Syllabus 2017

Faculty of Pharmaceutical Sciences
Tohoku University

INDEX

Subject	Introduction to Pharmaceutical Sciences 1				
Course Numbering	YAL-PHA201J	Categories	Required		
Preferable Participants	1st	Semester	1	Credits	2
Instructor	Prof. Yoshiharu Iwabuchi, Prof. Yoshiteru Oshima, Prof. Masahiko Yamaguchi, Prof. Takayuki Doi, Prof. Hidetoshi Tokuyama, Prof. Nariyasu Mano, Prof. Atsushi Matsuzawa, Prof. Tomoyuki Oe, Prof. Shoichiro Kurata, Prof. Toshifumi Inada, Prof. Junken Aoki, Prof. Kohji Fukunaga, Prof. Takakazu Nakabayashi, Prof. Hiroshi Sato, Prof. Yoshihisa Tomioka				
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	Doi	Introduction(1)	
2	Oshima	Introduction(2)	
3	Tokuyama	Introduction(3)	
4	Yamaguchi	Introduction(4)	
5	Oe	Introduction(5)	
6	Nakabayashi	Introduction(6)	
7	Inada	Introduction(7)	
8	Matsuzawa	Introduction(8)	
9	Kurata	Introduction(9)	
10	Fukunaga	Introduction(10)	
11	Mano	Introduction(11)	
12	Sato	Introduction(12)	
13	Tomioka	Introduction(13)	
14	Aoki	Introduction(14)	
15	Iwabuchi	Introduction(15)	

Record and evaluation method	
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	

In addition	

Subject	Functional Morphology 1					
Course Numbering	YAL-PHA231J	Categories	Elective			
Preferable Participants	1st	Semester	1	Credits	2	
Instructor	Professor Noriyasu Hirasawa					
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.
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	Professor Takayuki Doi				
Objectives and summary of class	In the organic chemistry 1, studied are 1) the structure, property and reactions of alkenes and alkynes; 2) basis of a multistep synthesis; 3) conjugation and resonance of conjugated compounds; 4) property and stability of aromatic compounds.				
Goal of study	To be able to explain structure, nomenclature, chemical property of alkenes and alkynes To be able to explain the mechanisms, selectivity, and stereochemistry of the reactions of alkenes and alkynes To be able to explain carbon–carbon bond forming reactions using acetylides To be able to explain the effect of electron delocalization and to draw resonance contributors To be able to explain aromaticity and stability of aromatic compounds To be able to explain the reactions under kinetic versus thermodynamic control To be able to explain the Diels-Alder reaction				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Doi	Alkenes 1	Structure, property, and nomenclature of alkenes
2	Doi	Alkenes 2	How do the alkenes undergo addition reactions?
3	Doi	Alkenes 3	The reactions under kinetic control versus thermodynamic control
4	Doi	The Reactions of alkenes 1	The electrophilic addition to alkenes
5	Doi	The Reactions of alkenes 2	Hydration of alkenes and addition of alcohols to alkenes.
6	Doi	The Reactions of alkenes 3	Hydroboration–oxidation and halogen addition to alkenes
7	Doi	Stereochemistry in the Reactions of Alkenes	Oxidative reaction of alkenes, reduction of alkenes, and stereochemistry in electrophilic addition to alkenes
8	Doi	The Reactions of Alkynes 1	Structure, property, and nomenclature of alkynes
9	Doi	The Reactions of Alkynes 2	Electrophilic addition to alkynes
10	Doi	The Reactions of Alkynes 3	Carbon − carbon bond formation using acetylides and its application to multiple step synthesis
11	Doi	Delocalized Electrons and Their Effect 1	Conjugation, resonance, resonance hybrid, and electron delocalization in conjugated systems
12	Doi	Delocalized Electrons and Their Effect 2	Criteria for aromaticity and structures of heteroaromatic compounds
13	Doi	Delocalized Electrons and Their Effect 3	Anti-aromatic compounds, π-molecular orbitals,
14	Doi	Delocalized Electrons and Their Effect 4	Kinetic versus thermodynamic control in electrophilic addition to conjugated dienes

15	Doi	Delocalized Electrons and Their Effect 5	The Diels-Alder reations
Record and evaluation method		Evaluated by examination	
Textbook		Organic Chemistry Seventh ed. Paula Y. Bruice	
Reference			
Preparation and Review			
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 TEL: 795-6865	
In addition			

Subject	Organic Chemistry 2					
Course Numbering	YAL-PHA222J	Categories	Elective			
Preferable Participants	1st	Semester	2	Credits	2	
Instructor	Professor Hidetoshi Tokuyama and Assistant Professor Hirofumi Ueda					
Objectives and summary of class	In the organic chemistry 1, studied are 1) substitution reaction (S_N1 and S_N2 reaction) and elimination reaction (E1 and E2 reaction) with alkyl halides; 2) the structure, property and reaction of alcohols, ethers, epoxides, amines, and thiols; 3) the structure, property and reaction of radical; 4) basis of multistep synthesis.					
Goal of study	To be able to explain the feature, reaction mechanism, stereochemistry, and factor affecting reaction about substitution reaction with alkyl halides (S_N1 and S_N2 reaction). To be able to explain the feature, reaction mechanism, regioselectivity, stereochemistry, competition from substitution reaction, and factor affecting reaction about elimination reaction with alkyl halides (E1 and E2 reaction). To be able to explain structure, chemical property, and reaction of alcohols, ethers, epoxides, amines, and thiols. To be able to explain the structure, property and reaction of radical. To be able to design multistep synthesis					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Tokuyama Ueda	Substitution reaction with alkyl halides (1)	Properties, structures, nomenclature of alkyl halide and concept of nucleophilic substitution reaction.
2	Tokuyama Ueda	Substitution reaction with alkyl halides (2)	The mechanisms for an S_N2 reaction nucleophilic substitution reaction and factors that affect S_N2 reactions
3	Tokuyama Ueda	Substitution reaction with alkyl halides (3)	The mechanisms for an S_N1 reaction nucleophilic substitution reaction Factors that affect S_N1 reactions
4	Tokuyama Ueda	Substitution reaction with alkyl halides (4)	Competition between S_N1 and S_N2 reactions Intermolecular versus intramolecular reactions
5	Tokuyama Ueda	Elimination reaction with alkyl halides (1)	The concept, reaction mechanism, and regioselectivity of E2 reaction
6	Tokuyama Ueda	Elimination reaction with alkyl halides (2)	The concept, reaction mechanism, and regioselectivity of E1 reaction Competition between E1 and E2 reactions
7	Tokuyama Ueda	Competition between substitution and elimination	Elimination from substituted cyclohexanes Competition between substitution and elimination
8	Tokuyama Ueda	Reactions of alcohols 1	Structure, property, and nomenclature of alcohols Methods used to convert alcohols into alkyl halides
9	Tokuyama Ueda	Reactions of alcohols 2	Elimination and oxidation of alcohols
10	Tokuyama Ueda	The reactions of ethers and epoxides	Reactions of ethers and epoxides
11	Tokuyama Ueda	Reactions of amines and thiols	Reactions of amines and thiols
12	Tokuyama Ueda	Organometallic compounds	Property and reactivity of organometallic compounds Method for preparation of organometallic compounds
13	Tokuyama Ueda	Radicals･reactions of alkanes 1	Property and reactivity of alkanes Methods used to convert alkanes into alkyl halides
14	Tokuyama Ueda	Radicals・reactions of alkanes 2	Stability and reactivity of radicals The reactivity-selectivity principle

15	Tokuyama Ueda	Radicals · reactions of alkanes 3	The stereochemistry of radical substitution and radical addition reactions Designing multistep synthesis
Record and evaluation method	Evaluated by attendance and examination		
Textbook	Organic Chemistry Seventh ed. Paula Y. Bruice		
Reference			
Preparation and Review	Before lecture, students are required to read the relevant part of the textbook. After 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: tokuyama@m.tohoku.ac.jp TEL: 022-795-6887		
In addition			

Subject	Analytical Chemistry 1					
Course Numbering	YAL-PHA211J	Categories	Elective			
Preferable Participants	1st	Semester	2	Credits	2	
Instructor	Professor Tomoyuki Oe					
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 JP16
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 JP16
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), 2nd Ed., Ed. J. Haginaka, M. Yamaguchi, M. Chikuma, Nankodo Co., Ltd., 2012 (ISBN 978-4-524-40287-8)

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	Senior Assistant Professor Shinji Kajimoto					
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	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.
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).
In addition	

Subject	Functional Morphology 2					
Course Numbering	YAL-PHA232J	Categories	Elective			
Preferable Participants	1st	Semester	2	Credits	2	
Instructor	Hiroshi Sato, Kohji Fukunaga, Nobuyuki Takahashi, Yasushi Yabuki					
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	Yabuki	Central Nerve 1	Understanding the spinal and central control of movement and sensory organization through the spinal cord.
10	Yabuki	Central Nerve 2	Understanding the anatomy of central nervous system and the methods to define the functional analyses of nervous system.
11	Fukunaga	Central Nerve 3	Understanding the specific brain regions accounting for disorders in sleep, memory, epilepsy and pervasive development.
12	Yabuki	Peripheral Nerve	Understanding the regulation of peripheral homeostasis through autonomic nervous system and somatic sensation.
13	Fukunaga	Sensory Organ 1	Understanding the functional morphology of somatic and visceral sensation, and visual system.
14	Fukunaga	Sensory Organ 2	Understanding the functional morphology of auditory and balance senses, and .the chemical senses such as taste and smell.

15	Fukunaga	Muscle	Understanding the functional morphology and contraction of skeletal, cardiac and smooth muscles.
Record and evaluation method		Students are evaluated comprehensively based on a written examination, attendance, and so on.	
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: hsymhs2i@m.tohoku.ac.jp (Hiroshi Sato).	
In addition			

Subject	Biochemistry 1				
Course Numbering	YAL-PHA233J	Categories	Elective		
Preferable Participants	1st	Semester	2	Credits	2
Instructor	Shoichiro Kurata				
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 all the small tests and the final examinations.
Textbook	Basic Pharmaceutical Sciences Textbook Series: Biochemistry, Editor: Yoshinobu Nakanishi,
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: kurata@m.tohoku.ac.jp　TEL: 795-5916
In addition	

Subject	Introduction to Pharmaceutical Sciences 2					
Course Numbering	YAL-PHA202J	Categories	Required			
Preferable Participants	2nd	Semester	3	Credits	1	
Instructor	Prof. Takayuki Doi, Lecturer Masafumi Kikuchi, Atsuko Tominaga, Koji Ikeda, Chikako Uneyama, Masakazu Aizawa, Kiyomi Ueno, Kenji Chiba and Takahiko Taniguchi					
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	Doi Kikuchi	Guidance/ Introduction (1)	
2	Tominaga	Introduction (2)	
3	Chiba	Introduction (3)	
4	Taniguchi	Introduction (4)	
5	Ikeda	Introduction (5)	
6	Ueno	Introduction (6)	
7	Uneyama	Introduction (7)	
8	Aizawa	Introduction (8)	
9		Introduction (9)	
10	Doi	Visiting laboratory and institution	

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

Subject	Organic Chemistry 3					
Course Numbering	YAL-PHA223J	Categories	Elective			
Preferable Participants	2nd	Semester	3	Credits	2	
Instructor	Professor Masahiko Yamaguchi and Associate Professor Mieko Arisawa					
Objectives and summary of class	In the organic chemistry 3, students will learn about instrumental methods 1) to determine the molecular weight and molecular formula of a compound, 2) to identify a compound's functional groups, 3) to identify the carbon-hydrogen framework of a compound. Students will also learn about a) conjugation and resonance of a conjugated compound, b) aromoticity of benzene, and c) reactions of aromatic compounds.					
Goal of study	To be able to identify structures of simple organic compounds using MS spectrometry and IR and NMR spectroscopies To be able to explain what resonance is and to draw resonance structure To be able to explain reactions under kinetic versus thermodynamic control To be able to explain the Diels-Alder reaction To be able to explain aromaticity and reactivity of aromatic compounds To be able to explain mechanism of electrophilic aromatic substitution reaction of substituted benzenes To understand substituent effects in electrophilic aromatic substitution and to be able to design multistep synthesis of substituted benzenes To be able to explain mechanism of nucleophilic aromatic substitution reaction of substituted benzenes To be able to explain chemistry of benzyne					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Yamaguchi Arisawa	MS and IR (1)	Students will learn about key concepts of mass spectrometry and its use in structure determination of organic compounds.
2	Yamaguchi Arisawa	MS and IR (2)	Students will learn about key concepts of infrared spectroscopy and its use to identify the functional groups in a molecule.
3	Yamaguchi Arisawa	NMR (1)	Students will learn about the basis of nuclear magnetic resonance spectroscopy, chemical shift, and shielding/deshielding effects.
4	Yamaguchi Arisawa	NMR (2)	Students will learn about spin-spin splitting and coupling constant in ^{1}H NMR and their use in structure determination of organic compounds.
5	Yamaguchi Arisawa	NMR (3)	Students will learn about ^{13}H NMR and its use in structure determination of organic compounds.
6	Yamaguchi Arisawa	Conjugation, Resonance, and Dienes (1)	Students will learn about conjugation, resonance, resonance hybrid, and electron delocalization in common conjugated systems.
7	Yamaguchi Arisawa	Conjugation, Resonance, and Dienes (2)	Students will learn about kinetic versus thermodynamic control in electrophilic addition of conjugated dienes.
8	Yamaguchi Arisawa	Conjugation, Resonance, and Dienes (3)	Students will learn about the Diels-Alder reaction and the specific rules that govern the Diels-Alder reaction.
9	Yamaguchi Arisawa	Benzene and Aromatic Compounds (1)	Students will learn about the criteria for aromaticity. Students will understand Benzene's unusual stability and learn about examples of aromatic compounds.
10	Yamaguchi Arisawa	Benzene and Aromatic Compounds (2)	Students will learn about key concepts of molecular orbitals.
11	Yamaguchi Arisawa	Reactions of Aromatic Compounds (1)	Students will learn about the general mechanism of electrophilic aromatic substitution reaction and understand halogenation, nitration, and sulfonation of benzene.

