11:00-12:00 Dr. Kyogo Kawaguchi

RIKEN Cluster for Pioneering Research,
Center for Biosystems Dynamics Research

Many-body physics in biology: collective cell dynamics, interacting cell fates, and protein condensates (Japanese)

12:00-13:15 lunch time

13:15-14:15 Dr. Li-Kun Phng

RIKEN Center for Biosystems Dynamics Research

Mechanics of vascular tube formation, maintenance and diameter regulation (English)

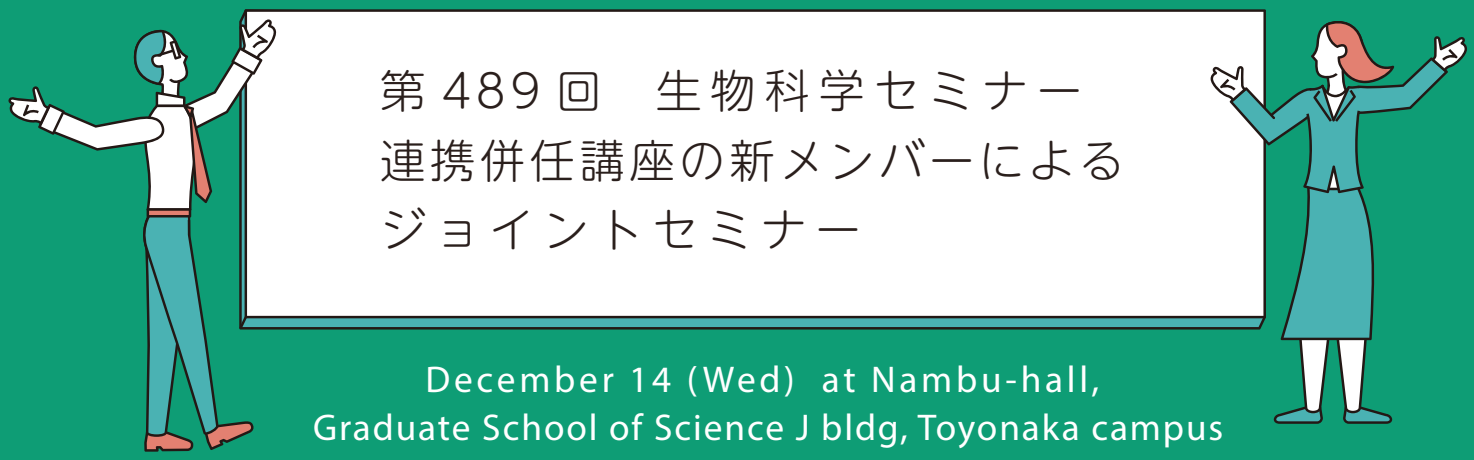
14:20-15:20 Dr. Ken'ya Furuta

National Institute of Information and Communications Technology

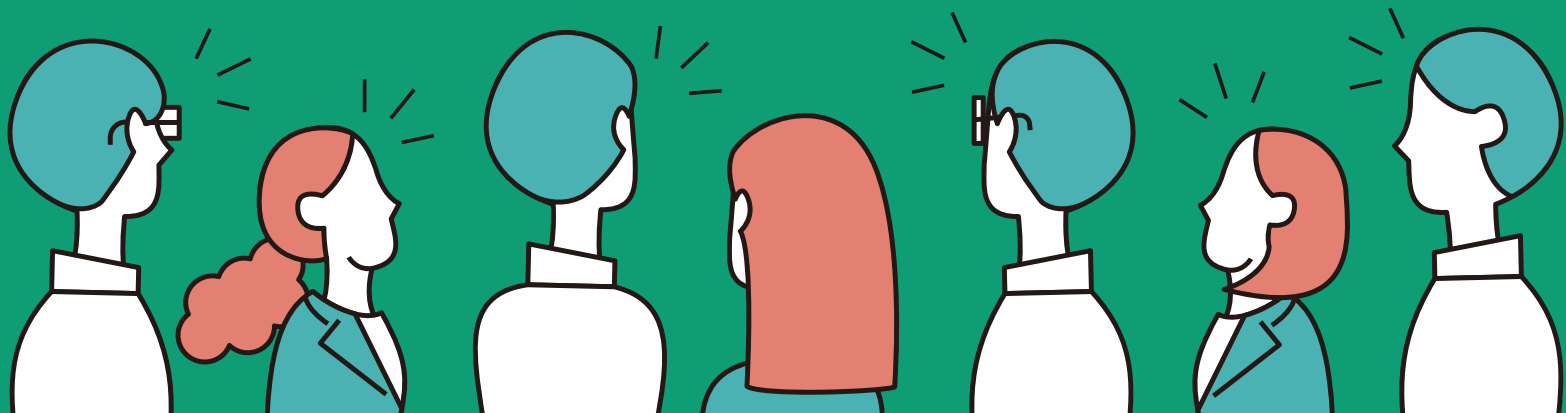
Engineering motor proteins to move on synthetic tracks for programmable molecular transport (Japanese)

