whether and how the mechanical properties of the two spindle poles are symmetrically balanced. Here, we quantitatively measured the mechanical stiffness, the microtubule density, and the response to the deformation of spindle poles by micromanipulation techniques and 3D analysis. To directly deform the spindle self-assembled in *Xenopus* egg extract, we inserted two glass micro-needles into a pole region and widened it perpendicularly to the pole-to-pole axis. We found that the stiffness and the microtubule density in the manipulated pole region reduced upon widening. Surprisingly, this reduction propagated to the other side, which resulted in the formation of a symmetrical defocused barrel-like shape of the unmanipulated pole region. On the other hand, it is known that inhibition of the dynein function causes the defocusing of pole regions, such that the barrel-shaped structure is formed. We compressed one side by the micro-needles and found that the stiffness and the microtubule density in the compressed region increased, and this effect propagated to the other side, resulting in the bipolar shape formation. Our results suggest that the symmetrical spindle shape is maintained by propagating the structural change from one side to the other via the communication through the central region.

3H0924 高圧負荷によって誘導されるクラミドモナス非運動性変異株鞭毛の屈曲運動

Resurrection of flagellar bending movements in *chlamydomonas* paralyzed mutants at high pressure

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Application of hydrostatic pressure modulates the activities of organisms. To examine the effect of the pressure on ciliary and flagellar motility, here we observed the flagellar movements of *chlamydomonas* under high-pressure conditions. Wild type cell movements were inhibited by the application of pressure; the swimming velocity and the percentage of moving cells decreased with the pressure increased, and the movements stopped under the pressure of >80 MPa at 25 °C. Surprising, however, paralyzed mutants lacking the central structures of the flagellum (central pair microtubule: CP, or radial spokes: RS) displayed vigorous beating under the pressure of 40 to 60 MPa, but the movements stopped under the pressure of >80 MPa at 25 °C. Axonemes (isolated and demembrated flagella) of the mutants did not display beating in the presence of 1 mM ATP, but they displayed beating under the pressure of 40 to 60 MPa. This suggests that the application of pressure modulates the functional activities of some axonemal components. The motility analysis of the double mutants lacking both of CP (RS) and various species of dyneins showed that outer-arm dynein is indispensable for the movements. Previous studies showed that the microtubule-sliding movements powered by dynein were reduced in the axonemes of the CP/RS-deficient mutants. We suggest that the application of pressure directly or indirectly activates the outer arm dynein and increases the sliding movements, which induces bending movements in the paralyzed mutants.

3H0936 走化性誘因物質の進行パルス刺激によって誘発された一方向細胞運動 Directed cell migration induced by travelling waves of chemoattractant

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Mirgration of Dictyostelium cells is mediated by chemotaxis toward the chemoattractant cAMP. It is believed that cells determine their direction of motion by comparing the concentration difference between the head and rear of the cell. However in aggregating Dictyostelium, concentration profile of chemoattractant is not static, but takes the form of traveling waves. Because reversal of spatial gradient occurs repeatedly after each passing wave, cells could potentially move in the reverse direction in the wake of a passing wave. This problem is referred to as 'chemotactic wave paradox'. To address this problem, we designed and constructed a microfluidics system to generate traveling cAMP pulses of user-specified wave-length and propagation speed. Using this system, we studied chemotactic responses towards the traveling cAMP pulses and found that the migratory direction depends on the speed of pulse propagation. Cells migrate toward the in-coming cAMP pulse for waves with passage time of 3 ~ 10 min. In contrast, when the stimulus duration is less than 2 min, cells come almost to a halt. When stimulus duration is longer than 10 min, cells reversed their direction of motion at the back of the wave. These results indicate that cells are able to move towards the correct orientation only when stimulus duration time matches the cell response time. We will show how cytosolic signaling such as phosphatidylinositol and actin localization is related

to directed cell migration under the traveling cAMP pulses.

3H0948 極性を持つアメーバ細胞の走化性運動に関する理論

Theory on the chemotaxis of an amoeboid cell with the cell polarity

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Chemotactic amoeboid migration is an ubiquitous kind of cell motility, which is important for the immunological response, wound healing and developmental processes. In this presentation, we would like to explain our recent theory on the chemotactic migration of an amoeboid cell with the cell polarity, and share with you our results for the observable statistical quantities about the migrating direction based on the theoretical model in which we assume the following facts; 1. The cell has the polarity which is spontaneously organized. 2. The polarity is reoriented to the gradient direction the cell estimates from the binding states of chemoattractants to receptors. 3. The cell migrates to the direction of the polarity with a constant speed. 4. Chemotaxis is realized by the bias of the direction in which more chemoattractants bind to the receptors according to the chemical gradient. Using this model, firstly, we confirm our theory by comparison with the experimental data for the chemoattractant-concentration dependence of the correlation time of the spontaneous migrating direction. It should be noted that the spontaneous migration can also be discussed by our model as the case that the magnitude of the chemical gradient is zero. The results agree with the experimental data for Dictyostelium discoideum. Secondly, we derive the probability distribution of migrating directions and chemotaxis index. We find that the chemotaxis index is incremented by introducing the cell polarity. The details will be discussed on the day.

3H1010 Controlled cell migration with ultrasound

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Ultrasound is not only used for ultrasound imaging but also used for ultrasound healing therapy to recover from bone fracture recently while the mechanism for healing is not known surprisingly. Since it is reported that aggregation of cells is enhanced by ultrasound on a microscopic scale, it may be possible that ultrasound can control cell behavior closely related to the cell aggregation which could be one of main causes for enhancing bone fracture healing. To clarify cell aggregation by ultrasound irradiations, we have observed cell migration under optical microscopy with or without the irradiations directly. Ultrasound is generated from a homemade ultrasound needle made of tungsten wire with the diameter at 1.0 mm. The frequency of the ultrasound is near 1.5 MHz. The power intensity of the irradiations is near 24 mW/cm². In this conference, we will show the cell migration under ultrasound irradiation and discuss the result, converging cells on ultrasound exposure area. Finally, we will discuss the influence of ultrasound on cell migration.

3H1022 筋肉と異なるストレスファイバーの収縮特性

Contractile properties of stress fibers are distinct from those of muscles

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Actin stress fibers play essential roles in cell adhesion regulation and tensional homeostasis. Here we measured the contractile properties of single stress fibers isolated from vascular smooth muscle cells. Cells were deroofed with low ionic strength buffers to extract basal stress fibers. Western blotting analysis and negative staining electron microscopy indicated that the extracted stress fibers were intact with regard to structure and function. Individual stress fibers were isolated from the substrate using two glass needles. Mg-ATP solutions were added to induce contractile activity of the stress fibers, and forces were measured from the deflection of one of the glass needles with a known spring constant. We obtained a convex form of contractile forces as a function of sarcomere distance, which was similar to that of myofibrils. Interestingly, the shortening rate of the stress fibers drastically decreased when an external load was applied. Thus, the shortening rate-loading relationship was sharply different from that of muscles typically having a parabolic curve. We speculate that a recently reported load-dependent decrease in ADP release rate of nonmuscle myosin II may be responsible for this unique contractile property of stress fibers.