12	Yamaguchi Arisawa	Reactions of Aromatic Compounds (2)	Students will learn about Friedel-Crafts alkylation and Friedel-Crafts acylation reaction.
13	Yamaguchi Arisawa	Reactions of Aromatic Compounds (3)	Students will learn about orientation effects in substituted benzenes.
14	Yamaguchi Arisawa	Reactions of Aromatic Compounds (4)	Students will learn about logic of multistep synthesis to obtain substituted benzenes efficiently.
15	Yamaguchi Arisawa	Reactions of Aromatic Compounds (5)	Students will learn about nucleophlic aromatic substitution by addition-elimination and by elimination-addition (benzyne).

Record and evaluation method	Evaluation is performed comprehensively based on submitted reports (20%) and written examination (80%).
Textbook	「スミス 基礎有機化学(上・下)第３版」J. G. Smith 著、山本尚・大嶌幸一郎 監訳　化学同人（2012） 「Organic Chemistry」Author: J. G. Smith，McGraw Hill Higher Education
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means before students will visit office. E-MAIL: yama@m.tohoku.ac.jp, arisawa@m.tohoku.ac.jp　TEL: (795)-6812, (795)-6814
In addition	

Subject	Pharmacognosy 1				
Course Numbering	YAL-PHA226J	Categories	Elective		
Preferable Participants	2nd	Semester	3	Credits	2
Instructor	Professor Yoshiteru Oshima				
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	Oshima	Introduction	Definition and history of Pharmacognosy
2	Oshima	Biosynthesis of constituents of crude drugs 1	Outline of biosynthetic pathways of constituents of crude drugs
3	Oshima	Biosynthesis of constituents 2	Outline of biosynthetic pathways of constituents of crude drugs
4	Oshima	Mevalonate pathway: terpenoids	Biosynthetic pathway and chemical properties of terpenoids
5	Oshima	Mevalonate pathway: steroids	Biosynthetic pathway and chemical properties of steroids
6	Oshima	Alkaloid pathway 1	Biosynthetic pathway and chemical properties of alkaloids
7	Oshima	Alkaloid pathway 2	Biosynthetic pathway and chemical properties of alkaloids
8	Oshima	Shikimate pathway: phenylpropanoids	Biosynthetic pathway and chemical properties of phenylpropanoids
9	Oshima	Shikimate pathway: flavonoids	Biosynthetic pathway and chemical properties of flavonoids
10	Oshima	Acetate pathway: polyketides	Biosynthetic pathway and chemical properties of polyketides
11	Oshima	Crude drugs 1	Sources, constituents, pharmacological properties and therapeutic uses of medicinally important crude drugs.
12	Oshima	Crude drugs 2	Sources, constituents, pharmacological properties and therapeutic uses of medicinally important crude drugs.
13	Oshima	Crude drugs 3	Sources, constituents, pharmacological properties and therapeutic uses of medicinally important crude drugs.
14	Oshima	Crude drugs 4	Sources, constituents, pharmacological properties and therapeutic uses of medicinally important crude drugs.
15	Oshima	Crude drugs 5	Sources, constituents, pharmacological properties and therapeutic uses of medicinally important crude drugs.

Record and evaluation method	Evaluation is performed based on the points from the test.
Textbook	Basic textbook series for the students learning pharmaceutical sciences7 Pharmacognosy, Natural products chemistry, Edited by Masayuki Yoshikawa, Kagaku Dojin (2013)
Reference	

Preparation and Review	Self-study on a learning problem given as needed is required to understand this course.
Language Used in Course	Japanese
Office hours	The office hours are from 10:00 to 19:00. Make an advance appointment via e-mail. E-mail: oshima@mail.pharm.tohoku.ac.jp
In addition	

Subject	Physical Chemistry 2				
Course Numbering	YAL-PHA215J	Categories	Elective		
Preferable Participants	2nd	Semester	3	Credits	2
Instructor	Professor Jun-ichi Anzai				
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	Anzai	Solution 1	Properties of non-electrolyte solutions
2	Anzai	Solution 2	Chemical potential
3	Anzai	Solution 3	Raoult's law, Henry's law
4	Anzai	Solution 4	Colligative properties
5	Anzai	Interface 1	Surface and surface tension
6	Anzai	Interface 2	Surface adsorption
7	Anzai	Interface 3	Physical adsorption, chemical adsorption
8	Anzai	Interface 4	Adsorption isotherms
9	Anzai	Electrolyte solution 1	Strong electrolytes, weak electrolytes
10	Anzai	Electrolyte solution 2	Ion conductivity, transference number, ion mobility
11	Anzai	Electrolyte solution 3	Ionic strength, Debye-Hückel theory
12	Anzai	Electrochemistry 1	Faraday's law
13	Anzai	Electrochemistry 2	Principle of chemical cells
14	Anzai	Electrochemistry 3	Electro-motive force
15	Anzai	Electrochemistry 4	Nernst equation, electro-analysis

Record and evaluation method	Students are evaluated on the small tests (30%) and final test (70%).
Textbook	"Physical Chemistry" ed. by Oshima and Handa, Nankodo (1999)
Reference	none
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.
In addition	

Subject	Biochemistory 2				
Course Numbering	YAL-PHA235J	Categories	Elective		
Preferable Participants	2nd	Semester	3	Credits	2
Instructor	Prof. Junken Aoki, Associate Professor Asuka Inoue				
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	Aoki		
2	Aoki Inoue		
3	Aoki Inoue		
4	Aoki Inoue		
5	Aoki Inoue		
6	Aoki Inoue		
7	Aoki Inoue		
8	Aoki Inoue		
9	Aoki Inoue		
10	Aoki Inoue		
11	Aoki Inoue		
12	Aoki Inoue		
13	Aoki Inoue		
14	Aoki Inoue		
15	Aoki Inoue		

Record and evaluation method	
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	

In addition	

Subject	Biochemistry 3					
Course Numbering	YAL-PHA235J		Categories	Elective		
Preferable Participants	2nd	Semester	3	Credits	2	
Instructor	Shoichiro Kurata, Tamaki Yano, and Touru Yamakuni					
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 characteristics of proteins to understand the mode of action of drugs and diseases such as cancer.					
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 functional disorder of proteins causing diseases such as cancer and neurodegenerative disorders.					
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	Yamakuni	Neurotrophins and the intracellular signaling	To understand the structures and functions of neurotrophins, and the intracellular signaling mechanism
9	Yamakuni	Electric signal and voltage-dependent ion channels	To understand the physiological role of action potential as electric signal and voltage-dependent ion channels that give rise to action potential
10	Yamakuni	Structures and functions of the voltage-dependent ion channels	To understand the structures and functions of representative voltage-dependent ion channels
11	Yamakuni	Neurotransmitter synthetic enzymes	To understand the functions of representative neurotransmitter synthetic enzymes and the regulatory mechanism of the activity
12	Yamakuni	Cytoskeletal proteins and the functions in the neurons	To understand the structures and functions of representative cytoskeletal proteins in neuronal cells
13	Yamakuni	Protein dysfunction and peripheral neurodegeneration	To learn protein dysfunction as pathogenic mechanism underlying peripheral neurodegenerative disorders
14	Yamakuni	Protein misfolding and central neuro-degeneration	To learn that protein misfolding causes representative neurodegenerative brain disorders
15	Yamakuni	Summary of the last half of this course	To confirm the contents that was handled in the last part of this course.

Record and evaluation method	Evaluation is performed based on midterm (50%) and the final (50%) examinations.
Textbook	Basic Pharmaceutical Sciences Textbook Series: Biochemistry, Editor: Yoshinobu Nakanishi,
Reference	Biochemistry: The Molecular Basis of Life, Fourth Edition, Trudy McKee and James R. McKee, Oxford University Press, Inc. Molucular Cell Biology, Fifth Edition, Lodish et al., W. H. Freeman and Campany
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: kurata@m.tohoku.ac.jp　TEL: 795-5916
In addition	

Subject	Pharmacology 1				
Course Numbering	YAL-PHA251J	Categories	Elective		
Preferable Participants	2nd	Semester	3	Credits	2
Instructor	Associate Professor Takahiro Moriya				
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	Moriya	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	Moriya	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	Moriya	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	Moriya	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	Moriya	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	Moriya	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	Moriya	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	Moriya	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.
9	Moriya	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.
10	Moriya	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.
11	Moriya	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.
12	Moriya	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.
13	Moriya	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.
14	Moriya	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.
15	Moriya	Chronopharmacology	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.
Record and evaluation method		Students are evaluated on the several mini tests and the final examination.	
Textbook			
Reference		Tanaka, Chikako and Kato, Ryuichi eds., *New Pharmacology (6th Edition)*. Nankodo, 2011. Nabeshima, Toshitaka and Inoue, Kazuhide eds., *Mitewakaru Yakugaku Zukai Yakurigaku (1st Edition)*. Nanzando, 2015. 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		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: E-MAIL: moriya@m.tohoku.ac.jp TEL: 022-795-3843
In addition	Materials are provided via ISTU.

Subject	Pharmacology 2					
Course Numbering	YAL-PHA252J	Categories	Elective			
Preferable Participants	2nd	Semester	3	Credits	2	
Instructor	Professor Kohji Fukunaga and Senior Assistant Professor Shigeki Moriguchi					
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	Fukunaga	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	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	Fukunaga	Central nervous system therapeutics (4)	Students learn the pharmacology of therapeutics for psychosis, schizophrenia, Parkinson's disease and narcolepsy.
11	Fukunaga	Neurodegenerative disorder therapeutics	Students learn the therapeutics for stroke, Alzheimer's disease, Huntington's disease and amyotrophic lateral sclerosis.
12	Fukunaga	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	Fukunaga	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	Fukunaga	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	Fukunaga	Gastrointestinal therapeutics (3)	Students learn the therapeutics acting on the intestinal immunity and intestinal flora.
Record and evaluation method		Examination, attendance 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.	
In addition			

Subject	Pharmaceutics 1					
Course Numbering	YAL-PHA261J	Categories	Elective			
Preferable Participants	2nd	Semester	3	Credits	2	
Instructor	Professor Tetsuya Terasaki, Associate Professor Masanori Tachikawa, and Assistant Professor Yasuo Uchida					
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	Terasaki	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	Terasaki	Solid formulation	Characteristics, production methods, and advantages of solid formulation
3	Terasaki	Semi-solid formulation	Characteristics and production methods of semi-solid formulation
4	Terasaki	Liquid formulation	Characteristics and production methods of liquid formulation
5	Terasaki	Sterile formulation	Characteristics, production methods, and administration pathway of the formulation for injection, ophthalmic solution, and ophthalmic ointments
6	Tachikawa	Drug delivery system	Basic concept, drug design, and formulation of drug delivery system
7	Tachikawa	Quality control, pharmaceutical test, stability	Quality tests of drug formulations for quality control in Japanese Pharmacopoeia (JP) and the stability of drug formulations
8	Tachikawa	Biomembrane transport	Mechanisms of biomebrane transport as a rate-limiting process of the fate of drugs in the body
9	Terasaki	Drug absorption	Mechanisms of drug absorption in the small intestine
10	Terasaki	Protein binding	Classification of drug-protein bindings and the analyzing methods
11	Uchida	Tissue distribution	Factors affecting the drug distribution in the targeted organs/tissues
12	Terasaki	Drug metabolism and First pass effect	Factors affecting the drug metabolizing rate, e.g., membrane permeability, protein binding, blood flow rate, and administration pathway
13	Terasaki	Renal and biliary excretion	Mechanisms of renal and biliary excretion as the main routs of drug elimination from the body
14	Tachikawa	Solubility and kinetics	Factors affecting the solubility and pharmacokinetics of drug formulations

