roles of genes regulating blood pressure on the metabolic syndrome, and understand current therapies of the metabolic syndrome.
3	Fukudo	Psychosomatic Medicine	This course covers recent advance in the diagnosis and treatment for psychosomatic disease.
4	Kawamorita	Treatment for Overactive Bladder	Overactive bladder is common disease in elderly people. The purpose of this course is to understand the pathophysiology of overactive bladder and to learn the current therapies.
5	Sato	Targeting the gut microbiota for the treatment of renal diseases	The involvement of intestinal microbiota in the pathogenesis of renal disease is clear. Students learn about the relationship between gut microbiota and renal diseases, and about the treatment targeting gut microbiota.
6	Hasegawa	Etiology and Treatment of Neurological Disease	This course explains neurological diseases in an easy manner to understand and helps students to understand how to treat the diseases.
7	Miyagi	Organ Transplantation and Pharmacotherapy	Students learn about the outline of organ transplantation. The purpose of this course is to understand the vascular thrombosis and rejection after transplantation, and to learn the pharmacotherapy to preserve the transplant organs as long as possible.
8	Takahashi J	Ischemic Heart Disease; Pathogenesis and Management	Ischemic heart disease (IHD) is a leading cause of death in many countries and most often results from coronary artery atherosclerosis, thrombosis and vasospasm. Treatment involves risk factor management, antiplatelet therapy, and antianginal medications.
9	Miyazaki	Medication Treatment for the	With the advent of super-aging society, medical staffs encounter an increasing number of patients with potential

		Patients with Renal Failure	renal insufficiency. Students learn about treatment precaution for the patients with renal failure.
10	Nakagawa	Cerebrovascular Disease / Medical Innovation	Cerebrovascular disorders are roughly classified as cerebral infarction, cerebral hemorrhage, and subarachnoid hemorrhage. Minimum essential knowledge, including symptoms and signs, pathophysiology, diagnosis, treatment, and prevention will be discussed. Latter half of the lecture will be allocated for medical innovation. It covers variety of issues including finding and defining the needs to regulatory and reimbursement process. Minimum essential knowledge for pharmaceutical professionals will be discussed including the experience at Tohoku University Hospital.
11	Takase	Basics of diagnostic imaging using contrast materials and radio-pharmaceuticals.	To learn basics of diagnostic imaging such as CT, MRI, nuclear medicine, and ultrasound examinations using contrast materials and nuclear pharmaceuticals.
12	Yamagishi	Electrolyte Abnormalities and Pharmacotherapy	This course provides explanations of the classification of electrolyte abnormalities and pharmacotherapy based on clinical examples.
13	Saito	Pharmacotherapy in Obstetrics	This lecture provides comprehensive knowledge of pharmacotherapy in pregnancy and lactation.
14	Saijo	Cancer Chemotherapy, from the General to the Particular	Students learn about (1) characteristics of cancer cells, (2) carcinogenesis and metastasis, (3) recent advance in cancer chemotherapy, (4) genetic diagnosis and treatment for cancer.
15	Sugawara A	Endocrinology, from the General to the Particular	Students learn about general endocrinology including classical endocrine organs such as hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreas, and testis/ovary, and novel endocrine organs such as adipose tissues, vasculatures, and heart.

Record and evaluation method	Students are evaluated based on submitted reports.
Textbook	The textbook will be designated at the beginning of the course.
Reference	References are handed out at every class.
Preparation and Review	
Language Used in Course	Japanese
Office hours	The office hours are from 14:00 to 16:00 on Tuesdays. Make an appointment in advance via e-mail: nobuyuki.takahashi.a8@tohoku.ac.jp (Nobuyuki Takahashi).
In addition	This class is an omnibus lecture series.

Subject	Clinical Pharmaceutics				
Course Numbering	YPH-PHA363J	Categories	Elective		
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2
Instructor	Professor Akita Hidetaka, Lecturer Uchida Yasuo, Lecturer Sakurai Yu, Project leader Takao Inoue, Project leader Yoji Sato, Professor Tappei Takada, Professor Yasuo Yoshioka, Professor Yoshio Hayashi, Dr. Yuki Noguchi				
Practical business					
Objectives and summary of class	The purpose of this class is to understand the advanced application of the physical pharmacy and pharmacokinetics given by Pharmaceutics 1 and 2 in the clinics. Also, understand the latest pharmaceutical modalities. Small test will be given in each lecture to evaluate the achievement of understandings.				
Goal of study	Upon completion of this class, a student should be able to: ·Formulate two-compartment model and explain its application for dosage regimen ·Explain the concept of pharmacodynamics and its application in clinics ·Design drug dosage regimens in clinics ·Explain latest pharmaceutical modalities and their DDS.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Takada	Pharmaceutical science in hospital	It outlines the pharmaceutical research in hospital
2	Yoshioka	Overview of Vaccine Formulation	It outlines examples and formulations of vaccines.
3	Sato	Overview of Cell therapy	It outlines examples and formulations of cell therapy
4	Inoue	Overview of Nucleic acid therapy	It outlines examples and formulations of nucleic acid thrapy
5	Akita	Circadian rhythm and DDS	An overview and the mechanism by which individual changes in pharmacokinetics. Also, DDS technology will be summarized
6	Noguchi	Overview of antibody drug	It outlines the antibody drugs and their pharmacokinetics
7	Hayashi	Overview of Middle-Molecule Drug	It outlines the Middle-Molecule Drug and their DDS
8	Akita	Pharmacogenetics 1	Various enzymes are involved in drug metabolism, but the most important enzyme is cytochrome P450 (CYP). There are many molecular species of CYP, some of which show genetic polymorphism. We will outline the mechanism by which individual differences in drug efficacy occur, focusing on individual differences in CYP genetic polymorphisms and drug metabolism
9	Akita	Pharmacogenetics 2	Explain the genetic polymorphisms and individual differences of drug-metabolizing enzymes other than CYP, drug transporters and drug receptors.
10	Tanaka	Pharmacodynamics	It outlines the Basic concept of pharmacodynamics (PD) and their application
11	Tanaka	Practice on pharmaco-kinetic modeling	Computer-based simulation by physiologically based pharmacokinetic models
12	Akita	TDM1	Drugs which have close windows between effective and side effect concentrations require therapeutic drug monitoring (TDM) in the patient being treated. Introducing the drugs for which TDM is actually performed and their importance.
13	Akita	TDM2	We will explain and practice how to obtain and analyze data to maintain an appropriate blood concentration by TDM.
14	Tanaka	Biopharmaceutics exercise	Set issues related to biopharmaceutics, and conduct preliminary surveys, exercises, and explanations.

