

Japan-U.S. Brain Research Cooperation Program
Information Exchange Seminar Program FY2024: Report

Research Field: ____Plasticity/Circuits/Disease____

1. Seminar title:

Synaptic Basis of Cognition

2. Dates, from/to (mm/dd/yyyy)

11/03/2024-11/06/2024

3. Location:

Asilomar Conference Grounds

800 Asilomar Ave, Pacific Grove, CA 93950, United States

4. Coordinators

Japanese Coordinator

Name: Joshua Johansen

Title: Team Director

Affiliation: RIKEN Center for Brain Science

U.S. Coordinator

Name: Jason Shepherd

Title: Professor

Affiliation: University of Utah, Dept. of Neurobiology

5. Participants:

Japan: Invited participants _10_ people Others _4_ people

(Please give names, titles and affiliations of invited participants)

- 1) Ayako Watabe (Professor, Jikei University)
- 2) Yasunori Hayashi (Professor, Kyoto University)
- 3) Aya Ito-Ishida (Team Director, RIKEN Center for Brain Science)
- 4) Kaoru Inokuchi (Professor, Toyama University)
- 5) Yoko Yazaki-Sugiyama (Professor, Okinawa Institute of Science & Technology)
- 6) Haruhiko Bito (Professor, University of Tokyo)
- 7) Masanori Murayama (Team Director, RIKEN Center for Brain Science)
- 8) Kaz Tanaka (Assistant Professor, Okinawa Institute of Science & Technology)
- 9) Yukiko Gotoh (Professor, University of Tokyo)
- 10) Joshua Johansen (Team Director, RIKEN Center for Brain Science)

U.S.: Invited participants _8_ people Others _10_ people
(Please give names, titles and affiliations of invited participants)

- 1) Yuuta Imoto (Assistant Member, St. Jude Children's Hospital)
- 2) Kate Smith (Associate Professor, University of Colorado)
- 3) Ramendra Saha (Associate Professor, University of California, Merced)
- 4) Karen Zito (Professor, University of California, Davis)
- 5) Jayeeta Basu (Assistant Professor, New York University)
- 6) Na Ji (Professor, University of California, Berkeley)
- 7) Peri Kurshan (Assistant Professor, Albert Einstein College of Medicine)
- 8) Jason Shepherd (Professor, University of Utah)

6. Seminar Outline and Significance:

Overview

This international neuroscience conference was conceived not only as a platform for sharing cutting-edge scientific discoveries, but also as a cultural bridge uniting the Japanese and U.S. neuroscience communities. By bringing together junior and senior researchers from both countries, the meeting fostered collaboration, cross-cultural exchange, and the strengthening of global scientific networks.

Participants presented and discussed pioneering work at the intersection of molecular, cellular, and systems neuroscience, with a focus on how synaptic function supports cognition. The program was structured around five thematic sessions, each showcasing innovative research and facilitating dialogue across disciplines and borders.

1. Non-Neuronal Cell Types and Novel Molecular Mechanisms Regulating Synaptic Plasticity

This session expanded traditional perspectives on synaptic plasticity by examining the roles of previously underappreciated molecular and cellular actors. Key highlights included:

- The involvement of long genes in memory formation.
- A novel mechanism of transneuronal RNA communication via viral capsids that regulates synaptic plasticity and memory.

These findings suggest new molecular pathways and mechanisms for synaptic modification underlying cognitive processes.

2. Linking Synapses and Circuits

Traditionally studied in simplified models, synaptic plasticity is now being investigated in the intact brain. This session emphasized technological breakthroughs that enable in vivo analysis of synaptic dynamics:

- Advanced structural and functional imaging of dendritic spines in the visual cortex.
- Identification of synaptic input-specific changes in the hippocampus and amygdala that underlie spatial navigation and emotional learning.

These approaches illuminate how experience-driven synaptic changes shape circuit function.

3. Synaptic Plasticity Mechanisms Underlying Learning and Memory

The focus here was on dissecting the link between spine-level structural changes and in-vivo neural coding mediating behavioral learning and memory. Notable findings included:

- An optogenetic method to reverse learning-induced spine enlargement, revealing diverse, input-specific changes in synaptic connectivity and their role in neural coding.
- Cross-species analyses demonstrating how synaptic plasticity sustains memory amidst molecular and structural turnover.