15	Tachikawa	Clinical and personalized medicine	Basic concept of personalized medicine based on individual clinical dosage regimen
Record and evaluation method		Students are evaluated on their points from all the small tests (15%), and the midterm and regular examinations (85%).	
Textbook		1. (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） 2. (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)	
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)	
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 Associate Professor Naoki Kanoh				
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 Kanoh	Carboxylic acid 1	Nomenclature, structure, physical property, hydrogen bonding, synthetic method and reactions of carboxylic acid
2	Iwabuchi Kanoh	Carboxylic acid 2	Acidity and pKa value of carboxylic acid, separation using extraction, amino acid.
3	Iwabuchi Kanoh	Carbonyl compound 1	General reactions of carbonyl compounds. Reduction of aldehyde and ketone.
4	Iwabuchi Kanoh	Carbonyl compound 2	Stereochemistry in the reduction of carbonyl groups. Reduction of carboxylic acid and derivatives. Oxidation of aldehyde.
5	Iwabuchi Kanoh	Carbonyl compound 3	Basic concept of organometallic reagents and reaction with aldehyde and ketone.
6	Iwabuchi Kanoh	Carbonyl compound 4	Reaction of organometallic reagents with carboxylic acid derivatives. a,b-Unsaturated carbonyl compounds and protecting groups.
7	Iwabuchi Kanoh	Aldehyde & ketone 1	Nomenclature, structure, physical property, synthetic method of aldehyde and ketone.
8	Iwabuchi Kanoh	Aldehyde & ketone 2	General reactions of aldehyde and ketones with hydride, carbon nucleophiles, cyanide.
9	Iwabuchi Kanoh	Aldehyde & ketone 3	Conversion of carbonyl groups to alkenes using Wittig reaction. Imine, enamine formation by the reaction with nitrogen nuclephiles.
10	Iwabuchi Kanoh	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 Kanoh	Carboxylic acid derivative 1	Nomenclature, structure, physical property of ester, amide, carboxylic acide anhydride.
12	Iwabuchi Kanoh	Carboxylic acid derivative 2	Reaction of carboxylic acid halide and anhydride.
13	Iwabuchi Kanoh	Carboxylic acid derivative 3	Conversion of carboxylic acid to ester, amide, anhydride. Reaction of ester and hydrolysis of lipid.
14	Iwabuchi Kanoh	Carboxylic acid derivative 4	Reaction of amides and biological activity of b-lactam. Natural and synthetic fibers with amide and ester linkages.
15	Iwabuchi Kanoh	Carboxylic acid derivative 5	Acylation in metabolism. Basic reactions of nitrile.

Record and evaluation method	Evaluated mainly by examination with partial consideration of attendance
Textbook	「スミス基礎有機化学(上・下)第３版」J. G. Smith 著，山本尚・大嶌幸一郎 監訳 化学同人（2012）
Reference	

Preparation and Review	
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: y-iwabuchi@m.tohoku.ac.jp (岩渕教授) TEL: 795-6846
In addition	

Subject	Organic Chemistry 5				
Course Numbering	YAL-PHA225J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Yoshinori Kondo, Masanori Shigeno				
Objectives and summary of class	In this course, students will learn about chemistry of carbonyl compounds amines, and heterocycles, and about pericyclic reactions.				
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	Kondo Shigeno	Basics of Enolates	Students will understand the acidity of the α-proton of carbonyl compounds.
2	Kondo Shigeno	Enolate Chemistry (1)	Students will understand the enolate formation and the α-alkylation of carbonyl compounds.
3	Kondo Shigeno	Enolate Chemistry (2)	Students will understand the alkylation of activated esters, β-keto esters and malonates
4	Kondo Shigeno	Condensation of Carbonyl Compounds (1)	Students will understand aldol reactions
5	Kondo Shigeno	Condensation of Carbonyl Compounds (2)	Students will understand the Claisen condensation, cross condensation, and intramolecular condensation.
6	Kondo Shigeno	Amines (1)	Students will understand the chemistry of amines and formation of amines.
7	Kondo Shigeno	Amines (2)	Students will understand the reactions of amines.
8	Kondo Shigeno	Carbon−Carbon Bond Formation (1)	Students will understand carbon−carbon bond forming reactions.
9	Kondo Shigeno	Carbon−Carbon Bond Formation (2)	Students will understand the synthetic methods for cyclopropane formation and metathesis.
10	Kondo Shigeno	Heterocycles (1)	Students will understand the chemistry of five-membered heterocycles.
11	Kondo Shigeno	Heterocycles (2)	Students will understand the chemistry of six-membered heterocycles.
12	Kondo Shigeno	Amino Acids and Proteins	Students will understand the chemistry of amino acids, peptides, and proteins.
13	Kondo Shigeno	Pericyclic Reactions (1)	Students will understand the molecular orbital theory and conservation of orbital symmetric theory
14	Kondo Shigeno	Pericyclic Reactions (2)	Students will understand cycloaddition reactions.
15	Kondo Shigeno	Pericyclic Reactions (3)	Students will understand electrocyclic reactions.

Record and evaluation method	Students are evaluated on the final examination (100%).
Textbook	'Organic Chemistry — 3rd 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	
Language Used in Course	Japanese

Office hours	Make an advance appointment via e-mail or other means. E-MAIL: ykondo@m.tohoku.ac.jp　TEL: 795-6804 E-MAIL: mshigeno@m.tohoku.ac.jp　TEL: 795-5917
In addition	

Subject	Pharmacognosy 2				
Course Numbering	YAL-PHA227J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Touru Yamakuni				
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.				
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	Yamakuni	Introduction	To understand the history and importance of pharmacognosy, and learn about the origins, properties and clinical applications of representative crude drugs as well as crude drug classification.
2	Yamakuni	Kampo medicine 1	To learn about the differences between Kampo medicine and western medicine, and understand an important position of Kampo medicine in modern medicine in Japan.
3	Yamakuni	Kampo medicine 2	To learn about the unique basic concepts of Kampo medicine, such as ki, ketsu and sui, and understand the diagnosis and treatment in Kampo medicine.
4	Yamakuni	Kampo medicine 3	To understand actions of the representative crude drugs and Kampo prescriptions listed in Japanese Pharmacopoeia, and learn about Kampo's adverse side effects and the precautions for their use.
5	Yamakuni	Crude drug identification	To learn about the methods for identification of crude drugs and understand the importance.
6	Yamakuni	Plant biotechnology	To understand the applications of plant biotechnology for production of useful bioactive constituents of crude drugs.
7	Yamakuni	Natural drugs' actions: the effects on intracellular signaling	To understand misregulated intracellular signaling associated with diseases, and actions of crude drugs and their constituents against the misregulated signaling.
8	Yamakuni	Summary of the first half of this course	To confirm the contents that was handled in the first part of this course.
9	Yamakuni	Natural drugs' actions: the effects on gene regulation	To understand the misregulation of gene expression associated with diseases, and effects of crude drugs and their constituents against the disease-associated misregulation of gene expression.
10	Yamakuni	Evaluation of the efficacy of natural drugs	To understand how to evaluate the efficacy of crude drugs, Kampo medicines and their constituents.
11	Yamakuni	Natural drugs for treatment of inflammation and allergy	To understand the mechanisms of anti-inflammatory and anti-allergic actions of crude drugs and natural compounds, and learn about the clinical potential and benefits.

12	Yamakuni	Natural drugs for treatment of neural disorders	To understand mechanisms underlying actions of natural drugs in the nervous system, and learn about the clinical potential and benefits.
13	Yamakuni	Natural drugs acting on cardiovascular system	To learn about the history of discover and isolation of natural drugs that act on cardiovascular system, and understand their action mechanisms and clinical applications.
14	Yamakuni	Natural drugs acting on digestive system	To understand the importance of natural drugs that are employed as digestants, stomachics, peptic ulcer agents, antidiarrheal drugs, cathartic drugs, emetics and antiemetics.
15	Yamakuni	Summary of the last half of this course	To confirm the contents that was handled in the last part of this course.
Record and evaluation method		Evaluation is performed based on midterm and the final examinations (90%) as well as submitted reports regarding the representative crude drugs listed in Japanese Pharmacopoeia (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.	
Language Used in Course		Japanese	
Office hours		Make an advance appointment via e-mail or other means. E-MAIL: yamakuni@m.tohoku.ac.jp TEL: 795-6853	
In addition			

Subject	Analytical Chemistry 2					
Course Numbering	YAL-PHA212J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Professor Tomoyuki Oe					
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, 16th Ed. (JP16) 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	Basic of chromatography I	Watching two Videos to image chromatography, followed by overviewing chromatographic methods
5	Oe	Basic 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	Basic of chromatography III	Learning about other chromatography: Ion exchange chromatography, size exclusion chromatography, affinity chromatography
7	Oe	Basic of chromatography IV	Learning about the instrumentation and structures of LC system (pump, detector)
8	Oe	Basic 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 JP16
12	Oe	Qualitative inorganic analysis	Learning about systematic separation and identifications of metal cations (Separation scheme by precipitation and each confirmatory test)
13	Oe	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	Oe	Mass spectrometry II	Overviewing MS and learning about typical ionization methods and mass analyzers
15	Oe	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), 2nd Ed., Ed. J. Haginaka, M. Yamaguchi, M. Chikuma, Nankodo Co., Ltd., 2012 (ISBN 978-4-524-40287-8) Analytical Chemistry II (パートナー分析化学 II), 2nd Ed., Ed. M. Yamaguchi, T. Masujima, H. Nohta, Nankodo Co., Ltd., 2012 (ISBN 978-4-524-40288-5)
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 from molecular mass (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)
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 Shozo Furumoto, Senior Assistant Professor Hiroko Yoshida, Senior Assistant Professor Yoshihito Funaki					
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	Yoshida	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	Yoshida	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	Yoshida	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 4th edition" Publisher: Nankodo Co., Ltd. ISBN978-4-524-40273-1. This textbook is available for purchase at the University Co-op.
Reference	No reference will be used.
Preparation and Review	
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 Takakazu Nakabayashi and Assistant Professor Kunisato Kuroi				
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 molecular 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	Intermolecular Interactions I	Permanent Dipole Moment, Ionic Bond, Molecular Polarizability, Induced Dipole Moment
2	Nakabayashi	Intermolecular Interactions II	Hydrogen Bond, Van der Waals Interaction, Lennard-Jones Potential, Hydrophobic Interaction
3	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
4	Nakabayashi	UV-Vis Absorption Spectroscopy II	Transition Dipole Moment, Franck-Condon Factor, Selection Rules
5	Nakabayashi	UV-Vis Absorption Spectroscopy III. Fluorescence Spectroscopy I	Structural Analysis of Proteins and Nucleic Acids Using UV-Vis Absorption, Jablonski diagram
6	Nakabayashi	Fluorescence Spectroscopy II	Fluorescence Lifetime, Fluorescence Quantum Yield, Radiative and Non-Radiative Rate Constants
7	Nakabayashi	Fluorescence Spectroscopy III	Application of Fluorescent Molecules and Proteins to Biological Science
8	Nakabayashi	Vibrational Spectroscopy I	Basic Concepts of Energy Levels and Wave Functions of Molecular Vibrations
9	Nakabayashi	Midterm Examination, Vibrational Spectroscopy II	Principles and Applications of IR and Raman Spectroscopy
10	Kuroi	Circular Dichroism	Optical Rotatory Dispersion, Structural Analysis of Biomolecules Using Circular Dichroism
11	Kuroi	X-Ray Crystallography I	Classification of Crystal Structures, Miller Indices, Bragg's Law, Fundamentals of Crystal Structure Analysis Using X-Ray Diffraction Pattern
12	Kuroi	X-Ray Crystallography II	Application of Powder and Single Crystal X-Ray Diffraction
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 (30-40%) and the term examination (60-70%).	
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, UniversityScience 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: takan@m.tohoku.ac.jp TEL: 795-6855	
In addition			

Subject	Biochemistory 4				
Course Numbering	YAL-PHA236J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Professor Junken Aoki, Associate Professor Asuka Inoue, Assistant Professor Kuniyuki Kano				
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	Aoki		
2	Aoki		
3	Aoki		
4	Aoki		
5	Inoue		
6	Inoue		
7	Aoki		
8	Aoki		
9	Kano		
10	Aoki		
11	Aoki		
12	Inoue		
13	Inoue		
14	Aoki		
15	Aoki Inoue		

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

Subject	Molecular biology					
Course Numbering	YAL-PHA237J		Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Professor Toshifumi Inada					
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
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 elongation steps of protein synthesis
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	Students are evaluated on their points from all the small tests and attendance (about 15%) and the final examination (about 85%).
Textbook	Essential Biology III
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	
In addition	

Subject	Pharmacology 3				
Course Numbering	YAL-PHA253J	Categories	Elective		
Preferable Participants	2nd	Semester	4	Credits	2
Instructor	Prof. Kohji Fukunaga and Senior Assistant Prof. Shigeki Moriguchi				
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	Fukunaga	Introduction of cardiovascular pharmacology	Students learn the pathology of cardiovascular and kidney diseases and pharmacology of therapeutics acting on circulatory organs.
2	Fukunaga	Cardiovascular therapeutics (1)	Students learn the heart failure and its therapeutics including cardiac glycoside, beta adrenergic agents and angiotensin-converting enzyme inhibitors.
3	Fukunaga	Cardiovascular therapeutics (2)	Students learn the therapeutics for angina including nitrate, calcium channel blockers, vasodilators and beta receptor inhibitors.
4	Fukunaga	Cardiovascular therapeutics (3)	Students learn the antiarrhythmia agents such as sodium channel inhibitors.
5	Fukunaga	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	Fukunaga	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	Fukunaga	Renal therapeutics s	Students learn the regulation of urine formation and the effects of diuretic agents on hypertension and heart failure.
8	Fukunaga	Urinary organ therapeutics	Students learn the therapeutics for dysuria and prostatic hyperplasia.
9	Fukunaga	Genital organ therapeutics	Students learn the agents of uterine construction, uterine relaxant and improving drugs for sexual cycle and functions.
10	Moriguchi	Metabolic disease therapeutics (1)	Students learn the lipid and purine metabolism and the therapeutics for hyperlipidemia and gout.
11	Moriguchi	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	Moriguchi	Eye and skin disease therapeutics	Students learn the therapeutics for eye and skin diseases including glaucoma, atopic dermatitis and decubitus
13	Moriguchi	Anticancer therapeutics (1)	Students learn the mechanism of anticancer regents and the application for typical cancers.
14	Moriguchi	Anticancer therapeutics (2)	Students learn the mechanism for the resistance acquisition and the therapeutics for prevention of side effects of anticancer regents.