15	Sakurai	Physical Pharmaceutics / Pharmaceuticals exercise	Set issues related to physics pharmaceutics and formulation, and conduct preliminary surveys, exercises, and explanations.
Record and evaluation method		Students are evaluated on their points from all the small tests (15%), the regular examinations (65%), and the reports (20%).	
Textbook		No textbook will be used.	
Reference		1. (English) Clinical Pharmacokinetics and Pharmacodynamics: concepts and applications Fourth Edition Malcolm Rowland and Thomas N. Tozer, Lippincott Williams and Wilkins (2009) (ISBN:9780781750097) 2. (Japanese) Tsuji's pharmacokinetics Episode Pharmacokinetics (ISBN:9784901789998) エピソード薬物動態学―薬物動態学の解明、京都廣川書店（2012） 3. (Japanese) Biopharmaceutics (ISBN:9784567482349) わかりやすい生物薬剤学 第 5 版 荻原琢男執筆者代表、廣川書店（2014） 4. (Japanese) Clinical pharmacokinetics (ISBN: 9784524250554) 臨床薬物動態学 第 4 版 加藤隆一著、南江堂 (2009) 5. (Japanese)製剤化のサイエンス　第 3 版　山本恵司監修、Elsevier (2016).	
Preparation and Review		Getting basic knowledge on each topic using the references above as a pre-study and Trying several practice problems as a review	
Language Used in Course		Japanese	
Office hours		Please make an advance appointment via e-mail or other means. The contact information for the lecturer will be given in the class.	
In addition			

Subject	Prescription Analysis					
Course Numbering	YPH-PHA364J	Categories	Elective			
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2	
Instructor	Kikuchi Masafumi					
Practical business	○					
Objectives and summary of class	In the process of dispensing, it is essential to analyze and interpret a prescription. Students learn about basic knowledge of prescription and appropriate pharmacotherapy for patients throughout case analyses. Also this course provides students with opportunities to recognize directions and methods for solving problems by self-learning, small group discussions, and presentations.					
Goal of study	The purpose of this course is to help students understand and interpret the prescription.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Kikuchi	Introduction (1)	Prescription and Dispensing Process
2	Kikuchi	Introduction (2)	Drug Information for the Analyses Guidance for Group Work and Self-Learning
3	Kikuchi	Basic case analysis (1)	Hypertension, Diabetes Mellitus; group work and self-learning
4	Kikuchi	Basic case analysis (1)	Hypertension, Diabetes Mellitus; presentation and discussion
5	Kikuchi	Basic case analysis (2)	Cardiovascular Disorders, Thrombosis; group work and self-learning
6	Kikuchi	Basic case analysis (2)	Cardiovascular Disorders, Thrombosis; presentation and discussion
7	Kikuchi	Basic case analysis (3)	Psychiatric Disorders; group work and self-learning
8	Kikuchi	Basic case analysis (3)	Psychiatric Disorders; presentation and discussion
9	Kikuchi	Basic case analysis (4)	Gastrointestinal Disorders; group work and self-learning
10	Kikuchi	Basic case analysis (4)	Gastrointestinal Disorders; presentation and discussion
11	Kikuchi	Basic case analysis (5)	Immune disorders, Allergies; group work and self-learning
12	Kikuchi	Basic case analysis (5)	Immune disorders, Allergies; presentation and discussion
13	Kikuchi	Basic case analysis (6)	Respiratory Disease, Infectious Disease; group work and self-learning
14	Kikuchi	Basic case analysis (6)	Respiratory Disease, Infectious Disease; presentation and discussion
15	Kikuchi	Advanced case analysis	Neoplastic Disorders; group work, self-learning, presentation and discussion

Record and evaluation method	Minute Paper 70 %, Report 25 %, Presentations 5 %
Textbook	
Reference	References will be handed out at every class.

Preparation and Review	
Language Used in Course	Japanese
Office hours	Office hours are from 9:00 to 17:00 on Wednesdays. Make an appointment in advance via e-mail. The contact information for the lecturer will be given in class.
In addition	You must attend the first class session.

Subject	Pharmacotherapeutics 2				
Course Numbering	YPH-PHA373J	Categories	Required		
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	2
Instructor	Associate Professor Hiratsuka Masahiro				
Practical business	○				
Objectives and summary of class	In this course, students will learn about bone･joint disease, skin disease, allergy･immune disease, and respiratory･chest disease and understand a means of estimating a disease cause and a disease name from a patient's condition and inspection findings and determining a treatment policy and the prescription drugs.				
Goal of study	The purpose of this course is to help students develop a treatment policy from inspection findings and present a specific prescription example.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Hiratsuka	Bone/joint disease (1)	Students will learn about osteoporosis and rheumatoid arthritis.
2	Hiratsuka	Bone/joint disease (2)	Students will learn about osteoarthritis and osteomalacia.
3	Hiratsuka	Respiratory/chest disease (1)	Students will learn about chronic obstructive pulmonary disease and bronchial asthma.
4	Hiratsuka	Respiratory/chest disease (2)	Students will learn about upper respiratory infection and influenza.
5	Hiratsuka	Respiratory/chest disease (3)	Students will learn about pneumonia and interstitial pneumonia.
6	Hiratsuka	Respiratory/chest disease (4)	Students will learn about pulmonary tuberculosis.
7	Hiratsuka	Allergy/immune disease (1)	Students will learn about anaphylactic shock and acquired immunodeficiency syndrome.
8	Hiratsuka	Allergy/immune disease (2)	Students will learn about systemic lupus erythematosus and other immune diseases.
9	Hiratsuka	Skin disease (1)	Students will learn about atopic dermatitis and dermatomycosis.
10	Hiratsuka	Skin disease (2)	Students will learn about urticaria and drug eruption.
11	Hiratsuka	Skin disease (3)	Students will learn about bullous dermatosis and psoriasis.
12	Hiratsuka	Skin disease (4)	Students will learn about contact dermatitis, photosensitivity, and pressure ulcer.
13	Hiratsuka	Other drug therapy (1)	Students will learn about transplantation and blood transfusion.
14	Hiratsuka	Other drug therapy (2)	Students will learn about general anesthesia and palliative medicine.
15	Hiratsuka	Other drug therapy (3)	Students will learn about supportive therapy and genital disease.

