Premedical Course

Biology

Koji Takada, *Professor*　　Rie Hiratsuka, *Associate Professor*

General Summary

Our research themes are as follows: (1) studies of the evaluation and mechanism of cytotoxicity associated with proteostasis disruption and (2) subcellular localization analysis of endogenous adjuvant molecules in Japanese cedar pollen.

Research Activities

Development and standardization of the cytotoxicity evaluation system by quantification of hardly-soluble polyubiquitin-protein conjugates

Eukaryotic cells have various mechanisms to keep the internal environment stable. The ubiquitin-proteasome system and autophagy are parts of such mechanisms and maintain cellular protein homeostasis (proteostasis) by appropriately degrading unnecessary proteins. Because proteasome recognizes polyubiquitin tags as degradation signals and because the autophagic pathways preferably degrade polyubiquitin-containing aggregates in a ubiquitin adaptor p62-dependent manner, the polyubiquitin amount reflects the state of proteostasis. Exposure of epithelial cells to cadmium at a level equivalent to a median effective concentration (EC_{50}) induces significant increases of hardly-soluble polyubiquitin amounts preceding cell death. Therefore, we regard this phenomenon as cytotoxicity accompanied by proteostasis disruption (proteostatic toxicity) and are attempting to clarify its biological significance. Following last year, we refined a series of toxicity assessment procedures for labor saving. In addition, we tried to standardize the analysis protocols to expand this system to the toxicity analysis of various chemicals. In the first step, the EC_{50} of a test substance for the 48-hour exposure of the cultured cells is determined. In the second step, the same cells exposed to the test substance of the EC_{50} for 24 hours are collected, and "the soluble fraction" extracted with 1% Triton X-100 and "the hardly-soluble fraction" insoluble in 1% Triton X-100 but soluble in 2% sodium dodecylsulfate are prepared. In the final stage, levels of proteins and polyubiquitin in both fractions are assayed, and the case where the amount of the hardly-soluble polyubiquitin significantly increased by the exposure to the EC_{50} was judged as proteostatic toxicity-positive. Examination with this criterion using epithelial cells showed that cadmium, methylmercury, and arsenous acid were strongly positive; that hexavalent chromium was mildly positive; and that paraquat was negative. Molecular mechanisms of proteostatic toxicity will be studied by systematically analyzing various chemical substances.

Localization of β-1, 3-glucan in Japanese cedar pollen

To clarify the adjuvanticity of β-1, 3-D-glucan (β-glucan) contained in Japanese cedar

pollen, its localization in pollen was analyzed immunohistochemically. The results clearly showed that β-glucan was localized in the exine (the outer layer of a pollen wall) and in the generative cell wall. After water absorption, β-glucan localized in the exine was exposed to the outside by its rupture. Co-workers have shown that the exine induces tumor necrosis factor α and interleukin 6 production in a β-glucan-receptor-dependent manner. In the onset and exacerbation of Japanese cedar pollinosis, β-glucan localized in the exine is considered to stimulate the innate immune system in a β-glucan-receptor-dependent manner and to promote the immune response to a pollen allergen.

Physics

Tsuyoshi Ueta, *Professor*　　Katsumi Kasono, *Assistant Professor*

General Summary

1. We have proposed a disordered air rod photonic crystal as a model of a sponge structure inside a barb of the red-flanked bluetail and are attempting to reproduce the structural color of birds by confirming the reflection spectrum.
2. We have found that an incident electromagnetic wave is amplified resonantly within an artificially vibrating 1-dimensional metallic photonic crystal. We are investigating the relation of the conditions of the amplification to the virtual bound states.
3. We are studying an ultrasonic lens with an adaptively deformable phononic structure constructed with microtubes into which liquid metal is injected. In this research, we are attempting to stimulate a cerebral deep part by designing a phononic lens in which a brain and the cranial bones are also taken into account as metamaterials.
4. We have been studying computational methods and algorithms for the condensed matter theory. The phenomena of interest are phase transitions and critical phenomena.

Research Activities

1. We consider amplification of an incident electric-magnetic wave within a disordered photonic crystal (photonic amorphous), which is made of stacked metallic plates of random thickness arranged in parallel with equi-intervals. We have confirmed that amplification of an incident electromagnetic wave occurs by resonance with weakly localized states, namely the virtual bound states.
2. We propose a computational method of the most suitable initial structure for topology optimization and show the resulting structure (acoustic lens). To generate the phononic structure with multiple focuses, we employ a holographic technique with which a suitable phononic lens is obtained as low-valued domains of the interference pattern between radiative waves from all of the focal points within the skull and a reference wave, namely a plane wave. The phononic structure is the same as the so-called Fresnel zone plate. The influence of scattering by the skull on the phononic structure will be discussed.