15	Fukunaga	Drug-induced suffering	Students learn the cause of harmful side effects and skill for prevention of the drug-induced suffering.
Record and evaluation method		Examination, attendance 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.	
In addition			

Subject	Health Chemistry 1					
Course Numbering	YAL-PHA241J	Categories	Elective			
Preferable Participants	2nd	Semester	4	Credits	2	
Instructor	Professor Atsushi Matsuzawa					
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	Matsuzawa	Toxicity of chemicals (1)	Understanding of the mechanisms of carcinogenesis induced by chemicals and drugs.

13	Matsuzawa	Toxicity of chemicals (2)	Understanding of the mechanisms of tissue damages induced by chemicals and drugs.
14	Matsuzawa	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.	
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: matsushi@m.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 Tetsuya Terasaki, Associate Professor Masanori Tachikawa, and Assistant Professor Yasuo Uchida					
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	Tachikawa	Compartment models-1	Basic concept and principle of one-compartment model Application of one-compartment model for bolus intravenous administration
2	Tachikawa	Compartment models-2	Application of one-compartment model for constant infusion and multiple dosage regimen
3	Tachikawa	Compartment models-3	Application of one-compartment model for the actual cases of dosage regimen
4	Terasaki	Physiologi- cally based pharmaco-kinetic models	Understanding of physiologically based pharmacokinetic (PBPK) model in which the drug distribution process in the tissues. Prediction of the fate of drugs by mathematical PBPK modeling Significance of the PBPK model in the predictions of efficacy, toxicity, safety of new drugs
5	Terasaki	Clearance theory	Clearance theory to formulate the elimination process of drugs Definitions of total body clearance, organ clearance, intrinsic clearance and their relationships
6	Tachikawa	Clinical pharmaco-kinetics	Principles and clinical significance of the dosage regimen design in drug therapeutics
7	Tachikawa	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
8	Tachikawa	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
9	Terasaki	Nonlinear pharmacokinetic s	Processes the show saturation characteristics, e.g., metabolism, membrane transport, and plasma protein binding Principle of nonlinear pharmacokinetics
10	Terasaki	Drug-drug interaction-1	Basic principle of drug-drug interactions Changes in the pharmacological effect of drugs by the other concomitantly administrated drugs
11	Terasaki	Drug-drug interaction-2	Mechanisms and kinetics of drug-drug interactions

12	Terasaki	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	Terasaki	Therapeutic drug monitoring and high molecular-weight drugs	Application of therapeutic drug monitoring for clinical dosage regimen Basic concepts of high molecular-weight drugs
14	Tachikawa	Population pharmacokinetics	Basic concepts of population pharmacokinetics
15	Uchida	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.

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) 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）
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）
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	Hidetoshi Tokuyama				
Objectives and summary of class	This course provides a basis for retrosynthetic analysis of small organic molecules, a problem-solving technique for transforming the structure of a synthetic target to a sequence of progressively simpler structures, to help students develop practical abilities to synthesize small organic molecules.				
Goal of study	Students will develop skills needed to design synthesis of small organic molecules, especially biologically active small molecules.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Tokuyama	Introduction	Introduction to the retrosynthetic analysis
2	Tokuyama	Two-group disconnections	1,2-Disconnections, 1,3-Disconnections
3	Tokuyama	C-C disconnections	Disconnections next to the alkyne group, Synthetic design using the reactivity of carbonyl group
4	Tokuyama	Disconnections next to O-H group	Disconnections next to OH group leading to carbonyl compounds, Functional group interconversion between alcohols and ketones
5	Tokuyama	1,3-Dicarbonyl compounds	Disconnections of β-hydroxycarbonyl compounds, α,β-unsaturated carbonyl compounds, and 1,3-dicarbonyl compounds
6	Tokuyama	1,5-Dicarbonyl compounds	Disconnections of 1,3-dicarbonyl compounds using a retro-Mannich reaction, Synthetic utilities of Robinson annulation and Mannich reaction
7	Tokuyama	Umpolung	Natural reactivity and umpolung, Disconnections of 1,2-difunctional compounds

Record and evaluation method	Evaluation is performed comprehensively based on the submitted Minute Paper and the final examination.
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)
Preparation and Review	Before this course, students are required to overview fundamental organic transformations, which have been learned in Organic Chemistry 1~5. After lecture, students are required to review the contents of the lecture and the problem session of retrosynthetic analysis or building of synthetic plan.
Language Used in Course	Japanese
Office hours	Make an appointment in advance via e-mail. E-mail: tokuyama@m.tohoku.ac.jp
In addition	

Subject	Organic Reaction				
Course Numbering	YAL-PHA229J	Categories	Elective		
Preferable Participants	3rd	Semester	5	Credits	2
Instructor	Professor Masahiko Yamaguchi, Professor Yoshinori Kondo, Associate Professor Mieko Arisawa and Senior Assistant Professor Masanori Shigeno				
Objectives and summary of class	Biologically active compounds often contain nitrogen, oxygen, sulfur, and phosphorus atoms, and students will understand the property and synthesis of such organoheteroatom compounds along with their application to drugs. In addition, students learn organometallic chemistry to synthesize these compounds.				
Goal of study	To be able to understand and explain the chemical property, synthesis of nitrogen, oxygen, sulfur, and phosphorus 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	Yamaguchi Arisawa	Introduction to organo metallic chemistry	History of organometallic chemistry
2	Yamaguchi Arisawa	Metal-carbon bond	18 electron rule and HSAB principle
3	Yamaguchi Arisawa	Synthesis of organometallic compounds 1	Synthesis of main element organometallic compounds
4	Yamaguchi Arisawa	Synthesis of organometallic compounds 2	Synthesis of transition metal organometallic compounds
5	Yamaguchi Arisawa	Reaction of organometallic compounds 1	Reaction of main element organometallic compounds
6	Yamaguchi Arisawa	Reaction of organometallic compounds 2	Reaction of transition metal organometallic compounds
7	Yamaguchi Arisawa	Organometallic catalysis	Catalysis by organometallic compounds
8	Yamaguchi Arisawa	Summary and middle examination	Summary of organometallic chemistry
9	Kondo Shigeno	Introduction to heteroatom chemistry	Outline of organic sulfur and organic phosphorous chemistry
10	Kondo Shigeno	Carbon-heteroatom bond	Nature of carbon-heteroatom bonds
11	Kondo Shigeno	Synthesis of organosulfur compounds	Synthesis of organosulfur compounds
12	Kondo Shigeno	Reaction of organosulfur compounds 1	Transformation of organosulfur compounds
13	Kondo Shigeno	Reaction of organosulfur compounds 2	Synthetic reactions using organosulfur compounds
14	Kondo Shigeno	Synthesis & reaction of organophosphorous compounds 1	Synthesis and transformation of organophosphorous compounds

15	Kondo Shigeno	Synthesis & reaction of organophosphorous compounds 2	Synthesis and transformation of organophosphorous compounds
Record and evaluation method		Evaluated mainly by examination with partial consideration of attendance	
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: yama@m.tohoku.ac.jp （山口教授） TEL: 795-6812 ykondo@m.tohoku.ac.jp（根東教授） 795-6804	
In addition			

Subject	Analytical Chemistry 3					
Course Numbering	YAL-PHA213J	Categories	Elective			
Preferable Participants	3rd	Semester	5	Credits	2	
Instructor	Professor Tomoyuki Oe					
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 date 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), 2nd Ed., Ed. J. Haginaka, M. Yamaguchi, M. Chikuma, Nankodo Co., Ltd., 2012 (ISBN 978-4-524-40287-8) Analytical Chemistry II (パートナー分析化学 II), 2nd Ed., Ed. M. Yamaguchi, T. Masujima, H. Nohta, Nankodo Co., Ltd., 2012 (ISBN 978-4-524-40288-5) 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) 「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 Jun-ichi Anzai				
Objectives and summary of class	The purpose of this course is to learn colloids, high polymers and gels, detergents, 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 colloids, high polymers and gels, detergents, thin films, liposomes, emulsions, microspheres and microcapsules, rheology, and powders.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Term	Lecturer	Theme	Contents
1	Anzai	Colloids	Characteristic features of colloids
2	Anzai	Polymers and gels 1	Characteristic features of polymers and gels
3	Anzai	Polymers and gels 2	Characteristic features of polymers and gels
4	Anzai	Polymers and gels 3	Applications of polymers and gels
5	Anzai	Polymers and gels 4	Biomedical applications of polymers and gels
6	Anzai	Detergents 1	Structure and properties of detergents
7	Anzai	Detergents 2	Thermodynamics of detergents
8	Anzai	Thin films 1	Monomolecular and bimolecular films
9	Anzai	Thin films 2	Multilayer films
10	Anzai	Thin films 3	Bioanalytical applications of thin films
11	Anzai	Liposomes	Preparation and use of liposomes
12	Anzai	Emulsions	Preparation and use of emulsions
13	Anzai	Microsphere microcapsule	Preparation and use of microspheres and microcapsules
14	Anzai	Rheology	Principle of rheology and biomedical applications
15	Anzai	Powders	Characteristic features of powders and applications in drug preparation

Record and evaluation method	Students are evaluated on the small tests (30%) and final test (70%).
Textbook	“Physical Chemistry” ed. by Oshima and Handa, Nankodo (1999)
Reference	none
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.

In addition	

Subject	Pharmacology 4					
Course Numbering	YAL-PHA254J	Categories	Elective			
Preferable Participants	3rd	Semester	5	Credits	2	
Instructor	Associate Professor Takahiro Moriya, Associate Professor Masafumi Nakayama,					
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	Moriya	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	Moriya	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	Moriya	Hormone and drugs (3)	In this course, students will understand the physiological/pathophysiological roles of insulin and learn about drugs for Diabetes Mellitus.
4	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 hemostatic drugs.
5	Moriya	Hematology and drugs (2)	In this course, students will learn about hemostatic drugs and agents to treat anemias.
6	Nakayama	Anti-inflammatory drugs (1)	In this course, students will learn about steroidal anti-inflammatory drugs.
7	Nakayama	Anti-inflammatory drugs (2)	In this course, students will learn about Nonsteroidal Anti-inflammatory Drugs (NSAIDs) and antipyretic analgesics.
8	Nakayama	Immunology and drugs	In this course, students will learn about drugs that act on immuno-system and agents to treat allergy diseases.
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 several mini tests and the midterm and final 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		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: E-MAIL: moriya@m.tohoku.ac.jp TEL: 022-795-3843	
In addition		Materials are provided via ISTU.	