Record and evaluation method	Students are evaluated on the final examination (100%).
Textbook	
Reference	Pharmacotherapy (Nanzando)
Preparation and Review	The session time is limited and therefore self-directed learning is important. Students are required to prepare and review for each class.

Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. masahiro.hiratsuka.a8@tohoku.ac.jp
In addition	

Subject	Pharmacotherapeutics 3				
Course Numbering	YPH-PHA374J	Categories	Required		
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	2
Instructor	Takahashi Nobuyuki, Sato Emiko				
Practical business	○				
Objectives and summary of class	This course provides students with basic knowledge on the etiology and therapeutic strategy in the treatment of cardiovascular disease, kidney and urinary tract disease, endocrine disease, and digestive system disease.				
Goal of study	The purpose of this course is to help students propose treatments and prescriptions for patients, based on their chief complaints, symptoms, physical examinations, and laboratory findings.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others ( )				

Term	Lecturer	Theme	Contents
1	Takahashi	Cardiovascular system disease 1	Students learn about the pathophysiology of ischemic heart diseases, arrhythmias, and so on.
2	〃	〃	Students learn to plan therapeutic strategy, formulation, and basic precautions in the treatment of ischemic heart diseases, arrhythmias, and so on.
3	Takahashi	Cardiovascular system disease 2	Students learn about the pathophysiology of hypertension, congestive heart diseases, and so on.
4	〃	〃	Students learn to plan therapeutic strategy, formulation, and basic precautions in the treatment of hypertension, congestive heart diseases, and so on.
5	Takahashi	Kidney and urinary tract system disease	Students learn about the pathophysiology of nephritis, nephrotic syndrome, prostatic hypertrophy, and so on.
6	〃	〃	Students learn to plan therapeutic strategy, formulation, and basic precautions in the treatment of nephritis, nephrotic syndrome, prostatic hypertrophy, and so on.
7	Takahashi	Endocrine system disease	Students learn about the pathophysiology of endocrine diseases, diabetes mellitus, and so on.
8	〃	〃	Students learn to plan therapeutic strategy, formulation, and basic precautions in the treatment of endocrine diseases, diabetes mellitus, and so on.
9	Sato	Digestive System Disease 1	Students learn about the disease status of gastritis, peptic ulcer, and so on.
10	〃	〃	Students learn about the planning of therapeutic strategy, formulation, and basic precautions in the treatment of gastritis, peptic ulcer, and so on.
11	Sato	Digestive System Disease 2	Students learn about the disease status of hepatitis, liver cirrhosis, and so on.
12	〃	〃	Students learn about the planning of therapeutic strategy, formulation, and basic precautions in the treatment of hepatitis, liver cirrhosis, and so on.
13	Sato	Digestive System Disease 3	Students learn about the disease status of cholecystolithiasis, cholecystitis, pancreatitis, bowel disorders, and so on.
14	〃	〃	Students learn about the planning of therapeutic strategy, formulation, and basic precautions in the treatment of cholecystolithiasis, cholecystitis, pancreatitis, and so on.

15	〃	〃	Students learn about the planning of therapeutic strategy, formulation, and basic precautions in the treatment of bowel disorders, and so on.
Record and evaluation method		Students are evaluated comprehensively based on a written examination (80%) and class performance (20%).	
Textbook		The textbook will be designated at the beginning of the course.	
Reference		References are handed out at every class.	
Preparation and Review		Students deepen understanding and improve how to plan therapeutic strategy, formulation, and basic precautions in the treatment of various diseases as pharmacists.	
Language Used in Course		Japanese	
Office hours		The office hours are from 14:00 to 16:00 on Tuesdays. Make an appointment in advance via e-mail: nobuyuki.takahashi.a8@tohoku.ac.jp (Takahashi Nobuyuki).	
In addition			

Subject	Clinical Laboratory Medicine				
Course Numbering	YPH-PHA311J	Categories	Elective		
Preferable Participants	4th	Semester	8	Credits	2
Instructor	Associate Professor Matsumoto Yotaro, Associate Professor Maekawa Masamitsu, Professor Takahashi Kazuhiro, Professor Sugawara Akira, Assistant Professor Hiratsuka Masahiro, Assistant Professor Kanamori Hajime and Medical technologist Katsumi Makoto				
Practical business	○				
Objectives and summary of class	Clinical tests in medical care are used for diagnosis and medical treatment, because the objective evidence of physiological changes resulted from disease can be obtained. Therefore, studying each clinical test is important to understand the symptom resulted from a disease. This course covers how to read clinical data together with patient background (genetic, age, physiological, complication, etc.) and aims to help students understand the relationship between clinical test and disease specific symptoms.				
Goal of study	Basic knowledge of typical symptoms and the meaning of clinical data are acquired in order to understand each disease by physiological change. Basic knowledge for personalized medicine are acquired in order to make an administrating plan for individual patient				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Matsumoto	Introduction: Clinical Laboratory Medicine	Overviwing clinical laboratory medicine and personalized medicine: how to utilize the clinical data for patients
2	Matsumoto	Personalized medicine I	Learning about the relationship between the genetic predisposition and PK/PD of drugs
3	Matsumoto	Personalized medicine II	Learning about the concern for drug treatment to newborn, infant, and elderly patients
4	Matsumoto	Personalized medicine III	Learning about the concern for drug treatment to pregnant, lactating, and obesity patients
5	Matsumoto	Personalized medicine IV	Learning about the concern for drug treatment to renal, hepatic, and cardiovascular patients
6	Matsumoto	Personalized medicine V	Learning about the administration plan based on individual PK/PD parameters with concerning of the population pharmacokinetic methods and circadian rhythm
7	Maekawa	Symptoms	Learning about the typical symptoms (fever, headache, eruption, jaundice, cyanosis, *etc.*) together with each cause and related disease.
8	Maekawa	Analysis of endogenous compounds	Learning about the typical clinical laboratory tests using urine and feces samples to estimate the related diseases with the data
9	Takahashi	Endocrinology test I	Learning about the typical clinical laboratory tests for endocrine and metabolic disorder to estimate the related disease from the data
10	Sugawara	Endocrinology test II	Learning about the typical clinical laboratory tests for endocrine and metabolic disorder to estimate the related disease from the data
11	Hiratsuka	Genetic test I	Learning about genetic testing to estimate the typical diseases from the data.
12	Hiratsuka	Genetic test II	Learning about genetic testing to estimate the typical diseases from the data
13	Kanamori	Microbiology test	Learning about microbiology test to estimate the typical diseases from the data
14	Katsumi	Practical work for blood and physiological tests	Learning about the practical work in clinical laboratories through blood and physiological tests