This session underscored the importance of methodological innovation and diverse behavioral models in elucidating memory mechanisms.

4. New Views on Synapse Function

Moving beyond classic synaptic models, this session highlighted novel cellular and molecular frameworks:

- Studies on transcriptional regulation, endocytosis, and cell-type-specific factors governing synapse formation and maintenance.

These insights provide a more nuanced understanding of how synaptic functions are built and preserved at a detailed molecular level.

5. Distributed Synaptic and Circuit Connectivity Underlying Cognition

The final session addressed the challenge of linking synaptic and circuit-level phenomena to complex cognitive behaviors and disease. Key topics included:

- The formation of cognitive maps for complex memory and emotion.
- How disruptions in synaptic development contribute to circuit dysfunction and cognitive disorders.

This session emphasized the relevance of synaptic research for understanding cognition and potentially treating neurodevelopmental and psychiatric conditions.

Conclusion

Designed as both a scientific symposium and a cross-cultural initiative, this conference successfully advanced understanding of the synaptic basis of cognition while strengthening ties between the Japanese and U.S. neuroscience communities. By facilitating interdisciplinary discussion and international collaboration, the event illuminated how diverse approaches can converge to unravel the complexities of brain function. The meeting stands as a model for future initiatives seeking to combine scientific excellence with international dialogue and exchange.

7. Seminar Results and Future Implications:

Overview

The conference successfully convened leading scientists and emerging researchers from Japan and the United States to explore trailblazing research on how synapses and the neural circuits they form underlie cognition and are affected in neurological and psychiatric disorders.

The meeting achieved its goals by:

1. Creating a dynamic environment for the constructive exchange of ideas.
2. Fostering cross-cultural and scientific collaboration between the Japanese and U.S. neuroscience communities.
3. Highlighting emerging themes and identifying key directions for future research.

A Platform for Scientific and Cross-Cultural Exchange

The conference was intentionally designed to promote inclusivity, interaction, and meaningful engagement across all career stages and disciplines. Participants ranged from molecular neuroscientists studying synaptic signaling in simplified systems to systems neuroscientists examining circuit-level processes and behavior.

To support broad participation and vibrant exchange:

- All attendees were given opportunities to present their work.
- Invited speakers delivered plenary talks, while trainees participated in two dedicated “Young Investigator Sessions” and presented posters during a lively social gathering on the first evening.
- Informal interactions were prioritized through shared meals in an on-site dining hall and group activities, including a beach hike on the first day and bonfire gathering on the final evening.

This combination of formal sessions and informal networking fostered a collaborative spirit where every participant — regardless of seniority or specialization — could learn from one another. Attendees formed lasting friendships and developed intellectual and practical collaborations.

Scientific Impact and Key Insights

Scientifically, the meeting underscored the value of interdisciplinary perspectives. Presenters gained new insights and feedback from researchers working in different model systems or at different levels of analysis. The convergence of diverse methodologies and conceptual frameworks led to intellectually rich discussions that broadened participants' understanding of the synaptic basis of cognition.

Several promising directions for future research were identified:

- **Technological innovation** continues to be the primary driver of progress. The field is transitioning from studying synaptic structure and function in reduced preparations to probing these mechanisms *in vivo* in awake, behaving animals.

- **Molecular precision** remains equally vital. Understanding how individual molecules are trafficked and contribute to synapse formation and plasticity is essential. Emerging micro-scale technologies will play a crucial role in these efforts.
- There is a growing need to bridge **molecular-level insights** with **systems-level understanding**, linking synaptic changes to cognitive outcomes across developmental, behavioral, and pathological contexts.

Looking Ahead

This conference served not only as a milestone for scientific exchange but also as a successful model for international cooperation and cultural connection in neuroscience. By uniting two vibrant scientific communities, it set the stage for new collaborative projects, the development of shared research agendas, and the mentoring of the next generation of neuroscientists in a globally integrated environment.

The enthusiasm, openness, and rigor displayed at this meeting affirm the power of combining cross-cultural exchange with high-level scientific inquiry. The momentum generated here is expected to carry forward into ongoing partnerships and transformative research on the neural underpinnings of cognition.

8. Other (implementation issues, feedback, etc.)

The implementation went smoothly and no issues were encountered.