Subject	Environmental Health Science					
Course Numbering	YAL-PHA242J	Categories	Elective			
Preferable Participants	3rd	Semester	5	Credits	2	
Instructor	Associate Professor Gi-Wook Hwang and Assistant Professor Takashi Toyama					
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	Hwang	Overview	History of public health and social significance
2	Hwang	Environmental factors	Relation with environmental parameters and the human health
3	Hwang	Health statistics	Significance of health statistics and method of its evaluation
4	Hwang	Epidemiology	Method and significance of epidemiology
5	Hwang	Prevention	Significance and effect of disease prevention care
6	Hwang	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	Hwang	Global environment	Changes in global environment and human life
10	Hwang	Water 1	Purification system of drinking water
11	Hwang	Water 2	Water pollution and its evaluation
12	Hwang	Air	Air and health
13	Hwang	Air pollution	Significance and evaluation of air pollution
14	Hwang	Occupational health	Cause of the occupational illness and its prevention
15	Hwang	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 participation (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 Tomoyuki Oe)					
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, 16th Ed (JP16) Manual (第１６改正日本薬局方解説書), Editing Committee of Japanese Pharmacopoeia Manual, Hirokawa-Shoten Ltd., 2011 (ISBN 978-4-567-01521-9) Analytical Chemistry I (パートナー分析化学 I), 2nd Ed., Ed. J. Haginaka, M. Yamaguchi, M. Chikuma, Nankodo Co., Ltd., 2012 (ISBN 978-4-524-40287-8) 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 Pharmaceutical Physicochemistry and Laboratory of Bio-Structural Chemistry				
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: Hidetoshi Tokuyama and Hirofumi Ueda (Medicinal Chemistry Laboratory)				
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.				
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

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	平成 29-30 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, 7th Edition, written by R. M. Silverstein, F. X. Webster, and D. J. Kiemle, Wiley (2005)
Preparation and Review	Students must read the relevant sections in the textbook and understand the contents in advance.
Language	Japanese

Used in Course	
Office hours	Make an appointment in advance. E-mail: tokuyama@m.tohoku.ac.jp, Phone: 022-795-6887
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: Yoshiharu Iwabuchi and Naoki Kanoh (Synthetic Chemistry Laboratory) Yoshiteru Oshima and Haruhisa Kikuchi (Natural Products Chemistry Laboratory)				
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	平成 28-29 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, 7th Edition, written by R. M. Silverstein, F. X. Webster and D. J. Kiemle, Wiley (2005)
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 by phone. 022-795-6846 (Iwabuchi), 022-795-6822 (Oshima)
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 and Biochemical Toxicology, Gene Regulation				
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 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. - Learning the methods and handling skills of RNA for the detection of mRNA in the cell. Obtaining the purification techniques of huge cellular ribonucleoprotein complex. Understanding of the quality control system to maintain the gene expression homeostasis.				
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				

Training Contents

【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) Quantification and purification of proteins/enzymes

Separation and isolation of proteins, 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

【 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.

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 enzyme activity.

3) Analyses of gene expression using reporter genes

Detecting the expression of innate immune responsive genes using reporter genes in cultured cells.

【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 gene transfer between *E. coli* (bacterial conjugation) by observing the newly acquired phenotypes. Furthermore, this practical training performs the introduction of gene into the *E. coli* (transformation).

【Molecular Biology】
1) Detection and quantification of mRNA I (RT-PCR)
mRNA is first converted into a complementary DNA (cDNA) by reverse transcriptase, and then amplified by PCR.

2) Detection and quantification of mRNA II (Northern Blotting)
mRNA in the cell is analyzed by Northern Blotting.

Discussion about the differences between RT-PCR and Northern Blotting.

3) Purification of RNP (Ribonucleoprotein complex) by immunoprecipitation.
Ribosome, which is protein synthesis machine in the cell, is purified by immunoprecipitation via ribosome protein fused epitope tag.

Record and evaluation method	Evaluate submitted report, attendance, and class participation. Details will be explained in the first lecture session.
Textbook	
Reference	
Preparation and Review	
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				
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 submitted report, attendance and so on.
Textbook	Textbooks will be provided.
Reference	References will be provided as necessary.
Preparation and Review	
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	Associate Professor Haruhisa Kikuchi					
Objectives and summary of class	Natural products are very important for developing drugs. This course aims to learn about structures, chemical properties and biological activities of natural products.					
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	Kikuchi	Natural products in drug discovery (1)	This lecture aims to learn about natural products used as pharmaceuticals and their lead compounds.
2	Kikuchi	Natural products in drug discovery (2)	The same as above.
3	Kikuchi	Natural products in drug discovery (3)	The same as above.
4	Kikuchi	Natural products in drug discovery (4)	The same as above.
5	Kikuchi	Natural products in drug discovery (5)	The same as above.
6	Kikuchi	Discovery of natural resources	This lecture aims to learn about discovery of natural resources for drug discovery.
7	Kikuchi	Isolation of natural products (1)	This lecture aims to learn about methods of extraction and isolation of natural products.
8	Kikuchi	Isolation of natural products (2)	The same as above
9	Kikuchi	Antibiotics (1)	This lecture aims to learn about antibiotics used as antibacterials, antifungals, anticancers and so on.
10	Kikuchi	Antibiotics (2)	The same as above
11	Kikuchi	Antibiotics (3)	The same as above
12	Kikuchi	Antibiotics (4)	The same as above
13	Kikuchi	Antibiotics (5)	The same as above
14	Kikuchi	Production of antibiotics (1)	This lecture aims to learn about methods for production of antibiotics.
15	Kikuchi	Production of antibiotics (2)	The same as above

Record and evaluation method	Evaluation is performed comprehensively based on attendance and written examination.
Textbook	「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（2008）
Reference	「天然生理活性物質の化学」　多田全宏編、宣協社（2000） 「天然物化学改訂第５版」田中　治、野副重男、相見則郎、永井正博編、南江堂（1998） 「薬用資源学」山崎幹夫、斉藤和季編、丸善（1997）
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: hal@mail.pharm.tohoku.ac.jp　Tel: +81-22-795-6824
In addition	

Subject	Organic Synthesis					
Course Numbering	YPS-PHA322J		Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2	
Instructor	Hidetoshi, Tokuyama, Yoshiharu Iwabuchi, Naoki Kanoh					
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	Tokuyama	Introduction to the Total Synthesis	What is total synthesis, What is convergence and linearity in total synthesis
2	Tokuyama	Functional group transformation	Representative functional group transformation, Oxidation, Reduction
3	Tokuyama	Chemoselectivity	Chemoselective transformation, Protective group in organic synthesis
4	Tokuyama	Regioselectivity	Regioselective transformations and their reaction mechanisms
5	Tokuyama	Stereoselectivity	Stereoselective transformations and their reaction mechanisms
6	Tokuyama	Asymmetric synthesis	Optical resolution, Enantioselective reaction, Chiral pool, Enzymatic reaction
7	Tokuyama	Practical organic synthesis	Review of practical organic synthesis
8	Iwabuchi/ Kanoh	Terpene	Selected total synthesis of terpenes
9	Iwabuchi/ Kanoh	Steroid	Selected total synthesis of steroids
10	Iwabuchi/ Kanoh	Prostaglandin	Selected total synthesis of prostaglandins
11	Iwabuchi/ Kanoh	Macrolide	Selected total synthesis of macrolides
12	Iwabuchi/ Kanoh	Alkaloid (1)	Selected total synthesis of alkaloids
13	Iwabuchi/ Kanoh	Alkaloid (2)	Selected total synthesis of alkaloids
14	Iwabuchi/ Kanoh	Alkaloid (3)	Selected total synthesis of alkaloids
15	Iwabuchi/ Kanoh	Alkaloid (4)	Selected total synthesis of alkaloids

Record and evaluation method	Students are evaluated on their points from all the short test and the final examination (80% total) and the level of class participation (20%)
Textbook	
Reference	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. E-mail: tokuyama@m.tohoku.ac.jp (Tokuyama), nkanoh@m.tohoku.ac.jp (Kanoh)
In addition	

Subject	Medicinal Chemistry 2				
Course Numbering	YPS-PHA323J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	1
Instructor	Professor Takayuki Doi				
Objectives and summary of class	In this course, students will learn about concept and development of historical and genomic drug discovery.				
Goal of study	· Students can explain about drug discovery, patent, pharmacophore, biological equivalence, and structure-activity relationships. · Students can illustrate 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	Doi	Drug Discovery (1)	Historical drug discovery
2	Doi	Drug Discovery (2)	Genonic drug discovery
3	Doi	Drug Discovery (3)	Patents and generic drugs
4	Doi	Target Molecules (1)	Drug targets
5	Doi	Structures of Drugs (2)	Pharmacophores and biological equivalence in the structures of drugs.
6	Doi	Typical Drug (1)	Biological mechanisms based on the structures of drugs and targets
7	Doi	Typical Drug (2)	Biological mechanisms based on the structures of drugs and targets
8	Doi	Typical Drug (3)	Biological mechanisms based on the structures of drugs and targets

Record and evaluation method	Students are evaluated on the final examination (100%).
Textbook	Basic Pharmaceutical Textbook Series 6, Pharmaceutical Science and Medicinal Chemistry, Kagakudojin (2011)
Reference	The Practice of Medicinal Chemistry, second edition/ C. G. Wermuth, ELSEVIER LIMITED (2003)
Preparation and Review	
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 TEL: 795-6865
In addition	

Subject	Structure Analysis of Organic Compound					
Course Numbering	YPS-PHA324J	Categories	Elective			
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2	
Instructor	Yoshiteru Oshima, Masahiko Yamaguchi, Yoshinori Kondo, Yoshiharu Iwabuchi, Takayuki Doi, Hidetoshi Tokuyama, Naoki Kanoh, Haruhisa Kikuchi, Mieko Arisawa, Masahito Yoshida, Hirofumi Ueda, Masanori Shigeno, Nozomi Saito, Yusuke Sasano, Juri Sakata, Saori Tanii					
Objectives and summary of class	This course aims to improve the students' ability to interpret spectra (NMR, IR, UV-Vis, and MS spectra) of simple organic molecules and to identify organic structures from their spectra. The course will have problem-solving sessions throughout, thus each student will be responsible for leading one of the sessions.					
Goal of study	Students will develop the basic abilities necessary to interpret spectra of organic molecules and to identify organic structures from their spectra.					
Method of class	[Lecture] · [Practice] · Training · On-site training · SGD · PBL · Roleplay · e-learning · Others( )					

Term	Lecturer	Theme	Contents
1	Oshima	MS and IR spectra	Principle of mass spectrometry (MS) and infrared (IR) spectroscopy
2	Oshima	NMR and UV-Vis spectra-1	Principle of nuclear magnetic resonance (NMR) spectrometry and ultraviolet (UV)-Visible (Vis) spectroscopy
3	Oshima	NMR and UV-Vis spectra-2	Principle of nuclear magnetic resonance (NMR) spectrometry and ultraviolet (UV)-visible light (Vis) spectroscopy
4	Iwabuchi/ Arisawa	Aliphatic compounds-1	Spectrometric identification of aliphatic compounds
5	Doi/ Ueda	Aliphatic compounds-2	Spectrometric identification of aliphatic compounds
6	Tokuyama/ Kikuchi	Aliphatic compounds-3	Spectrometric identification of aliphatic compounds
7	Shigeno/ Sasano	Aromatic compounds-1	Spectrometric identification of aromatic compounds
8	Kondo/ Yoshida	Alcohols	Spectrometric identification of alcohols
9	Yamaguchi /Kanoh	Aldehydes	Spectrometric identification of aldehydes
10	Yamaguchi /Kikuchi	Ketones	Spectrometric identification of ketones
11	Iwabuchi/ Sakata	Carboxylic acids	Spectrometric identification of carboxylic acids
12	Doi/ Ueda	Esters	Spectrometric identification of esters
13	Tokuyama/ Yoshida	Amines	Spectrometric identification of amines
14	Shigeno/ Tanii	Phenols	Spectrometric identification of phenols
15	Kondo/ Arisawa	Summary	Summary of spectrometric identification of organic molecules

Record and evaluation method	Presentations and class participation (25%), the midterm and final examinations (75%)
Textbook	

Reference	Spectrometric identification of organic compound, 7th edition (translated in Japanese), written by R. M. Silverstein, F. X. Webster and D. J. Kiemle, translated by S. Araki, O. Yamamoto, T. Kamata, Tokyo Kagaku Dojin (2006)
Preparation and Review	
Language Used in Course	Japanese
Office hours	Make an appointment in advance via e-mail. E-mail: yama@m.tohoku.ac.jp, arisawa@m.tohoku.ac.jp, Phone: 795-6812, 795-6814
In addition	

Subject	Principles of Clinical Medicine				
Course Numbering	YPS-PHA301J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	2
Instructor	Hiroshi Sato, Nobuyuki Takahashi, Mutsuo Yamaya, Hiroo Matsuoka, Jun-ichi Kameoka, Takahiro Arima, Takeshi Naito, Masakazu Ichinose, Toshiaki Abe, Yugo Ashino, Nobuhisa Nakajima, Tomonori Ishii, Yoichi Kakuta, Hiroaki Akai				
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	Sato	General Internal Medicine	Students learn about diagnostic process for various disease including medical interviews, physical examinations, clinical laboratory tests, and so on.
2	Sato	Recent Advance in CKD	Students learn about the concept of chronic kidney disease (CKD) which is important as an underlying condition of end-stage renal failure and cardiovascular disease.
3	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.
4	Akai	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.
5	Yamaya	General Geriatrics	In this course, students will understand the characteristics, pathogenesis, treatment, care and/or prevention of diseases developed in the elderly adults by learning about the pathogenesis, treatment, care and/or prevention of aspiration pneumonia and chronic obstructive pulmonary diseases.
6	Matsuoka	Etiology and Treatment of Psychiatric Disorders	Students learn about the pathogenesis and treatment of endogenous, exogenous and psychogenic mental disorders.
7	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.