15			
Record and evaluation method	Based on the results of quiz/report by each lecturer.		
Textbook	Handouts of the power point slides are provided.		
Reference	Laboratory Medicine (薬剤師のための臨床検査ハンドブック), 2nd Ed., Ed. M. Maeda, Y. Takagi, Maruzen Publishing Co., Ltd., 2011 (ISBN 978-4-621-08420-5) Clinical Chemistry (薬学生のための臨床化学), 3rd Ed., Ed. J. Goto, Y. Katayama, Nankodo Co., Ltd., 2010 (ISBN 978-4-524-40262-5)		
Preparation and Review			
Language Used in Course	Japanese		
Office hours	An appointment required by E-mail or phone		
In addition			

Subject	Pharmaceutic Laws 2					
Course Numbering	YPH-PHA381J	Categories	Required[Pharmacy]			
Preferable Participants	4th	Semester	8	Credits	1	
Instructor	Kimura Takahiro, Ishibashi Tsuyoshi					
Practical business	○					
Objectives and summary of class	In this course, students will understand several laws to be necessary when they will be active as a pharmacist in society in the future: e. g. “Pharmaceutical and Medical Device Act,” “Pharmacist Act,” “Narcotics and Psychotropics Control Act,” “Poisonous and Deleterious Substances Control Act,” and other pharmaceutical related laws, medical service related laws, social security related laws, and those system.					
Goal of study	A pharmacist state examination is contemplated, and students will understand “Pharmaceutical and Medical Device Act,” and medical service and insurance related laws to be necessary when the pharmacist is active in society in the future. The aim of this course is to help students learn the purposes and changes of these laws, recognize what the pharmacist as a medical bearer is required, and utilize the laws concerned.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Kimura	Mission and ethic of the pharmacist, Pharmaceutical related laws outline	Recognizing the history of medicine and pharmacy, understanding the role of the pharmacist as a medical bearer, and to wear the mission as the pharmacist and the ethics of the medical life.
2	Kimura	Pharmacist Act	Understanding the license, duty, and business rules of the pharmacist to be active as a pharmacist concerned a person and society.
3	Kimura	Pharmaceutical and Medical Device Act (1)	Learning the purpose and the definition of pharmaceuticals etc., and the pharmacy, the pharmaceutical and medical device sales business on “Pharmaceutical and Medical Device Act,” and to understand the rule about the treatment of medicine.
4	Kimura Ishibashi	Pharmaceutical and Medical Device Act (2)	Learning the processes and the legal norms from development of drugs to approval, and understanding the post-marketing surveillance and safety measures.
5	Kimura Ishibashi	Narcotics and Psychotropics Control Act	Learning about the rule of narcotics, psychotropics, and stimulant raw materials, and understanding the preventive regulations against abuse about stimulants, cannabis, opium and designated drugs.
6	Kimura	Poisonous and Deleterious Substances Control Act	Understanding the rules about the handling of poisonous and deleterious substances. Learning about the handling of the creature origin products and the regenerative medicine, the blood supply system.
7	Kimura	Medical Act, The history of the harmful effect, Side effect victim relief system	Understanding the medical idea, the duty of medical bearer, and the rule of Medical Service Act about medical offer system. Learning about a pharmacist's role in the relief system of the healthy damage.

8	Kimura	The health insurance method, Price standards for medicines prescribed under the Health Insurance System, Medical treatment charge rule	Learning the present conditions of the Japanese social security system, and understanding the local cooperation system of health, medical care, and welfare.
Record and evaluation method		Evaluation is performed comprehensively based on the final examination (100%).	
Textbook			
Reference		"The commentary of the pharmaceutical law, system and ethic, 2020-21 version," Yakujinippou Corporation "The commentary of Pharmaceutical and Medical Device Act, Pharmacist Act, and Poisonous and Deleterious Substances Control Act," Yakujinippou Corporation	
Preparation and Review			
Language Used in Course		Japanese	
Office hours			
In addition		Lectures pharmacist national examination questions criteria (http://www.jshp.or.jp/cont/10/1015-1.pdf ') It will be mainly carried out the items that have been published in.	

Subject	Non-Prescription Medications and Care				
Course Numbering	YPH-PHA377J	Categories	Elective		
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	1
Instructor	Tomioka Yoshihisa, Kamo Masayuki, Takahashi Fumiaki, Saito Ryoko, Kutsuwa Motoharu, Saga Toshihide, Sakino Ken-ichi,				
Practical business	○				
Objectives and summary of class	This course is related to the Higashi Nihon Dai-shin-sai (Great East Japan Earthquake) and is related to self-care and self-medication support for local residents from normal times, and self-care and health management, disease prevention, public health, disaster prevention and mitigation, disaster medical care, etc., which are required as emergency responders. Learn knowledge and attitude for then. Learn about proper use of OTC drugs. Learn triage by pharmacists and how to respond. You will also learn about the importance of the family pharmacist system, multi-professional collaboration, and the role of a member of team medicine in a broad sense, and the future role of a pharmacist working in hospitals, pharmacies, governments, companies, and universities. Classes include lectures and tours, as well as small group discussions and presentations.				
Goal of study	Based on each patient's symptoms and laboratory findings, treatment strategies or support can be planning and formulated and specific prescription examples can be presented.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Tomioka	Overview	Learn basic knowledge of OTC medicines, self-care and self-medication. Learn about the response and activities of university faculty members during the Great East Japan Earthquake.
2	Sakino	OTC (1)	Learn the laws related to OTC drugs, classification of OTC drugs, and self-medication using OTC drugs and pharmacy drugs.
3	Sakino	OTC (2)	Learn the laws related to OTC drugs, classification of OTC drugs, and self-medication using OTC drugs and pharmacy drugs.
3	in adjustment	OTC (3)	Learn communication and counseling sales in OTC drug sales.
4	in adjustment	OTC (4)	Simulate communication and counseling sales in OTC drug sales.
5	Saito	Community pharmacy (1)	Learn primary care and self-medication in pharmacies through lecture exercises.
7	Kutsuwa	Community pharmacy (2)	Learn primary care and self-medication in pharmacies through lecture exercises.
8	Kamo Takahashi	Mobile pharmacy (1)	Learn the support of pharmacists during the Great East Japan Earthquake.
9	Saga	Hospital	Learn the support of pharmacists during the Great East Japan Earthquake.