3. A challenge is to determine the distribution of the liquid metal so that the ultrasonic wave can be converged to the thrombus accurately and intensively. To this end, we aim to develop a topology optimization system based on the boundary element method, boundary representation with level set function, time evolution of level set function, and the adjoint variable method. To verify our system, we solved a (simplified) optimization problem to maximize the sound pressure at a single point in air, without considering other media, such as the skull and brain. First, we used a box as the fixed design domain, where the liquid metal (scatter) is allowed to appear and disappear. The resulting liquid metal looked like a Fresnel zone plate. The sound pressure markedly increased at the target point.
4. We performed multigrid cluster Monte Carlo simulations of q-state ferromagnetic Potts models on square lattices. We studied relaxation times of parameters and energy.

Publications

Ueta T. Wave functions and phase shifts of amplified modes within a vibrating metallic photonic crystal. *Procedia Engineering*. 2018; **216C:** 152-67.
Ueta T. Resonance with Virtual Bound States and Amplification within a Vibrating 1D Photonic Crystal. *Proceedings of the 12th International Congress on Advanced Electromagnetic Materials in Microwaves and Optics-Metamaterials 2018*. IEEE Xplore Conference ID: 43757X, 978-1-5386-4702-8/18/$31.00: 407-9. DOI: 10.1109/ Meta Materials. 2018.8534077.

Chemistry

Takashi Okano, *Professor*
Naruyoshi Komiya, *Associate Professor*

General Summary

The research of this laboratory is focused on synthesis-oriented organic chemistry, including the synthesis of bioactive compounds and fluorine-containing materials, and the development of novel functional organic/organometallic compounds for fine organic synthesis.

Research Activities

Preparation of fluorine-containing organic compounds via N-heterocyclic carbene catalysis
N-heterocyclic carbenes (NHCs) are highly stable carbanions stabilized by the aromatic azolium system, including vitamin B_1. These NHCs are now attracting interests as environmentally compatible organic catalysts for various reactions, using aldehydes as acyl anion equivalents. For the application of NHC-catalyzed reactions to the synthesis of biologically active fluorinated materials, the strongly basic reaction conditions would cause a problem. Recently developed precursors for NHCs without basic reaction conditions were used in an attempt to check NHC reactions of fluorinated aldehyde hemiacetals.

Regiospecific remote Pt-H interactions in oligomethylene-vaulted (N^C^N)-pincer Pt(II) complexes

(N^C^N)-Pincer type bis(methylimino)phenylPt(II) complexes having a macrocyclic vaulting structure consisting of deca- undeca-, and dodecamethylene bridges were synthesized and subsequently characterized with nuclear magnetic resonance, infrared, and mass spectrometries and single-crystal X-ray powder diffraction. The unprecedented remote intramolecular Pt-H interactions were observed on the linker hydrogens at β- and ζ-positions with highly regiospecific manner both in crystal and solution states. The hydrogen bonding nature originated from overlap between Pt dz^2 and σ* of the specific C-H bonds was revealed with natural bond orbital analysis on the basis of density functional theory calculations.

Publications

Komiya N, Hosokawa T[1], Adachi J[1], Inoue R[1], Kawamorita S[1], Naota T[1] ([1]Osaka Univ). Regiospecific remote Pt-H interactions in oligomethylene-vaulted (N^C^N)-pincer Pt(II) complexes. *Eur J Inorg Chem.* 2018; **2018:** 4771-8.

Maeda T[1], Kuwajima Y[1], Akita T[1], Iwai Y[1], Komiya N, Uchida Y[1], Naota T[1] ([1]Osaka Univ). Helicity control of supramolecular gel fiber consisting of achiral Ni(II) complex in chiral nematic solvent. *Chem Eur J.* 2018; **24:** 12546-54.

Iwata S[1], Takahashi H[1], Ihara A[1], Hiramatsu K[1], Adachi J[1], Kawamorita S[1], Komiya N, Naota T[1] ([1]Osaka Univ). Syntheses, structures and solid-state phosphorescence characteristics of trans-bis(salicylaldiminato)Pt(II) complexes bearing perpendicular N-aryl functionalities. *Transision Met Chem.* 2018; **43:** 115-25.

Social Science (Law)

Ryuichi Ozawa, *Professor*

General Summary

Problems of Constitutional Law in present-day Japan

Research Activities

Ozawa published articles and books cited in the Japanese version of Research Activities 2018.