8	Arima	General Reproductive Medicine	This course covers general aspects of reproductive medicine. In addition, students learn about the precautions in a medication of pregnant female.
9	Ishii	Rheumatism and Collagen Diseases	This course covers recent advance in the diagnosis and treatment for collagen diseases including rheumatoid arthritis.
10	Naito	General Surgery	This course covers recent advance in endoscopic surgery including bariatric surgery.
11	Ichinose	Respiratory Disease	This course covers recent advance in the diagnosis and treatment for respiratory diseases.
12	Abe	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	Ashino	Infectious Diseases	This course covers recent advance in the diagnosis and treatment for various infectious diseases including HIV infection.
14	Nakajima	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	Kakuta	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 report, attendance and so on
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: hsymhs2i@m.tohoku.ac.jp (Hiroshi Sato).
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	Prof. Yoshihisa Tomioka, Prof. Noriyasu Hirasawa, Koji Ikeda, Ryoichi Nagatomi, Koichi Yoshinari, Yoshiteru Kamiyama, Shinichi Miura, Shigekazu Fujita, Hiroaki Yamada, Shoji Takamatsu, Ryosuke Nakamura, Yoshiro Saito				
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	Miura		
2	Kamiyama		
3	Fujita		
4	Ikeda		
5	Yamada		
6	Takamatsu		
7	Yoshinari		
8	Yoshinari		
9	Nakamura		
10	Nakamura		
11	Saito		
12	Saito		
13	Nagatomi		
14	Hirasawa Tomioka	SGD	
15	Hirasawa Tomioka	SGD	

Record and evaluation method	
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	

In addition	

Subject	Imaging Diagnosis				
Course Numbering	YPS-PHA303J	Categories	Elective		
Preferable Participants	3rd [Pharmaceutical Sciences]	Semester	6	Credits	1
Instructor	Professor Shozo Furumoto and Professor Zhang Ming-Rong				
Objectives and summary of class	This course will provide lectures about radiopharmaceuticals used for medical imaging diagnosis, especially on PET radiopharmaceuticals, and about their preparations and principles of imaging diagnosis using them. Additionally, this course will provide state-of-the-art knowledge about current status and a prospect of PET imaging which plays an important role in drug developments and modern molecular imaging researches.				
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 agents (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 agents (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	Zhang	Imaging agents for neurotransmitters (I)	In this class, students learn how to develop a useful in vivo imaging agent for neurotransmitters, such as receptors, enzymes, and transporters.
5	Furumoto	Imaging agents for neurotransmitters (II)	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	Production and quality control of PET radiopharmaceuticals	In this class, students learn the production, quality control and safety evaluation of PET radiopharmaceuticals for clinical usefulness.
7	Zhang	Molecular imaging probes and microdosing	In this class, students learn the usefulness of PET and molecular probes in microdosing clinical study and developmental study of new drugs.

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	
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	Takahiro Kimura, Tsuyoshi Ishibashi					
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( )					

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, GVP, and GPSP.
3	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 comprehensively based on class participation and the final examination.
Textbook	"The commentary of pharmaceutical laws, system, and ethic, 2017-18 version," Yakujinippou Corporation "The pharmaceutical related laws, revision 4th version," Nankodo Corporation

Reference	“The text book pharmaceutical industry, 2017-18 version,” Japan Pharmaceutical Manufacturers Association “Pharmaceutical hygiene compendium of laws, 2016 version,” Yakujinippou Corporation “The commentary of Pharmaceutical and Medical Device Act, Pharmacist Act, and Poisonous and Deleterious Substances Control Act,” Yakujinippou Corporation “Pharmaceutical laws and ordinances handbook, 2016 version,” Yakujinippou Corporation “Pharmaceutical laws and ordinances handbook, the approval permission requirement, 7th version,” 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				
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Training Contents					
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				
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Training Contents					
Record and evaluation method	Evaluated by the supervisor of the laboratory.				
Textbook					
Reference					
Office hours					
In addition					

Subject	Outline of Hospital Pharmacy				
Course Numbering	YPH-PHA371J	Categories	Elective		
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	2
Instructor	Hiroshi Sato, Nobuyuki Takahashi, Mutsuo Yamaya, Hiroo Matsuoka, Jun-ichi Kameoka, Takahiro Arima, Takeshi Naito, Masakazu Ichinose, Toshiaki Abe, Yugo Ashino, Nobuhisa Nakajima, Tomonori Ishii, Yoichi Kakuta, Hiroaki Akai				
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	Sato	General Internal Medicine	Students learn about diagnostic process for various disease including medical interviews, physical examinations, clinical laboratory tests, and so on.
2	Sato	Recent Advance in CKD	Students learn about the concept of chronic kidney disease (CKD) which is important as an underlying condition of end-stage renal failure and cardiovascular disease.
3	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.
4	Akai	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.
5	Yamaya	General Geriatrics	In this course, students will understand the characteristics, pathogenesis, treatment, care and/or prevention of diseases developed in the elderly adults by learning about the pathogenesis, treatment, care and/or prevention of aspiration pneumonia and chronic obstructive pulmonary diseases.
6	Matsuoka	Etiology and Treatment of Psychiatric Disorders	Students learn about the pathogenesis and treatment of endogenous, exogenous and psychogenic mental disorders.
7	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.

8	Arima	General Reproductive Medicine	This course covers general aspects of reproductive medicine. In addition, students learn about the precautions in a medication of pregnant female.
9	Ishii	Rheumatism and Collagen Diseases	This course covers recent advance in the diagnosis and treatment for collagen diseases including rheumatoid arthritis.
10	Naito	General Surgery	This course covers recent advance in endoscopic surgery including bariatric surgery.
11	Ichinose	Respiratory Disease	This course covers recent advance in the diagnosis and treatment for respiratory diseases.
12	Abe	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	Ashino	Infectious Diseases	This course covers recent advance in the diagnosis and treatment for various infectious diseases including HIV infection.
14	Nakajima	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	Kakuta	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 report, attendance and so on
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: hsymhs2i@m.tohoku.ac.jp (Hiroshi Sato).
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	Hiroshi Sato, Ichiro Tsuji, Takuhiro Yamaguchi, Yasutake Tomata, Masaki Matsuura, Hironori Nakamura, Naoyuki Kurokawa, Michihiro Satoh					
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	Tomata	Basic Statistics	Students learn about principal statistical tools used in the field of pharmacostatistics.
4	Satoh M	Statistics of Investigative Research	Students learn about investigative research such as pharmacoepidemiology associated with pharmacist activity, and learn about the related statistical methods.
5	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.
6	Kurokawa	Introduction to Meta-analysis	Students learn about the concept of meta-analysis, and about the related statistical methods.
7	Tsuji	Statistics of EBM	Students learn about the concept of evidence-based medicine, and about the related statistical methods.
8	Sato H	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 report, attendance and so on.
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: hsymhs2i@m.tohoku.ac.jp (Hiroshi Sato).
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 Tamaki Yano					
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. This course provides students the basic knowledge and deeper understanding of immune system.					
Goal of study						
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	Innate immunity	To understand the importance of innate immunity as a frontline of host defense, and learn about the innate immune system.
9	Yano	Complement system	To learn complement pathways and the functions of complement in immunity.
10	Yano	Mucosal immune system	To understand the characteristic properties of mucosal immune system, especially intestinal immunity.
11	Yano	Failures of host defense mechanism	To understand the host-pathogen interactions and learn about immune-deficiency syndrome.
12	Yano	Allergy	To learn effector mechanisms in allergic reactions.
13	Yano	Autoimmunity	To understand that autoimmune response are directed against self-antigens, and learn the mechanism under the autoimmune disease.
14	Yano	Immunologists' toolbox	To learn techniques using antibodies and lymphocytes as research and diagnostic tools.
15	Yano	General discussion	To have a general understanding of immune system and diseases caused by immune defect though discussions.

Record and evaluation method	Evaluate the examination (about 95%) and small tests (about 5%)
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: tyano@m.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	Associate Professor Gi-Wook Hwang and Assistant Professor Takashi Toyama				
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	Hwang	Overview	System and law relating to food hygiene administration, food poisoning occurrence and food contaminants
2	Hwang	Food and human health	Social significance which relates to consider human health from eating habits Novel type food with health function
3	Hwang	Food safety	Diversified food contamination Basic measures to ensure the food safety General food safety evaluation method
4	Hwang	Oral infections and food poisoning	Difference of between food poisoning and oral infection Characteristic of pathogens involving food poisoning and oral infection
5	Hwang	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	Hwang	Natural toxin	Plant toxin and animal toxin Mycotoxin
7	Toyama	Mutagen and carcinogen	Initiation and promotion in carcinogenesis Oncogene and tumor suppressor gene
8	Hwang	Food spoilage	Food spoilage and its prevention
9	Hwang	Food contamination 1	Organic halogen compounds and metal remaining in the food
10	Hwang	Food contamination 2	Endocrine disrupting substances and radioactive substances remaining in the food
11	Hwang	Pesticide residues	Pesticide residues and its safety
12	Hwang	Food additive	Food additive and its safety
13	Hwang	Genetically modified organism	Genetically modified organism and its safety
14	Hwang	Safety assessment of chemicals	Chemical substances control law Guidelines for the testing of chemicals

15	Hwang	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 participation (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	Prof. Junken Aoki, Prof. Yoshihisa Tomioka, Senior Assis. Prof. Yotaro Matsumoto, Assis Prof. Hiroki Tsukamoto				
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	Aoki		
2	Aoki		
3	Aoki		
4	Aoki		
5	Aoki		
6	Aoki		
7	Aoki		
8	Aoki		
9	Aoki		
10	Tomioka		
11	Tomioka		
12	Tomioka		
13	Matsumoto		
14	Matsumoto		
15	Tsukamoto		

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

Subject	Pathology				
Course Numbering	YPH-PHA375J	Categories	Elective		
Preferable Participants	3rd	Semester	6	Credits	2
Instructor	Hironobu Sasano, Yasuhiro Miki, Ryoko Saitoh, Yasuhiro Nakamura, Mareyuki Endoh, Kiyoshi Takagi, Junji Takeyama, Masaru Sasaki, Yukiko Shibahara, and Keely McNamara				
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. In parallel to the theoretical component above, it is imperative for the students in pharmacy to observe the practical elements involved in pathological work in order to fully understand the theory above. Therefore students may be able to observe the autopsy and how the histology or cytology specimens are produced in the laboratory, thus giving them a practical as well as theoretical understanding of pathology.				
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	Sasano	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	Sasano	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 neoplasms (cancer) including; their etiology or pathogenesis, the impact of cancers upon patient quality of life and the causes of cancer mortality.
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	Saitoh	Respiratory Pathology	The morphology of respiratory tract changes in variable ways depending on its surrounding environment. Pathological findings of lung tissues influenced by external stimuli, as well as lung tumor tissues will be covered in this lecture.
6	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
7	Endoh	Pathology of Liver, Gastrointestinal tract, and Kidney	These lecture 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

8 9	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).
10	Takeyama	Prenatal pathology	This component focuses on the physiology and histology of placenta. Placenta pathologies as they relate to fetal development are also covered.
11	Sasaki	Oral pathology	The mouth is an important organ with many different functions. Of particular interest to pharmacologists is the Oral mucosal barrier system. This lecture will cover the pathogenesis of the lesions of oral mucosa and salivary glands.
12 13	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.
14 15	McNamara	Intracrinology in breast and prostate cancers	Intracrinology refers to the ability of certain tissues to take steroid hormones from the circulation and then metabolize them in order to create tissue specific steroid profiles. These lectures will cover the background to intracrinology and how this process can be altered in breast and prostate cancer cells in order to allow unconstrained growth. This field is of interest, not only because it offers a way to further understanding of cancer biology but also because there are a number of potential ways in which intracrinology can be exploited pharmacologically for the benefit of the patients.

Record and evaluation method	Students are evaluated on the final exam or final report in some cases.
Textbook	Simple Pathology Revised 7 Edition NANKODO
Reference	
Preparation and Review	
Language Used in Course	Term1-13: Japanese, Term14-15: English
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	During winter breaks (form December to January), students (applicants) may possibly observe autopsy in Tohoku University Hospital.

Subject	Human Genomics					
Course Numbering	YPH-PHA333J	Categories	Required			
Preferable Participants	3rd [Pharmacy]	Semester	6	Credits	1	
Instructor	Toshifumi Inada					
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 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 termination.
7	Inada	Modification of gene expression and drug discovery II	Current state of drug discovery due to modification of the translation reaction.
8	Inada	Modification of gene expression and drug discovery III	Drug therapy by the modification of the RNA processing reactions.