15:30- tea time

JOINT SEMINAR by New Members from Extension Research Groups of
Department of Biological Sciences, Graduate School of Science, Osaka University



December 14 (Wed) at Nambu-hall,
Graduate School of Science J bldg, Toyonaka campus



JOINT SEMINAR by New Members from Extension Research Groups of Department of Biological Sciences, Graduate School of Science, Osaka University

11:00-12:00 Dr. Kyogo Kawaguchi

Many-body physics in biology: collective cell dynamics, interacting cell fates, and protein condensates (Japanese)

An important theme in biophysical studies is how to probe the rules of collective dynamics at multiple scales in biological phenomena, ranging from biomolecules to multicellular tissues. Although cell-to-cell interactions are crucial in developing and homeostatic tissues, probing the complex rules of those interactions is typically challenging. Even for the molecular level phenomena, where all the relevant components are defined, the rules of interactions between heteropolymers such as proteins, RNAs, and chromatin have been difficult to resolve computationally or theoretically.

In this talk, I will discuss some of our recent data-driven approaches to probing these rules. In the tissue level analysis, we take advantage of the large-scale live image data collected from adult mouse skin and cultured neural progenitors to estimate the “equation of motion” in multicellular dynamics. For the probing of protein interactions, we build a subcellular localization estimator of intrinsically disordered regions to extract the possible rules in condensation.

13:15-14:15 Dr. Li-Kun Phng

Mechanics of vascular tube formation, maintenance and diameter regulation (English)

The optimal distribution of blood to tissues requires the generation of well-patterned, hierarchically organized blood vessels of optimal diameter. How endothelial cells (ECs) behave and respond to haemodynamic forces to control lumenization, vessel morphology and vessel diameter are incompletely understood. By investigating the intersegmental vessels of the zebrafish embryo, we discovered that ECs utilize actomyosin cytoskeleton to control different cellular behaviours at different stages of blood vessel morphogenesis.

Initially, during the process of lumenization, ECs adapt to elevating blood pressure by fortifying the cell cortex with increased assembly of actomyosin cytoskeleton and by generating a balance network of linear and branched actin bundles. The failure of ECs to resist the deforming forces of blood pressure results in ectopic membrane blebbing, cell shape changes and vessel malformation in the zebrafish embryo.

After blood vessels become perfused, they undergo remodelling where vessels constrict to generate narrower tubes. This is mediated by a decrease in EC size and shortening of the EC. High-resolution image analysis revealed a transition in cortical actin cytoskeleton during the period of constriction, suggesting that actin remodelling may drive cell shape changes underlying vessel constriction. In addition, we observed dynamic oscillations in non-muscle myosin II in the cell cortex as indicated by fluctuations in the intensity if myosin light chain 9b (myl9b). Interestingly, a local increase in myl9b intensity correlates with a decrease in vessel diameter. When myosin II activity is decreased, the extent of vessel constriction is reduced.

Collectively, our studies demonstrate the diverse functions of actin cytoskeleton and myosin II activity in controlling EC mechanics and vessel morphogenesis.

14:20-15:20 Dr. Ken’ya Furuta

Engineering motor proteins to move on synthetic tracks for programmable molecular transport (Japanese)

Intracellular transport is the basis of microscale logistics within cells and is powered by biomolecular motors. Mimicking the transport for in vitro applications has been widely studied; however, the inflexibility in track design and control has hindered practical applications. Here, we developed protein-based motors that move on DNA nanotubes by combining a biomolecular motor dynein and DNA-binding proteins. The novel motors and DNA-based nanoarchitectures enabled us to arrange the binding sites on the track, locally control the direction of movement, and achieve multiplexed cargo transport by different motors. The integration of these technologies realized the microscale cargo sorter and integrator that automatically transport molecules as programmed in DNA sequences on a branched DNA nanotube.

DNA can be used as an information processor by employing a hybridization or transcription reaction cascade. The combination of our fast DNA motor with DNA reaction circuits should facilitate even faster DNA computing. Such computing is relevant to information processing in cells and may highlight differences between artificial systems and natural living organisms, leading to a deeper understanding of life.