Human Science

Kazushi Misaki, *Professor*

General Summary

The Study of Western philosophy and ethics

Research Activities

Origin of the ego: The intersubjective approach to the subject
Descartes' "cogito," the ego as the subject of thought, is still a popular and paradigmatic image for the human subject: to be a mature human means that one can think independently and autonomously and can act according to one's own beliefs.
In modern philosophy this image of the ego has been attacked from various positions. From one such position, an intersubjective approach criticizes Descartes' cogito as an isolated subject and maintains that an ego can be a subject only in intersubjective relations. Through the recognition of the other, one can become and can be a subject. Studies by Donald Winnicott have shown how important the relationship of a baby with its mother is at the first stage of the ego. George Herbert Mead considered the development of the ego as a process of "ideal role-taking of others." The goal of this development is a subject that can think from the universal point of view, as Descartes imagined.

Learn from the experience in Auschwitz
From another respect, the "inhuman" situations in the Auschwitz concentration camp show various elements needed to be "human." From the experiences at Auschwitz written about by Viktor Frankl, we can learn the "human conditions" that in ordinary life remain unconscious but essential.

Japanese

Ikuko Noro, *Professor*

General Summary

A study of objective happiness and resilience.

Research Activities

A Web-based survey was administered to 480 workers in Japan to investigate the degree of happiness and resilience they perceive. We found that the degrees of objective happi-

ness and resilience were highest in workers older than 60 years, both male and female, and were lowest in male workers younger than 30 years. We presented the results at the 30th annual meeting of the Japanese Society of Developmental Psychology.

Mathematics

Katsuya Yokoi, *Professor* Yasuko Hasegawa, *Assistant Professor*

General Summary

I. To study dimension theory and topological dynamics
II. Some applications of automorphic forms of several variables to number theory

Research Activities

I. We studied omega-limit sets, (strong) chain recurrent sets on topological dynamics, the Conley index theory, and the Lusternik-Schnirelmann category.
II. We clarified the second term in the Laurent expansion of a real analytic Siegel-Eisenstein series around a certain point. Furthermore, we proved its harmonicity and automorphicity.

English

Osamu Ohara, *Professor* Tetsuro Fujii, *Professor*

General Summary

English audiovisual education and digital medieval English study (Ohara)
English language communication and education: material analysis and development (Fujii)
Ohara continued his study of graphology and morphology in the letters of the Pastons in the 15th century. Ohara also continued an investigation concerning how to make useful digital images and XML files of 15th century manuscripts, especially of the Paston Letters. The results of this investigation were discussed in the papers read at an international conference.
Fujii joined a project team to compile English textbooks for high school English classes: *English Communication I*, *II*, and *III*. Along with compiling the textbooks, Fujii has been writing their exercise materials and teacher's manuals. In addition, Fujii has been studying how teaching materials influence learner motivation and language development.

Research Activities

Ohara presented a paper at sessions of the International Medieval Congress held at Leeds University in England in July and at Aichi Educational University in December.
Fujii analyzed and collected authentic English materials to meet the level and the needs of high school textbooks based on current teaching methods, theories, and research findings on learning English as a foreign language. These materials were used to compile textbooks following the revised teaching guidelines set out by the Ministry of Education, Culture, Sports, Science and Technology. A new edition of the textbook, *World Trek – English Communication III*, was officially approved by the Ministry and published in February 2019.

Reviews and Books

Mochizuki M[1], Aizawa K[2], Allum P[3], Sasabe N[4], Hayashi Y[5], Fujii T, Miura S[6] ([1]Reitaku Univ, [2]Toyo Denki Univ, [3]Rikkyo Univ, [4]Toritsu Aoyama High, [5]Koshigaya High, [6]Tsurubunka Univ). *World Trek English Communication III.* Tokyo: Kirihara Shoten; 2019.

Mochizuki M[1], Aizawa K[2], Allum P[3], Sasabe N[4], Hayashi Y[5], Fujii T, Miura S[6] ([1]Reitaku Univ, [2]Toyo Denki Univ, [3]Rikkyo Univ, [4]Toritsu Aoyama High, [5]Koshigaya High, [6]Tsurubunka Univ). *World Trek English Communication III: Teacher's Book.* Tokyo: Kirihara Shoten; 2019.

First Foreign Languages

Katsumi Suzuki, *Professor*

General Summary

German contemporary literature

Research Activities

My research topic is the modern German literature of nonnative writers in German-speaking areas.
I am working now with the novels of Sherko Fatah. His father is Kurdish-Iraqi, and his mother is Polish-German. In fact, he is a native writer of German with the background of an immigrant. His heroines are always playing their part in Germany, as well as in the Middle East, mainly in Iraq. What is offered to him in the creative work as subjects, is the fatherland of his father. He writes his work in his mother tongue. I have already written and published an essay about the relationship between the fatherland and his mother tongue in his novels.