Record and evaluation method	Students are evaluated on their points from all the small tests and attendance (about 15%) and the final examination (about 85%).
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: tinada@m.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	Professor Takayuki Doi, Associate Professor Haruhisa Kikuchi, and Assistant Professor Masahito Yoshida					
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	Kikuchi	The chemistry of sugars (1)	This lecture aims to understand about monosaccharides, polysaccharides, and glycosides.
2	Kikuchi	The chemistry of sugars (2)	This lecture aims to understand about physiological activities of polysaccharide.
3	Kikuchi	The chemistry of lipids (1)	This lecture aims to understand about chemical structures of lipids.
4	Kikuchi	The chemistry of lipids (2)	This lecture aims to understand about chemical structures and physiological activities of lipid derivatives.
5	Doi	The chemistry of amino acids and peptides	This lecture aims to understand about chemical structures and physiological activities of amino acids and peptides.
6	Doi	The chemistry of proteins	This lecture aims to understand about secondary and tertiary structures and physiological activities of proteins.
7	Doi	The chemistry of nucleic acids (1)	This lecture aims to understand about chemical structures and physiological activities of nucleic acids, RNA and DNA.
8	Doi	The chemistry of nucleic acids (2)	The same as above
9	Kikuchi	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	Kikuchi	Structure analysis (2)	The same as above
11	Kikuchi	Structure analysis (3)	The same as above
12	Doi Yoshida	Structure analysis (4)	The same as above
13	Doi Yoshida	Structure analysis (5)	The same as above
14	Doi Yoshida	Structure analysis (6)	The same as above
15	Doi Yoshida	Structure analysis (7)	The same as above

Record and evaluation method	Evaluation is performed comprehensively based on attendance, submitted report, and written examination.
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 manual.
In addition	

Subject	Health Chemistry 2				
Course Numbering	YPH-PHA341J	Categories	Elective		
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2
Instructor	Professor Atsushi Matsuzawa				
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	Matsuzawa	Immune system	Understanding of basic immune system.
9	Matsuzawa	Immunity and food allergy	Students learn the mechanisms of allergy by immunity, and especially understand the factors of food allergy.
10	Matsuzawa	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.	
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: matsushi@m.tohoku.ac.jp TEL: 795-6827	
In addition		The most of lecture contents are included in pharmacist national examination guidelines.	

Subject	Outline of Hospital Pharmacy 2					
Course Numbering	YPH-PHA361J	Categories	Elective			
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2	
Instructor	Kiyotaka Naoe, Akira Toyama, Teiko Toyoguchi, Makoto Hayakari, Naoto Suzuki, Eiji Shimanuki					
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	Toyama 4/11		
2	Suzuki 4/18		
3	Toyoguchi 4/25		
4	Hayakari 5/2		
5	Toyoguchi 5/9		
6	Hayakari 5/16		
7	Toyoguchi 5/23		
8	Toyama 5/30		
9	Hayakari 6/6		
10	Suzuki 6/13		
11	Suzuki 6/20		
12	Toyoguchi 6/27		
13	Toyama 7/4		
14	Shimanuki 7/11		
15	Naoe 7/18		

Record and evaluation method	
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	

In addition	

Subject	Pharmacotherapeutics 1				
Course Numbering	YPH-PHA372J	Categories	Elective		
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2
Instructor	Prof. Yoshihisa Tomioka, Senior Assis. Prof. Yotaro Matsumoto, Assis. Prof. Hiroki Tsukamoto, Atsuhiro Sugitachi				
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	Tomioka 4/11		
2	Tomioka 4/18		
3	Tomioka 4/25		
4	Sugitachi 5/2		
5	Tomioka 5/9		
6	Tomioka 5/16		
7	Tomioka 5/23		
8	Tomioka 5/30		
9	Tomioka 6/6		
10	Tsukamoto 6/13		
11	Tsukamoto 6/20		
12	Matsumoto 6/27		
13	Matsumoto 7/4		
14	Matsumoto 7/11		
15	Matsumoto 7/18		

Record and evaluation method	
Textbook	
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	

In addition	

Subject	Medical Informatics					
Course Numbering	YPH-PHA362J	Categories	Elective			
Preferable Participants	4th	Semester	7	Credits	2	
Instructor	Nariyasu Mano, Masahiro Hiratsuka, Hiroaki Yamaguchi, Taku Obara, Masaki Matsuura, Youko Fujimoto, Mayumi Sato, Kazutoshi Akasaka, Masafumi Kikuchi					
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	In this course, students will understand position of various medical information generated in medical care, and catch an outline of drug safety management.
2	Hiratsuka	Medical Informatics	In this course, students will understand the positioning and needs of medical information in clinical setting.
3	Hiratsuka	Development and communications of medical information	In this course, students will understand the information collected by the process from development of medicines to the post marketing surveillance, how to be done the communication, and pharmaceutical regulatory-system.
4	Hiratsuka	Kind and the feature of the source of medical information (1)	In this course, students will understand a legal basis of a package insert of medicines and confirms the mentioning item as well as understands those point of view and way to read. Students will understand the meaning of the terminology used for a package insert, the degree of processing of the information of medicines and the how to use.
5	Hiratsuka	Kind and the feature of the source of medical information (2)	In this course, students will understand the point of view, the way to read and directions of the interview form. Students will understand the degree of the processing of the interview form and the how to use.
6	Hiratsuka	Study design about the validity of the medicines	In this course, students will understand the study design to estimate data about the validity of the medicines produced by clinical study and an epidemiologic study.
7	Sato	The use of medical information in prescription inspection	In this course, students will understand patient information to be utilized in prescription inspection as well as the variety of medical information.
8	Matsuura	Medical facility-specific information and regional cooperation network	In this course, students will learn about information and utilization examples of medical institutions that can be read from the DPC data.
9	Fujimoto	How to write and how to read the medical records	The medical record, which contains information about the history of important patient in determining the treatment plan. In this course, students will learn about the rules of the description and reading of the medical records.

10	Akasaka	The use of medical information in inpatient pharmaceutical service	In this course, students will understand the prescription, medication history, laboratory values data and learn about the use of information, such as electronic medical records and conditions.
11	Akasaka	The use of medical information in the emergency and critical care center and ICU	In this course, students will understand the collection and provision of the medical information for emergency and critical care center and ICU.
12	Kikuchi	Cancer chemotherapy and regional cooperation	In this course, students will understand the information about the safe and effective cancer chemotherapy to be provide to the community pharmacy.
13	Obara	Use of medical big data	In this course, students will understand the properties and the use of various medical big data.
14	Yamaguchi	Use of medical information for the promotion of personalized medicine	In this course, students will understand the personalized medicine based on medical information including blood concentration of drugs and genetic information.
15	Mano, Hiratsuka, Yamaguchi	Advanced case analysis	Neoplastic Disorders; joint program with 'Pharmacotherapeutics 1' and 'Medical Informatics')
Record and evaluation method		Evaluation is performed based on examination and attendance.	
Textbook			
Reference		References will be handed out at every class.	
Office hours			
In addition			

Subject	Kampo Medicine					
Course Numbering	YPH-PHA376J	Categories	Elective			
Preferable Participants	4th [Pharmacy]	Semester	7	Credits	2	
Instructor	Professor Makoto Arai					
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.					
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/ Introduction to Japanese herbal medicine (Kampo Medicine) and Japanese Health Care	The outline of the presentation is shown as follows; 1) Overview of the health insurance system in Japan, 2) History of Kampo medicine, 3) Present situation of Kampo medicine, 4) Strategies to promote the introduction of Kampo medicine into health insurance system, 5) How to convince the clinicians to accept the safety, and 6)

		System (in English)	Pharmaceutical price and herbal resource
Record and evaluation method		Evaluation is performed based on attendance, submitted reports and so on.	
Textbook		The textbook are handed out at every class.	
Reference		Shorei de wakaru Kampo-yaku nyumon (Introduction to Kampo medicine) by Makoto Arai (Nichu shuppan)	
Preparation and Review			
Language Used in Course		Japanese / English	
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	Hiroshi Sato, Nobuyuki Takahashi, Akira Sugawara, Yoichi Arai, Setsuya Aiba, Tetsuyuki Kitamoto, Kazuhiko Yanai, Hiroaki Simokawa, Takafumi Hasegawa, Ikuma Fujiwara, Shin Fukudo, Yutaka Kagaya, Masanobu Takahashi, Toshio Yamagishi				
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	Sato	Etiology and Treatment of Renal Failure	With the advent of super-aging society, medical staffs encounter an increasing number of patients with potential renal insufficiency. Students learn about treatment precaution for the patients with renal failure.
2	Sato	Glomerulonephritis and Nephrotic Syndrome	Students learn about the disease state and treatment of commonly-noted renal diseases, i.e. glomerulonephritis, nephrotic syndrome, and diabetic nephropathy.
3	N. Takahashi	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.
4	Sugawara	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.
5	Arai	Treatment for overactive bladder	Overactive bladder is common disease in elderly people. The purpose of this course is to understand the mechanism of micturition and to learn the recent advance in overactive bladder treatment.
6	Aiba	Clinical Features of Skin Diseases and Topical treatment	This course covers recent advance in the diagnosis and treatment for dermatological disease.
7	Kitamoto	Concept and Treatment of Prion Disease	The purpose of this course is to understand the prion protein conversion, propagation of abnormal form, and the history of the iatrogenic cases of Creutzfeldt-Jakob disease.
8	Yanai	Clinical Pharmacology, General Consideration	Clinical pharmacology is the science of drugs and their clinical use. It also deals with the management of clinical trial and drug development. In this lecture, we will learn the recent progress on the management process including Declaration of Helsinki and other guideline, good clinical practice (GCP), institutional review board (IRB), informed consent (IC), translational research (TR) center and clinical research coordinators (CRC).

9	Shimokawa	Cardiovascular Disease, from the General to the Particular	This course covers recent advance in the diagnosis and treatment for cardiovascular diseases including ischemic heart disease and heart failure.
10	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.
11	Fujiwara	Bone Metabolism and Pharmacotherapy	Students learn about the principle of bone and mineral metabolism, and about recent advance in the diagnosis and treatment for bone metabolism disorders including osteoporosis.
12	Fukudo	Psychosomatic Medicine	This course covers recent advance in the diagnosis and treatment for psychosomatic disease.
13	Kagaya	Therapeutic Agents for Cardiovascular Diseases; Focusing on Coronary Heart Disease and Chronic Heart Failure	Students learn about therapeutic agents for coronary heart disease including angina pectoris and myocardial infarction and those for chronic heart failure that can be induced by coronary heart disease and dilated cardiomyopathy. The students focus on the mechanisms of action and how to prescribe them. Students also understand the results of clinical trials that support the use of those therapeutic agents.
14	M. Takahashi	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	Yamagishi	Electrolyte Abnormalities and Pharmacotherapy	This course provides explanations of the classification of electrolyte abnormalities and pharmacotherapy based on clinical examples.

