SOKENDAI CampusPlan Web Service

Syllabus Reference

Course title	Molecular and Cellular Physiology 1		
Term	前期 1st Half		
Credit(s)	1		
The main day		The main period	
Program/Department	48 Physiological Sciences		
Lecturers	Kubo, Furuse, Fukata, Murata, Murakoshi et al.		
成績評価区分 Grading Scale	A,B,C,Dの4段階評価 Four-grade evaluation		
レベル Level	Level 3		
力量 Competence	専門力 Academic expertise、独創性 Creativity		

Instructor

Full name
* FUKATA MASAKI

Outline	Ion channels, receptors and cell-adhesion molecules in neurons and epithelial cells will be introduced from the point of view of their structure, function, regulation and analytical methods. In the 1st and 2nd lectures of this lecture series, the history and prospects of structure-function relationship studies of ion channels will be explained with various methodologies, such as "molecular movie" imaging of dynamic ion channels using an X-ray free electron laser. In the 3rd and 4th lectures, the molecular mechanisms and roles of cell adhesion and cell polarity will be introduced from the viewpoint of cell biology. In the 5th lecture, analysis methods of protein structures, including X-ray, NMR, and cryo-EM analysis, will be explained. In the 6th lecture, the regulatory mechanisms of dynamic cytoskeletons in neurons will be explained with the latest measurement methods. In the 7th and 8th lectures, we will focus on the molecular mechanisms for synaptic transmission and the physiopathological mechanisms for synaptic disorders. Especially, ionotropic glutamate receptors will be highlighted.
Learning objectives	(1) To understand the characteristics and the significance of the various cutting-edge approaches for the dynamic structure-function relationship study. (2) To understand the molecular basis of cytoskeleton, cell adhesion and cell polarity in terms of physiological functions of epithelial cells and neurons. (3) To understand the molecular basis of synaptic transmission and synaptic transmission.
Grading policy	Assignments based on the above achievement goals (1), (2) and (3) will be presented, and students will be asked to answer one of them in a report. Students who submit reports by the deadline and are judged to have understood the main points will receive credit. Attendance of at least half of the class is required for credit.
Lecture Plan	1st lecture, April 21 (Fri) "Structure-function relationship study of ion channels: Looking back and seeing ahead" Yoshihiro Kubo (Division of Biophysics & Neurobiology) The lecture will start with the explanation how the molecular identities of ion channels were proved. Then, the advantage of the usage of in vitro expression system for ion channel study will be explained, and also the distinguished achievements of the structure-function relationship study will be introduced. Next, the results of the dynamic structural rearrangements achieved by the development of new methodologies will be explained. Finally, the perspectives of this research field beyond the structure information will be mentioned towards better understanding of the functioning mechanisms. 2nd lecture, April 28 (Fri) "How to analyze and interpret the three-dimensional structure of ion channels" Takushi Shimomura (Division of Biophysics & Neurobiology) This lecture will provide students with an overview of experimental techniques to solve the three-dimensional structure of ion channels, as well as their contribution to the structure-function relationship study. First, an outline of the meaning and

	significance of the information of the three-dimensional structure of proteins will be explained. Next, an overview of the methodology of the protein structural analysis such as X-ray crystallography will be introduced. It will also be explained how the elucidated structures of the ion channels and receptors can contribute to the understanding of their function. Finally, as an example of a state-of-the-art technique, "molecular movie" imaging of dynamic ion channels using an X-ray free electron laser will be introduced. 3rd lecture, May 12 (Fri) "Molecular mechanism of cell adhesion" Mikio Furuse (Division of Cell Structure) This lecture will provide an overview of cell adhesion in animals. The concepts of cell-extracellular matrix adhesion and intercellular adhesion will be explained, and the molecular mechanisms of each will be reviewed in terms of adhesion molecules and their interactions with the cytoskeleton. The molecular mechanisms and roles of intercellular junctions in vertebrate cells will also be introduced. 4th lecture, May 19 (Fri) "Molecular basis of cell polarity formation" Yasushi Izumi (Division of Cell Structure) In this lecture, I will first outline what “cell polarity” is. I will then introduce pioneering studies of asymmetric cell division in C. elegans embryo and Drosophila neuroblast, which led to the discovery of key molecules involved in cell polarity formation. Further, I will talk about the molecular mechanism underlying mammalian epithelial cell polarization. 5th lecture, May 26 (Fri) "Protein structure and its analysis method" Kazuyoshi Murata (Division of Structural Biology) In this lecture, the structure of protein and its structure determination method are outlined. Currently, X-ray, NMR, and cryo-electron microscopy are available as methods for determining protein structure. Explain the advantages and disadvantages of each method. Furthermore, explain where and how soluble proteins and membrane proteins perform their biological functions. 6th lecture, June 2 (Fri) "Regulatory mechanisms and functions of the cytoskeleton" Hideji Murakoshi (Section of Multiphoton Neuroimaging, Supportive center for brain research) The cytoskeleton is the basic framework of cell morphological regulation. In this lecture, the cytoskeleton and its regulatory mechanisms and functions will be reviewed. Particular attention will be paid to the fundamental components of the cytoskeleton such as the actin filaments and microtubules and their localization, dynamics, function, and the intracellular signaling molecules that regulate their activities. In addition, state-of-the-art methods for measuring these events will also be presented, with a focus on neurons. 7th lecture, June 23 (Fri) "Synapse biology and Synaptic disorders" Masaki Fukata (Division of Membrane Physiology) In this lecture, I will introduce the molecular mechanisms for synaptogenesis and synaptic transmission, and the physiopathological mechanisms for synaptic disorders. First, I will overview the basic knowledge about cytoskeletons and neuronal cell adhesion molecules, which dynamically regulate the synapse formation and functions. I will also mention about the recent topic for liquid-liquid phase separation in the synapse. Furthermore, synaptic disorders induced by congenital mutations and autoantibodies against synaptic proteins will be introduced. 8th lecture, June 30 (Fri) "Structure-function relationships of synaptic protein complexes" Norihiko Yokoi (Division of Membrane Physiology) In this lecture, I will introduce how to identify and characterize the protein complexes that regulate synaptic transmission. This lecture will mainly focus on protein complexes related to ionotropic glutamate receptors (iGluRs). I will explain mode of interaction of iGluR-protein complexes from the structural point of view and regulatory mechanisms for iGluRs. Furthermore, the relationships between protein structure and drug design will be discussed.
Location	Online
Language	English
Textbooks and references	Reference books (1) Ion channels of excitable membranes 3rd Edition (by Hille B), Sinauer, 2001 (2) Mark F.Bear et al, “Neuroscience: Exploring the Brain, Fourth edition” : Lippincott Williams & Wilkins Inc. (3) Alberts et al, "Molecular Biology of the Cell 7th Edition", Norton
Notes for students of other programs	Nothing special