Record and evaluation method	Evaluate based on reports (100%).
Textbook	
Reference	
Preparation and Review	Preparation: Read related items in the reference book specified by the lecture time. Review: Summarize the outline of the lecture content. Learn the parts of the lack of understanding in the reference book related items to deepen your understanding.
Language Used in Course	Japanese
Office hours	E-MAIL: ytomioka@tohoku.ac.jp

In addition	8th ; On-site training (Mobile Pharmacy)

Subject	Clinical Communication Skills				
Course Numbering	YPH-PHA301J	Categories	Required		
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	1
Instructor	Tomioka Yoshihisa, Hirasawa Noriyasu, Tominaga Atsuko, Sato Kenta				
Practical business	○				
Objectives and summary of class	Through dialogue with patients / consumers and other occupations, acquire the fundamental ability to understand the psychology, position, and environment of the other person and to build trust. In the class, surveys, role play/presentations, and discussions are conducted by small groups together with lectures				
Goal of study	Based on each patient's symptoms and laboratory test's data, pharmacotherapy/treatment strategies can be planned and presented of actual prescription examples				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1 2	Tomioka Tominaga	Case study (1)	Learn about communication and fundamental social communication skills. Explain how to give bad news and the basics of dealing with complaints. Learn how to respond to diabetic patients through role play
3 4	Tominaga	Case study (2)	Learn how to deal with neuropsychiatric disease patients through role play.
5 6	Tominaga	Case study (3)	Learn how to deal with allergic disease patients through role play.
7	Hirasawa Sato	Basics of interpersonal communication (1)	Learn interpersonal communication skills through exercises and role play
8	Hirasawa Sato	Basics of interpersonal communication (2)	Learn interpersonal communication skills through exercises and role play.
9	Hirasawa Sato	Basics of interpersonal communication (3)	Learn interpersonal communication skills through exercises and role play.

Record and evaluation method	Evaluate based on each report (100%).
Textbook	
Reference	
Preparation and Review	Preparation: Read related items in the reference book specified by the lecture time. Review: Summarize the outline of the lecture content. Learn the parts of the lack of understanding in the reference book related items to deepen your understanding.
Language Used in Course	Japanese
Office hours	Contact: ytomioka@tohoku.ac.jp
In addition	

Subject	Pharmaceutical English				
Course Numbering	YPH-PHA302J	Categories	Required		
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	2
Instructor	Prof. Nakabayashi Takakazu, Prof. Matsuzawa Atsushi, Prof. Takahashi Nobuyuki, Prof. Tomioka Yoshihisa, Prof. Oe Tomoyuki, and Prof. Yoshikai Naohiko				
Practical business					
Objectives and summary of class	Pharmacy English is important for acquiring knowledge and information in advanced pharmaceutical fields from an international perspective and for globally exchanging information from a professional standpoint of view. In this lecture, we aim to learn the terms and expressions used in pharmaceutical fields and to develop a sense of international communication.				
Goal of study	Understand the specialized English terms and usage of chemistry, biology, medical care which are considered to be necessary for pharmaceutical English, and can be used for collecting, exchanging and transmitting information.				
Method of class	[Lecture] ・ [Practice] ・ Training ・ On-site training ・ SGD ・ PBL ・ Roleplay ・ e-learning ・ Others( )				

Term	Lecturer	Theme	Contents
1	Nakabayashi	Guidance	Lecture overview
2	Matsuzawa	English reading and writing in biology	Learn composition of the paper to read and write it by yourself.
3	Takahashi	English communication in medical care	Learn English communication based on a lecture by a native speaker.
4	Tomioka	English reading and writing in medical care	Understand medical documents and learn English sentences in various scenes.
5	Oe	English communication in chemistry	Learn basic English conversation at a laboratory.
6	Yoshikai	English presentation	Learn scientific presentation in English.
7	Nakabayashi	Practice	Practice English presentation
8	Nakabayashi	Practice	Practice English presentation

Record and evaluation method	Evaluated by class performance (50%) and report (50%)
Textbook	Not specified
Reference	
Preparation and Review	
Language Used in Course	English and Japanese
Office hours	Make an advance appointment via e-mail to the lectures. See e-mail addresses in a student handbook.
In addition	Lecture schedule will be notified in Classroom and on a message board.

Subject	Advance Training in Pharmacy 1				
Course Numbering	YPH-PHA391J	Categories	Required		
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	6
Instructor	Supervisor of the laboratory				
Practical business					
Objectives and summary of class	Students will develop skills to solve research themes by organic association of the practical knowledge and basic experiment skills studied in basic pharmaceutical trainings. This training are located to develop skills that are necessary for Research Training held in 5th and 6th grade.				
Goal of study	The purpose of this course is to understand research themes and do experiments thinking the purpose to achieve themes logically.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents
Students do trainings based on the theme given by the supervisor of the laboratory. Moreover, students are required to participate in the seminar held in the laboratory.

Record and evaluation method	Evaluated by the supervisor of the laboratory.
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	

Subject	Advance Training in Pharmacy 2				
Course Numbering	YPH-PHA392J	Categories	Required		
Preferable Participants	4th [Pharmacy]	Semester	7・8	Credits	12
Instructor	Supervisor of the laboratory				
Practical business					
Objectives and summary of class	Students will develop skills to solve research themes by organic association of the practical knowledge and basic experiment skills studied in basic pharmaceutical trainings. This training are located to develop skills that are necessary for Research Training held in 5th and 6th grade.				
Goal of study	The purpose of this course is to understand research themes and do experiments thinking the purpose to achieve themes logically.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents
Students do trainings based on the theme given by the supervisor of the laboratory. Moreover, students are required to participate in the seminar held in the laboratory.