Record and evaluation method	Students are evaluated based on submitted report, attendance and so on.
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: hsymhs2i@m.tohoku.ac.jp (Hiroshi Sato).
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 Tetsuya Terasaki, Associate Professor Masanori Tachikawa, and Assistant Professor Yasuo Uchida					
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. Students are required to get the practical skills of presentation and communication in terms of clinical pharmaceutics. 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					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Terasaki	Clinical application of drug dosage regimen-1	Case studies: mechanisms and kinetics of drug-drug interactions in clinics
2	Terasaki	Clinical application of drug dosage regimen-2	Case studies: mechanisms and kinetics of the pathological changes in absorption, distribution, metabolism and elimination (ADME) and inter-individual differences in clinics
3	Terasaki	Clinical application of drug dosage regimen-3	Molecular basis of the drug dosage regimen in clinics
4	Terasaki	Formulation and bioavailability	Importance of drug formulation and its effects on bioavailability
5	Tachikawa	Basic pharmaco-dynamics	Basic concept of pharmacodynamics (PD) Relationship between the efficacy and the blood-concentration of drugs Principle of pharmacokinetic (PK) and PD theory
6	Tachikawa	Applied pharmaco-dynamics	Clinical application of the PK/PD theory
7	Uchida	Practice on pharmaco-kinetic modeling-1	Computer-based simulation by physiologically based pharmacokinetic models Analysis of time-concentration curves in the blood and tissues after intravenous administration Design of basic pharmacokinetic parameters
8	Uchida	Practice on pharmacokinetic modeling-2	Analysis of time-concentration curves in the blood and tissues after oral administration Estimation of are under the blood concentration curve (AUC) Analysis of administration route-dependence
9	Uchida	Practice on pharmaco-kinetic modeling-3	Effect of changes in the kinetic parameters on time-concentration curves in the blood and tissues under pathological conditions
10	Uchida	Practice on pharmaco-kinetic modeling-4	Computer-based simulation by physiologically based pharmacokinetic model of intravenous administration at a constant rate
11	Tachikawa	Clinical application of compartment models	Concept and principle of two compartment model Formulation of two compartment model Clinical application of two-compartment model for the design of drug dosage regimen

12	Tachikawa	Case studies of clinical pharmacokinetics-1	Case studies of clinical pharmacokinetics and drug dosage regimen design: Antibiotics and central nerves system (CNS)-acting drugs
13	Tachikawa	Case studies of clinical pharmacokinetics-2	Case studies of clinical pharmacokinetics and drug dosage regimen design: Anti-cancer drugs and drugs for cardiovascular diseases
14	Tachikawa	Practice on design of drug dosage regimen	Practical design of drug dosage regimen in clinic
15	Tachikawa	Practice on clinical pharma- ceutics	Small group discussion and presentation regarding the problems on clinical pharmacokinetics and their solutions

Record and evaluation method	Students are evaluated on their points from all the small tests (10%), the regular examinations (40%), and the reports (50%).
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) Applied clinical pharmacokinetics (ISBN:9784906992140) Applied 臨床薬物動態学 岩城正宏、齋藤浩司、灘井雅行 編集、京都廣川書店（2015） 6. (English) Basic Clinical Pharmacokinetics (ISBN:9780781779036) ウィンターの臨床薬物動態学の基礎」Michael E. Winter 著、樋口駿 監訳、じほう（2013） 7. (Japanese) Scenario case studies (ISBN: 9784906992430) シナリオ症例解析 第 2 版 髙山明 総編集、京都廣川書店（2014） 8.(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	Masafumi Kikuchi					
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; joint program with 'Pharmacotherapeutics 1' and 'Medical Informatics')

Record and evaluation method	Minute Paper 70 %, Portfolio 25 %, Presentations 5 %
Textbook	
Reference	AHFS Drug Information 2016, American Society of Health-System Pharmacists (2016)

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	Elective		
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	2
Instructor	Associate Professor Masahiro Hiratsuka				
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.
14	Hiratsuka	Other drug therapy (2)	Students will learn about general anesthesia.
15	Hiratsuka	Other drug therapy (3)	Students will learn about supportive therapy.

Record and evaluation method	Evaluation is performed comprehensively based on attendance and the examination.
Textbook	
Reference	Pharmacotherapy 4th edition (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. mhira@m.tohoku.ac.jp
In addition	

Subject	Pharmacotherapeutics 3					
Course Numbering	YPH-PHA374J	Categories	Elective			
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	2	
Instructor	Hiroshi Sato, Nobuyuki Takahashi					
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, attendance, and so on.
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: hsymhs2i@m.tohoku.ac.jp (Hiroshi Sato).
In addition	

Subject	Clinical Laboratory Medicine				
Course Numbering	YPH-PHA311J	Categories	Elective		
Preferable Participants	4th	Semester	8	Credits	2
Instructor	Professor Yoshihisa Tomioka, Associate Professor Yotaro Matsumoto, Associate Professor Toshifumi Niwa, Assistant Professor Yusuke Ohsaki, Professor Yoko Aoki and Assistant Professor Yuko Abe				
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	Tomioka	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	Niwa	Symptoms	Learning about the typical symptoms (fever, headache, eruption, jaundice, cyanosis, *etc.*) together with each cause and related disease.
8	Niwa	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	Ohsaki	Endocrinology test I	Learning about the typical clinical laboratory tests for endocrine and metabolic disorder to estimate the related disease from the data
10	Ohsaki	Endocrinology test II	Learning about the typical clinical laboratory tests for endocrine and metabolic disorder to estimate the related disease from the data
11	Aoki	Genetic test I	Learning about genetic testing to estimate the typical diseases from the data.
12	Aoki	Genetic test II	Learning about genetic testing to estimate the typical diseases from the data
13	Sogi	Microbiology test	Learning about microbiology test to estimate the typical diseases from the data
14	Abe	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					
Course Numbering	YPH-PHA381J	Categories	Required[Pharmacy]			
Preferable Participants	4th	Semester	8	Credits	1	
Instructor	Takahiro Kimura, Tsuyoshi Ishibashi					
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,” “Poisonous and Deleterious Substances Control Act,” “Narcotics and Psychotropics Control Act,” and other pharmaceutical related laws, medical service related laws, and social security related laws.					
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(Reporting)					

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 Ishibashi	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	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 class participation and the final examination.
Textbook	“The commentary of the pharmaceutical law, system and ethic, 2016-17 version,” Yakujinippou Corporation
Reference	“Pharmaceutical hygiene compendium of laws, 2016 version,” Yakujinippou Corporation “The commentary of Pharmaceutical and Medical Device Act, Pharmacist Act, and Poisonous and Deleterious Substances Control Act,” Yakujinippou Corporation “Pharmaceutical laws and ordinances handbook, 2016 version,” Yakujinippou Corporation “Pharmaceutical laws and ordinances handbook, the approval permission requirement, 7th version,” 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	Pharmaceutical English				
Course Numbering	YPH-PHA302J	Categories	Elective		
Preferable Participants	4th [Pharmacy]	Semester	8	Credits	2
Instructor	Prof. Yoshiharu Iwabuchi, Prof. Tomoyuki Oe, Prof. Masahiko Yamaguchi, Prof. Tetsuya Terasaki, Prof. Atsushi Matsuzawa, Prof. Yoshihisa Tomioka, Assoc. Prof. Nobuyuki Takahashi				
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	Iwabuchi	Guidance	
2	Oe		
3	Yamaguchi		
4	Terasaki		
5	Matsuzawa		
6	Takahashi		
7	Tomioka		
8	Iwabuchi	Practice	

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

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				
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Training Contents					
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				
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Training Contents					
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, Pharmacy Education and Research Center				
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Contents					
Record and evaluation method					
Textbook					

Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	
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				
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Training Contents					
Record and evaluation method					
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	10	Credits	10
Instructor	Lecturer of Department of Pharmacy				
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Training Contents					
Record and evaluation method					
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				
Objectives and summary of class					
Goal of study					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )				
Training Contents					
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 Takakazu Nakabayashi					
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 (30-40%) and the term examination (60-70%).
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: takan@m.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 Jun-ichi Anzai and Assistant Professor Katsuhiko Sato					
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	Anzai	An outline of this class	
2	Anzai	Chemical thermodynamics 1	Molecular theory of gases,
3	Anzai	Chemical thermodynamics 2	Potential energy, enthalpy, entropy
4	Anzai	Chemical thermodynamics 3	First law of thermodynamics
5	Anzai	Chemical thermodynamics 4	Free energy
6	Anzai	Phase equilibria 1	Phase rule
7	Anzai	Phase equilibria 2	Immiscible liquids, solid-liquid system
8	Anzai	Phase equilibria 2	Phase equilibria of 2-component and 3-component systems
9	Sato	Kinetics of chemical reactions 1	Rate of chemical reactions, zero- and first-order rate reactions
10	Sato	Kinetics of chemical reactions 2	Second-order rate reactions
11	Sato	Kinetics of chemical reactions 3	Reversible reactions, complex rate equations
12	Sato	Kinetics of chemical reactions 4	Reaction rate and temperature, activation energy
13	Sato	Kinetics of chemical reactions 5	Catalysts in chemical reactions
14	Sato	Kinetics of chemical reactions 6	Acid-base rate reactions
15	Sato	Kinetics of chemical reactions 7	Enzyme-catalyzed reactions

Record and evaluation method	Students are evaluated on the small tests (30%) and final test (70%).
Textbook	“Physical Chemistry” ed. by Oshima and Handa, Nankodo (1999)
Reference	none
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.

In addition	

Subject	Chemistry C					
Course Numbering	ZDN-CHE113J		Categories	Elective		
Preferable Participants	1st	Semester	1	Credits	2	
Instructor	Yoshinori Kondo, Masanori Shigeno					
Objectives and summary of class	In this course, students will learn about structure, bonding, and concepts of hybridization and understand the basis of organic chemistry. They will also study about resonance and electronegativity and understand acid-base reactions and acidity. The course will outline the property of common functional groups and introduce important roles of organic molecules in vivo. They will learn about representation of molecular structures and understand nomenclature and physical properties of organic molecules.					
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 vivo. · Students will understand nomenclature and physical properties of common organic molecules, and conformation of alkanes and cycloalkanes.					
Method of class	Lecture・Practice・Training・On-site training・SGD・PBL・Roleplay・e-learning・Others( )					

Term	Lecturer	Theme	Contents
1	Kondo Shigeno	Basis of General Chemistry (1)	Students will understand structure of an atom, distribution of electrons in an atom, and ionic, covalent, and polar bonds.
2	Kondo Shigeno	Basis of General Chemistry (2)	Students will understand representation of structure, atomic orbitals, and an introduction to molecular orbital theory.
3	Kondo Shigeno	Basis of General Chemistry (3)	Students will understand bondings in methane, ethane, ethene, ethyne, methyl cation, methyl radical, and methyl anion.
4	Kondo Shigeno	Basis of General Chemistry (4)	Students will understand bondings in ammonia, ammonium ion, water, and hydrogen halides, and dipole moments of molecules.
5	Kondo Shigeno	Acids and Bases (1)	Students will understand basis of acids and bases, organic acids and bases, pKa and pH.
6	Kondo Shigeno	Acids and Bases (2)	Students will be able to predict the outcome of acid-base reactions and understand effect of structure on pKa.
7	Kondo Shigeno	Acids and Bases (3)	Students will understand introduction to delocalized electrons and resonance, effect of pH on the structure of an organic compound, buffered solution, and Lewis acids and Lewis bases.
8	Kondo Shigeno	Introduction to Organic Compounds (1)	Students will understand nomenclature of alkyl substituents, alkanes, cycloalkanes, and alkyl halides.
9	Kondo Shigeno	Introduction to Organic Compounds (2)	Students will understand nomenclature of ethers, alcohols, and amines, structures of alkyl halides, alcohols, ethers, and amines, and physical properties of alkanes, alkyl halides, alcohols, ethers, and amines.
10	Kondo Shigeno	Introduction to Organic Compounds (3)	Students will understand conformations of alkanes, ring strain of cycloalkanes, and conformations of cyclohexane.
11	Kondo Shigeno	Introduction to Organic Compounds (4)	Students will understand conformations of monosubstituted cyclohexanes, disubstituted cyclohexanes, and fused rings.
12	Kondo Shigeno	Isomers (1)	Students will understand cis-trans isomers, chirality, asymmetric carbons, chirality centers, stereocenters, isomers with one asymmetric carbon, and drawing enantiomers.

13	Kondo Shigeno	Isomers (2)	Students will understand the *R*, *S* system of nomenclature, optical activity, optical purity, and enantiomeric excess.
14	Kondo Shigeno	Isomers (3)	Students will understand isomers with more than one asymmetric carbon and meso compounds.
15	Kondo Shigeno	Isomers (4)	Students will understand the *R*, *S* system of nomenclature for isomers with more than one asymmetric carbon, separating enantiomers, and nitrogen and phosphorus chirality centers.

Record and evaluation method	Students are evaluated on the final examination (100%).
Textbook	'Organic Chemistry —7th ed.' P. Y. Bruice.
Reference	
Preparation and Review	
Language Used in Course	Japanese
Office hours	Make an advance appointment via e-mail or other means. E-MAIL: ykondo@m.tohoku.ac.jp TEL: 795-6804 E-MAIL: mshigeno@m.tohoku.ac.jp TEL: 795-5917
In addition	

Subject	Biology A					
Course Numbering	ZDN-BIO111J	Categories	Elective			
Preferable Participants	1st	Semester	1	Credits	2	
Instructor	Professor Toshifumi Inada					
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	Introduction to Cells	
2	Inada	Introduction to Cells: Structure and Function of Organelles	
3	Inada	Chemical component of Cells (amino acids, nucleic acids, lipids)	
4	Inada	Chemical component of Cells (amino acids, nucleic acids, lipids)	
5	Inada	Energy, Catalysis and Biosynthesis	
6	Inada	Protein Structure and Function	
7	Inada	Protein Structure and Function	
8	Inada	DNA and Chromosomes	
9	Inada	Sex and Genetics (Mendelian inheritance)	
10	Inada	Sex and Genetics	
11	Inada	From DNA to Protein: How Cells Read the Genome	
12	Inada	From DNA to Protein: How Cells Read the Genome	
13	Inada	From DNA to Protein: How Cells Read the Genome	
14	Inada	Analyzing Genes and Genomes	
15	Inada	Confirmation of all the small tests to review the contents	

Record and evaluation method	Students are evaluated on their points from all the small tests and attendance (about 15%) and the final examination (about 85%).
Textbook	
Reference	

Preparation and Review	
Language Used in Course	Japanese
Office hours	
In addition	Conducts a small test on every lecture, to check the level of understanding.