SOKENDAI

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| Course title | Molecular and Cellular Physiology 2 |
| Term | 前期 1st Half |
| Credit(s) | 1 |
| The main day | The main period |
| Program/Department | 48 Physiological Sciences |
| Lecturers | Y. Kubo, M. Furuse, K. Murata, 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 |
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| * FURUSE MIKIO |
| KUBO YOSHIHIRO |
| MURATA KAZUYOSHI |
| IZUMI YASUSHI |
| KOBAYASHI KENTA |
| OHASHI MASATO |

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| Outline | In the 1st lecture, the lecturer will explain the fundamental matters of membrane physiology such as the mechanisms of resting membrane potential and action potential generation. In the 2nd lecture, the lecturer will explain the molecular diversity and the functioning mechanisms of ion channels and receptors. In the 3rd and 4th lectures, we will explain the basic concept and molecular mechanisms of the transepithelial transport and epithelial homeostasis as basic functions of the epithelium, which is responsible for physiological functions of various organs. In the 5th lecture, the lecturer will explain the fundamental processes of intracellular vesicle transport and its applications to specific biological phenomena. In the 6th lectures, we will explain the basic concept of intracellular signal transduction. In the 7th, and 8th lectures, we will explain the relationship between the structure and function of soluble proteins and membrane proteins in cells. The structural analysis method will also be explained. |
| Learning objectives | (1) Students can explain the mechanisms of resting membrane potential and the action potential generation. Students can also exemplify the molecular diversity and the functioning mechanisms of ion channels and receptors.<br>(2) Students can describe the basic mechanisms that drive epithelial fluid transport, and can explain the mechanism of the reabsorption of electrolytes, water, and nutrients in nephron segments in terms of transcellular and paracellular transport. Students can describe structure and function of the intestine. Students can explain molecular mechanism involved in intestinal stem cell proliferation and epithelial differentiation, which is required for maintaining intestinal homeostasis.<br>(3) Students can explain the fundamental steps of intracellular vesicle transport and the functions of the molecules that drive them, using specific biological phenomena as examples. Students can also explain the basic concept of intracellular signal transduction.<br>(4) The relationship between the structure and function of soluble proteins and membrane proteins in cells can be explained with examples. Further, the structural analysis methods can be also explained. |
| Grading policy | Assignments based on the above achievement goals (1), (2), (3), and (4) will be presented, and students will be asked to answer any 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 18 (Fri)<br>"Introduction of cell physiology, mechanisms of membrane potential and generation of action potential"<br>Yoshihiro Kubo (Division of Biophysics & Neurobiology)<br>The lecture will start with the explanation of the basics of membrane physiology, including the ionic composition of intracellular and extracellular solutions, the electro-chemical potential and the equilibrium potential. Next, the mechanism of the determination of the resting potential will be explained. The lecturer will then explain the voltage- and time dependent activity of ion channels which was uncovered by voltage-clamp analysis, and show that the generation of action potential can be reconstituted based on the activity of Na+ and K+ channels.<br><br>2nd lecture, April 25 (Fri)<br>"Molecular diversity and mechanism of function of ion channels and receptors"<br>Yoshihiro Kubo (Division of Biophysics & Neurobiology)<br>The lecture will start with the overview of the researches after 1980 which undoubtedly proved the presence of ion channels/receptors by elucidating the molecular identity. Then, the molecular and functional diversity of ion channels/receptors will be explained. The lecturer will then explain the mechanisms and structural determinants of ion channel functions, focusing on the ionic selectivity and the voltage-dependent gating. Finally, various inherited diseases caused by genetic mutations of ion channel genes will be briefly introduced.<br><br>3rd lecture, May 9 (Fri)<br>"Mechanisms of epithelial fluid transport"<br>Mikio Furuse (Division of Cell Structure)<br>In this lecture, the structure of the epithelium and the epithelial fluid transport will be outlined as introduction. The lecture will explain the basic mechanism by which major electrolytes and water are absorbed into or secreted from epithelial cells by the driving force of the sodium pump. In addition, the molecular mechanism of the paracellular transport, which has recently been clarified, will be described. Then, the mechanism of fluid transport in renal epithelia will be explained.<br><br>4th lecture, May 16 (Fri)<br>"Mechanisms of the maintenance of epithelial homeostasis"<br>Yasush Izumi (Division of Cell Structure)<br>In this lecture, I will outline intestinal structure and function in mammals and Drosophila, and then introduce molecular mechanisms underlying their intestinal stem cell proliferation and epithelial differentiation, which is required for maintaining intestinal homeostasis. Further, I will talk about the effect of inflammation, aging, microbial infection on intestinal epithelial homeostasis.<br><br>5th lecture, May 23 (Fri) |

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| | "Intracellular Vesicular Transport"<br>Masato Ohashi (Division of Cell Structure)<br>Intracellular vesicular transport is essential for moving materials within cells. This lecture will cover the basic steps of vesicle formation, docking, and fusion, and explore how these processes contribute to biological phenomena like synaptic transmission and epithelial polarity. The lecture will also review the functions of key molecular players such as coat proteins, SNARE complexes and Rab GTPases and discuss their potential involvement in various diseases.<br><br>6th lecture, May 30 (Fri)<br>"Intracellular signal transduction"<br>Kenta Kobayashi (Section of Viral Vector Development,)<br>In this lecture, I will explain the basic concept of intracellular signal transduction. In particular, signaling pathways mediated by trimeric G proteins, small G proteins, and kinases will be presented. In addition, I will discuss in vitro and in vivo studies of signaling molecules.<br><br>7th lecture, June 6 (Fri)<br>"Structural-function linkage and its structural analysis method of intracellular soluble proteins"<br>Kazuyoshi Murata (Division of Structure Biology)<br>In this lecture, I will explain the structures of intracellular soluble proteins such as proteasomes, spliceosomes, and ribosomes, whose detailed molecular structure dynamics and their functional relationships have been clarified in recent years. The latest structural analysis method that make this possible will also be described.<br><br>8th lecture, June 13 (Fri)<br>"Structural-function linkage and its structural analysis method of intracellular membrane proteins"<br>Kazuyoshi Murata (Division of Structure Biology)<br>In this lecture, I will explain the structures of intracellular membrane proteins such as ion channels, transporter, and GPCR, whose detailed molecular structure dynamics and their functional relationships have been clarified in recent years. The latest structural analysis method that make this possible will also be described. |
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| Language | English |
| Textbooks and references | (1) Ion channels of excitable membranes 3rd Edition (by Hille B), Sinauer, 2001<br>(2) Mark F.Bear et al, 「Neuroscience: Exploring the Brain, Fourth edition」 : Lippincott Williams & Wilkins Inc.<br>(3) Boron & Boulpaep "Medical Physiology 3rd Edition", Elsevier |
| Notes for students of other programs | Please contact Prof. Furuse, the person in charge of the course, in advance to confirm the content and level of the lecture. |
| Contact for Course Inquiries | Mikio Furuse<br>furuse@nips.ac.jp |