Record and evaluation method	Evaluated by the supervisor of the laboratory.
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	

Subject	Basic Training in Biopharmacy and Pharmacy Practice				
Course Numbering	YPH-PHA493J	Categories	Required		
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	4
Instructor	Clinical Pharmacology and Therapeutics, Oncology Pharmacy Practice and Science, Pharmacotherapy of Life-Style Related Diseases, Social Pharmacy Management, Pharmacy Education and Research Center				
Practical business	○				
Objectives and summary of class	Learn the knowledge, skills and attitudes that form the basis of the pharmacist's duties, such as dispensing, preparation, medication instruction, etc., in order to participate in the medical and health insurance business and open up the next generation. This practice is done inside the university prior to pharmacy practice in hospital and in community. The first half is the basic practice and the second half is the development practice with the clinical pharmacy exercise 2 (OSCE exercise) and the OSCE in between. Mainly in accordance with the core education model core curriculum, in development practice, we add original contents of our university.				
Goal of study	This training will comply with the "Model Core Curriculum for Pharmacy Education -2015 version" Based on a patient-oriented perspective, in order to become active as a pharmacist at clinical sites such as hospitals and pharmacies, the students need to acquire the basic matters necessary for practicing drug therapy and participating in team medicine and community health care. (1) Fundamentals of Pharmacy Practice In order to properly practice the activities required as a medical person, the students learn about the basic mental attitude and the basic flow of pharmacological management at clinical sites. ◎ Mental attitude in clinical practice ◎ Basics of clinical training (2) Prescription Processing, Medication Preparation, and Dispensing In order to safely and properly carry out dispensing work based on prescription, the students acquire basic dispensing work including supply and management of medicines. ◎ Understanding and complying with laws and regulations ◎ Prescription and doubt inquiry ◎ Preparation of prescription medicines ◎ Patient and visitor responses, medication instruction, patient education ◎ Supply and management of chemicals ◎ Safety management (3) Practical Application of Pharmacotherapy In order to provide safe and optimal medication therapy to patients, the students properly evaluate the medical conditions by appropriately gathering patient information, propose and apply medication therapy suitable for each patient based on appropriate medicinal information, and then evaluate applied medical therapy. ◎ Understanding patient information ◎ Collection and utilization of drug information ◎ Practice of prescription design and drug therapy (Prescription design and proposal) ◎ Practice of prescription design and drug therapy (Evaluation of efficacy and side effects in drug therapy)				

	(4) Participation on Interprofessional Collaborative Work In order to actively participate in team-centered team medicine in which multiple types of medical workers collaborate and cooperate in medical institutions and communities, the students understand the role and significance of multi-occupation in team medicine, share information, propose and practice better medical examination with other co-workers. ◎ Medical institution team medicine
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )

Contents
Basic training: It aims to provide students with the confidence, skills and knowledge needed to efficiently and effectively carry out their responsibilities as trainee in the hospital and clinical pharmacy. Learning outcomes ◎ Verify the legality, safety and appropriateness of prescription order. ◎ Prepare the medicines (powdered, liquid, tablet) in accordance with a prescription. ◎ Inspection that the quantities of medication are dispensed accurately. ◎ Listen to the patients, and understand their needs and what matters to them. ◎ Advise patients on the safe and effective use of their medicines and devices. Advanced training : Demonstrate the characteristics of a prospective professional pharmacist by learn a more specialized knowledge and techniques of the pharmaceutical care. Acquire the ability to keep professionally throughout their careers with developments in medicine and pharmacy. (Main contents: "Vital signs" "Side effects and physical assessment" "Informed consent" "Pathological analysis and case presentation" "Sterile preparation of anticancer drugs" "Radiopharmaceuticals" "Pharmaceutical management" "Danger prediction training" " Small group discussion ")

Record and evaluation method	Grading will be decided based on class performance (50%), reports (20%), rubric (10%), and the quality of the student's practical training performance (10%).
Textbook	OSCE Visual Guide
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means.
In addition	

Subject	Pharmacy Practice in Hospital				
Course Numbering	YPH-PHA494J	Categories	Required		
Preferable Participants	5th [Pharmacy]	Semester	9	Credits	10
Instructor	Lecturer of Department of Pharmacy				
Practical business	○				
Objectives and summary of class	In this training, students will understand the practices and responsibilities of hospital pharmacists and acquire basic knowledge, skills and attitudes about pharmacist skills such as dispensing and preparation, patient's education, etc. so that they can participate in team medicine.				
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents
Pharmacy Practice in Hospital will comply with the "Model Core Curriculum for Pharmacy Education - 2015 version" and carry out the following contents. In addition, there are opportunities to attend, observe, and experience the contents of distinctive operations at the training facility. Contents: Fundamentals of Pharmacy Practice, Prescription Processing, Medication Preparation, and Dispensing, Practical Application of Pharmacotherapy, Participation on Interprofessional Collaborative Work, Participation in Community Healthcare, Medical Care, and Welfare (things related to works characteristic of the facility, etc.)

Record and evaluation method	Grading will be decided based on class performance (20%), WEB system (diary / weekly report / self-evaluation), result report (40%), evaluation by faculty (20%), evaluation by supervising pharmacist (20%).
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	

Subject	Pharmacy Practice in Community				
Course Numbering	YPH-PHA495J	Categories	Required		
Preferable Participants	5th [Pharmacy]	Semester	8・9	Credits	10
Instructor	Lecturer of Department of Pharmacy				
Practical business	○				
Objectives and summary of class	In this training, students will understand the practices and responsibilities of community pharmacists and acquire basic knowledge, skills and attitudes about pharmacist skills such as dispensing and preparation, patient's education, etc. so that they can participate in team medicine.				
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents

Pharmacy Practice in Community will comply with the "Model Core Curriculum for Pharmacy Education -2015 version" and carry out the following contents. In addition, there are opportunities to attend, observe, and experience the contents of distinctive operations at the training facility.

Contents:
Fundamentals of Pharmacy Practice, Prescription Processing, Medication Preparation, and Dispensing, Practical Application of Pharmacotherapy, Participation on Interprofessional Collaborative Work,
Participation in Community Healthcare, Medical Care, and Welfare (things related to works characteristic of the facility, etc.)

Record and evaluation method	Grading will be decided based on class performance (20%), WEB system (diary / weekly report / self-evaluation), result report (40%), evaluation by faculty (20%), evaluation by supervising pharmacist (20%).
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	

Subject	General Training in Biopharmacy and Pharmacy Practice 1					
Course Numbering	YPH-PHA491J	Categories	Required			
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	2	
Instructor						
Objectives and summary of class						
Goal of study						
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	—	Pharmacy and Society	
2	—	Physical Pharmacy(1)	
3	—	Physical Pharmacy(2)	
4	—	Chemical Pharmacy(1)	
5	—	Chemical Pharmacy(2)	
6	—	Chemical Pharmacy(3)	
7	—	Biological Pharmacy(1)	
8	—	Biological Pharmacy(2)	
9	—	Health Pharmacy	
10	—	Biopharmacy(1)	
11	—	Biopharmacy(2)	
12	—	Biopharmacy(3)	
13	—	Biopharmacy(4)	
14	—	Biopharmacy(5)	
15	—	Clinical Pharmacy	

Record and evaluation method	Evaluation is performed based on attendance and CBT pre-test.
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	

Subject	General Training in Biopharmacy and Pharmacy Practice 2					
Course Numbering	YPH-PHA492J	Categories	Required			
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	1	
Instructor						
Objectives and summary of class						
Goal of study						
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
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Record and evaluation method	
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	

Subject	Practice in Pharmaceutical sciences				
Course Numbering	YPH-PHA400J	Categories	Required		
Preferable Participants	6th [Pharmacy]	Semester	12	Credits	2
Instructor					
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
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Record and evaluation method	
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	

Subject	Research Training				
Course Numbering	YPH-PHA400J	Categories	Required		
Preferable Participants	5th / 6th [Pharmacy]	Semester	10・11・12	Credits	20
Instructor	Supervisor of the laboratory				
Practical business					
Objectives and summary of class	Research Training is the most important subject scheduled in the last grade as a general decision of undergraduate education. Students belonging in each laboratories are given their research theme by their supervisor and do the research along the objective plan made by themselves. Students also make a summary of their research results as a graduation thesis and make a presentation of achievement and question-and-answer session in front of the research staff, undergraduate students and graduate students. Therefore, this subject is expected not only the basic preparation education for students to be a researcher but also useful for their career.				
Goal of study	・To help students seek and evaluate research achievements by for now related to their theme. ・To help students extract some problems to solve to achieve their theme. ・To help students make a research plan. ・To help students develop their observation eyes to grasp phenomena exactly through their theme. ・To help students summarize their research results. ・To help students consider and evaluate their research results. ・To help students presence their research achievement and question-and-answer exactly.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents
Students do their research given the theme obey to each specialized field by their supervisor of the laboratory. Research will be going obey to each laboratory's program; for example, participation in the seminar held in the laboratory, to audit some lectures.

Record and evaluation method	Evaluated by the supervisor of the laboratory.
Textbook	
Reference	
Office hours	
In addition	

Subject	Chemistry A				
Course Numbering	ZDN-CHE111J	Categories	Elective		
Preferable Participants	1st	Semester	1	Credits	2
Instructor	Professor Nakabayashi Takakazu				
Practical business					
Objectives and summary of class	This course provides basic concepts of atomic structures and chemical bonds based on quantum mechanics.				
Goal of study	Students will be familiar with the fundamentals of quantum mechanics including Schrödinger equation and wave function and will understand the basic concepts of atomic orbitals, electronic configurations of atoms, hybrid orbitals, molecular orbitals, and chemical bonds based on quantum mechanics.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Nakabayashi	Basic Quantum Mechanics I	Limitations of Classical Mechanics, Planck's Quantum Theory, Photoelectric Effect
2	Nakabayashi	Basic Quantum Mechanics II	Bohr's Theory, De Broglie Wave, Basic Principles of Quantum Mechanics
3	Nakabayashi	Basic Quantum Mechanics III	Basic Principles of Schrödinger Equation
4	Nakabayashi	Basic Quantum Mechanics IV	Properties of Wave Function
5	Nakabayashi	Basic Quantum Mechanics V	Application of Schrödinger Equation, Properties of Light
6	Nakabayashi	Atomic Orbitals I	Derivation, Shapes and Energies of Hydrogen Atomic Orbitals
7	Nakabayashi	Atomic Orbitals II	Configuration of Electrons Using the Building-Up Principle
8	Nakabayashi	Atomic Orbitals III	Physical Properties of Atoms Based on Electron Configurations
9	Nakabayashi	Midterm Examination, Molecular Orbitals I	Wave Functions and Energies of Hydrogen Molecular Ion
10	Nakabayashi	Molecular Orbitals II	Wave Functions and Their Energies of Homonuclear Diatomic Molecules
11	Nakabayashi	Molecular Orbitals III	Electron Configurations and Bonding Properties of Diatomic Molecules
12	Nakabayashi	Hyblid Orbitals I	Hybrid Orbitals of sp^1, sp^2, sp^3
13	Nakabayashi	Hyblid Orbitals II	Application of Hybrid Orbitals, Concept of Resonance Effect
14	Nakabayashi	π-Electron Approximation	Fundamentals and Application of π-Electron Approximation
15	Nakabayashi	Term Examination, Intermolecular Interactions	Metallic Bonds, Fundamentals of Intermolecular Interactions

Record and evaluation method	Students are evaluated on their points from the midterm examination (~30%), the term examination (~60%), and mini tests (~10%).
Textbook	

Reference	"Physical Chemistry for the Chemical and Biological Sciences" R. Chang, University Science Books（2000） "Physical Chemistry: A Molecular Approach" D. A. McQuarrie、J. D. Simon, University Science Books（1997）
Preparation and Review	Students are required to prepare and review for each class using handouts and references.
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. MAIL: takakazu.nakabayashi.e7@tohoku.ac.jp TEL: 795-6855
In addition	

Subject	Chemistry B					
Course Numbering	ZDN-CHE112J	Categories	Elective			
Preferable Participants	1st	Semester	2	Credits	2	
Instructor	Professor Konno Tomohiro					
Practical business						
Objectives and summary of class	The purpose of this course is to learn chemical thermodynamics and kinetics of chemical reactions.					
Goal of study	This course is designated to help students understand the basics and applications of chemical thermodynamics and kinetics of chemical reactions					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Konno	An outline of this class	Overview of this class
2	Konno	Chemical thermodynamics 1	Molecular theory of gases
3	Konno	Chemical thermodynamics 2	Potential energy, enthalpy, entropy
4	Konno	Chemical thermodynamics 3	First law of thermodynamics
5	Konno	Chemical thermodynamics 4	Free energy
6	Konno	Phase equilibria 1	Phase rule
7	Konno	Phase equilibria 2	Immiscible liquids, solid-liquid system
8	Konno	Phase equilibria 2	Phase equilibria of 2-component and 3-component systems
9	Konno	Kinetics of chemical reactions 1	Rate of chemical reactions, zero- and first-order rate reactions
10	Konno	Kinetics of chemical reactions 2	Second-order rate reactions
11	Konno	Kinetics of chemical reactions 3	Reversible reactions, complex rate equations
12	Konno	Kinetics of chemical reactions 4	Reaction rate and temperature, activation energy
13	Konno	Kinetics of chemical reactions 5	Catalysts in chemical reactions
14	Konno	Kinetics of chemical reactions 6	Acid-base rate reactions
15	Konno	Kinetics of chemical reactions 7	Enzyme-catalyzed reactions

Record and evaluation method	Students are evaluated on the small quizzes (40%) and final test (60%).
Textbook	
Reference	"Physical Chemistry 2nd Edition.", Publisher: Kagaku-Dojin Publishing Company, (2018) (ISBN: 978-4-7598-1628-0) "Atkins' Physical Chemistry, 10th Edition.", Publisher: Tokyo-Kagaku-Dojin Publishing Company, (2017) (ISBN: 978-4-8079-0908-7)
Preparation and Review	Students are required to prepare and review using handouts and textbook.

Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-mail: t-konno@tohoku.ac.jp　Phone: 795-6841
In addition	

Subject	Chemistry C				
Course Numbering	ZDN-CHE113J	Categories	Elective		
Preferable Participants	1st	Semester	1	Credits	2
Instructor	Professor Yoshiharu Iwabuchi and Lecturer Yusuke Sasano				
Objectives and summary of class	In this course, students will learn about structure, bonding, and concepts of hybridization and understand the basics of organic chemistry. And they will also study about resonance and electronegativity and understand acid-base reactions and acidity. The course will outline the property and reactivity of common functional groups and introduce important roles of organic molecules in vivo. They will learn about understand conformation and Fisher projection and understand nomenclature, physical properties, and reactivity of alkanes.				
Goal of study	· Students will be able to illustrate structure and bonding of organic molecules as well as hybridization. · Students will understand Brønsted–Lowry acids and bases, acid strength, and pKa and be able to predict the outcome of acid-base reactions. · Students will understand properties of common functional groups and be able to explain about important roles of organic molecules in vitamins, lipids, and the cell membrane. · Students will understand nomenclature, physical properties, and conformation of alkanes.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Iwabuchi Sasano	Structure and Bonding (1)	Students will understand ionic bonding, covalent bonding, and Lewis structures.
2	Iwabuchi Sasano	Structure and Bonding (2)	Students will understand resonance, molecular shape, and how to draw organic structures.
3	Iwabuchi Sasano	Structure and Bonding (3)	Students will understand hybridization, and three different kinds of bonding; ethane, ethylene, and acetylene.
4	Iwabuchi Sasano	Structure and Bonding (4)	Students will understand bond length, bond strength, electronegativity, and bond polarity.
5	Iwabuchi Sasano	Acids and Bases (1)	Students will understand Brønsted–Lowry acids and bases, acid strength, and pKa.
6	Iwabuchi Sasano	Acids and Bases (2)	Students will be able to predict the outcome of acid-base reactions and understand factors that determine acid strength.
7	Iwabuchi Sasano	Acids and Bases (3)	Students will understand common acids and bases, aspirin, and Lewis acids and bases.
8	Iwabuchi Sasano	Organic Molecules and Functional Groups (1)	Students will understand functional groups and intermolecular forces.
9	Iwabuchi Sasano	Organic Molecules and Functional Groups (2)	Students will understand physical properties, vitamins, and soap.
10	Iwabuchi Sasano	Organic Molecules and Functional Groups (3)	Students will understand the cell membrane, functional groups, reactivity, and biomolecules.
11	Iwabuchi Sasano	Alkanes (1)	Students will understand nomenclatures of acyclic and cyclic alkanes.
12	Iwabuchi Sasano	Alkanes (2)	Students will understand common names, physical properties of alkanes and conformation of ethane.
13	Iwabuchi Sasano	Alkanes (3)	Students will understand conformation of butane and cyclic alkanes including cyclohexane.

14	Iwabuchi Sasano	Alkanes (4)	Students will understand substituted cyclic alkanes, oxidation of alkanes and lipids.
15	Iwabuchi Sasano		Summary and Examination
Record and evaluation method		Evaluated mainly by examination (80%), with partial consideration of class performance (20%)	
Textbook		'Organic Chemistry — 5th edition' J. G. Smith	
Reference			
Preparation and Review		Students should read above contents in the textbook before lecture and solve problems in the textbook to deepen their understanding after the lecture.	
Language Used in Course		Japanese	
Office hours		Make an advance appointment via e-mail or other means. E-MAIL: y-iwabuchi@tohoku.ac.jp TEL: 795-6846 E-MAIL: ysasano@tohoku.ac.jp TEL: 795-6848	
In addition			

Subject	Biology A				
Course Numbering	ZDN-BIO111J	Categories	Elective		
Preferable Participants	1st	Semester	1	Credits	2
Instructor	Professor Matsuzawa Atsushi				
Practical business					
Objectives and summary of class	The purpose of this course is to learn the functions and structure of the cell and the principle of gene expression.				
Goal of study	Students will understand the functions and structure of the cell, the molecular basis of DNA replication, repair, transcription, RNA processing, and translation.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Matsuzawa	Introduction to cells	Constitution and function of cells
2	Matsuzawa	Organelles	Names and functions of organelles
3	Matsuzawa	Chemical component of cells	Amino acids, nucleic acids, lipids
4	Matsuzawa	Energy, catalysis and biosynthesis	Glycolysis and ATP synthesis
5	Matsuzawa	Protein structure	Structure of polypeptide, protein secondary structure, non-covalent interaction
6	Matsuzawa	DNA and chromosomes	Genes are made up of DNA
7	Matsuzawa	From DNA to protein	Transcription
8	Matsuzawa	From DNA to protein	Mechanism of meiosis
9	Matsuzawa	Analyzing genes and genomes	Principle of PCR, cloning, fluorescent protein, RNAi, etc.
10	Matsuzawa	Membrane transport	Transport between organelles
11	Matsuzawa	Mitochondria	Energy metabolism, cell death
12	Matsuzawa	Signal transduction	Intracellular signal transduction
13	Matsuzawa	Cytoskeleton	Structure and function of the cytoskeleton
14	Matsuzawa	Cell cycle and proliferation	Cell cycle control, cell division
15	Matsuzawa	Cell communications and cancer	Cancer cells, oncogenes, tumor suppressor genes

Record and evaluation method	Students are evaluated on their points from attendance (10%) and the final examination (90%).
Textbook	Essential Biology V
Reference	
Preparation and Review	Students are required to prepare lessons of each part and review thoroughly the points of each class and deepen the knowledge of the related and interesting contents.
Language Used in Course	Japanese

Office hours	E-MAIL: atsushi.matsuzawa.c6@tohoku.ac.jp　TEL: 022-795-6827
In addition	