than iPfam possibly due to the inclusion of many crystal contacts in iPfam. We will examine in detail the difference between PPI and DDI network with 3did.

- 1P-241 2種の栄養要求性大腸菌からなる人工相利共生系において観察される協力的な適応的表現型可塑性
Cooperative and adaptive phenotypic plasticity observed in a synthetic mutualism composed of two auxotrophs of *Escherichia coli*

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Natural mutualism, which is a symbiosis in which population size of both are increased in a reciprocal association, can be considered as a stable condition in which each of the species adapts to the environment where the other exists. How was the adaptation process? Molecular phylogeny has accumulated the knowledge about the genetic adaptation in mutualism, however, nobody can observe the phenotypic change in the adaptation process. The adaptive phenotypic plasticity, which is an adaptive change in phenotype as a response to environment during its life, should play important rolls for the adaptation process of mutualism especially at the initial stage before the genetic adaptation. We artificially constructed a mutualism composed of two different nutrient-requiring mutants (auxotrophs) of *Escherichia coli* (*E. coli*) to observe the dynamics of the bacterial population at the initial stage, as a consequence of the phenotype of *E. coli*. In the synthetic mutualism, we observed an adaptive phenotypic change of one strain of *E. coli*, and the change was necessary for both two strains to increase their population. Surprisingly, the changes was cooperative, which means one strain change favorable for the other strain instead of a cost (decrease of fitness) for oneself. That is, the theory of the natural selection can not explain the observed adaptive change. In the poster session, we show the results of the population dynamics of the mutualism suggesting the presence of adaptive phenotypic change, and the results of the transcriptome analysis about the change, although the principle of the change is still unclear.

- 1P-242 一細胞培養系を用いた中心珪藻の殻形態の表現型多様性の測定
Phenotypic plasticity of the cell morphology of the centric diatom (*Cyclotella meneghiniana*) by the on-chip single-cell cultivation system.

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Cell morphogenesis is affected by various gene expression changes, and it occurs through stochastic events or responses to environmental fluctuations. Diatoms are unicellular eukaryotic microalgae, and their new cell walls are synthesized only during cell division. *Cyclotella meneghiniana* Kützinger, an euryhaline centric diatom, has organs (called strutted process) extruding chitin adhesive fibrils and making a cell cluster which are postulated to sink within the water column. In addition, gene expressions for the chitin synthases are amplified in hyper- or hypo-saline condition (Abdullahi et al., J. phycol. 2006). However, the factors responsible for variation in the number of chitin fibril extruded organs have not been investigated quantitatively from an evolutionarily ecological point of view. We investigated effects of salinity on the number of strutted process in 6 clone cultures with possibly different genotypes. The number of strutted processes increased with higher salinity level, indicating phenotypic plasticity in response to salinity fluctuation and genetically-determined reaction norms among the strains in population scale. Furthermore, we examined difference in the number of strutted processes of two daughter cells that were originated from an isolated single mother cell, using the on-chip single-cell cultivation system. Relationship between phenotypic plasticity and variation among clonal cells under the equivalent environmental conditions will be discussed.

- 1P-243 圏論におけるゆるいカテゴリー同値をもちいた学習システムへの応用
Applying weak equivalence of categories between partial maps and pointed sets to the 2-arm bandit problem with changing conditions

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We usually think that there is a clear cut between known facts and unknown facts. In category theory, this can be expressed as equivalence of categories for partial map and pointed set. If this analogy is accepted, the difference of “before” and “after encoding” is destined to be ignored. The observer who ignores this difference never learns a new thing that he never knows in advance. To distinguish between “before” and “after observing”, the observer should make up the entire world at each moment that he observes it. We therefore admit this discrepancy and propose the system implementing the weak condition of equivalence of categories for partial map and pointed set, and show the advantage of our system in learning or cognitive systems. Especially we apply our system to 2-arms bandit problem so as to estimate the property of our system in terms exploitation and

exploration. This problem is well known for reinforcement learning. When the agent decides the answer in finite time, it gives rise to the problem that is trade-off between exploring and exploiting. This problem never arises given enough time. The agent must decide answer from his imperfect information under the finite time condition. Recently, the heuristic model is attracted to approach this problem (Shinohara et. 2008). We proposed different approach for 2-arms bandit problem. For the model of weak equivalence of categories that we proposed, the agent can change dynamically his knowledge and adapt the environment. Moreover, we check the changing condition of the problem, for example, changing the probability of the machine, and show that our model can also adapt under the changing condition.

- 1P-244 真性粘菌変形体における形態発展パターンの自発的切り替え
Spontaneous switching of morphology development pattern in the plasmodium of *Physarum polycephalum*

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Plasmodium of true slime mold *Physarum polycephalum* is a unicellular and multinuclear giant amoeba. The morphological patterns of the amoeba vary according to the environmental conditions. For example, the plasmodia show a round shape with a uniform sheet-like structure, in nutrient-rich favorable conditions. On the contrary, in unfavorable conditions, for instance on repellent containing substrate, they show a nonuniform dendritic shape. However, the both patterns can be observed at the same time also in plain conditions without any attractive or repulsive stimuli. After inoculation on a substrate, the plasmodia show a round shape in the early stage of the locomotion, but the organism spontaneously switches to a nonuniform dendritic shape with time.

To understand the mechanism of the spontaneous switching behavior, we analyzed the time series development of the plasmodial morphology in terms of closure area and number of cycles (closure area: the area of neighborhood form of the actual plasmodia, cycle: a blank space enclosed by the plasmodia). We tested the dependency of the switching time on the mass of the plasmodia, and plotted the switching time for each mass of the plasmodium in double logarithmic scale. The results indicated that the switching time depends on the mass of the plasmodium. Then we deduced the mechanism of the switching behavior, on the basis of a previous study describing that the locomotion velocity of the plasmodium depends on the mass of the plasmodium.

- 1P-245 二つの同値関係から構成される束と行動の論理（真性粘菌変形体の行動に関する束論的解析）
Analysis for the behavior of *Physarum* plasmodium using lattice

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Lattice is an algebraic structure on which two operations “join” and “meet” are defined. These operations satisfy associative, commutative, idempotency and absorption laws. They correspond to logical operations “AND” and “OR”. Lattices correspond to various logical structures. When two equivalent relations are defined on the universal set, we are able to construct a lattice as the subset of the power set of the universal set. We use rough set pseudo closure to obtain a lattice (mathematically the rough set is a pair of upper and lower-approximation set). Some lattices can be non-distributive, or non-complemental. These lattices are constructed by the difference of two equivalent relations and they are “ill-natured” logic. But, these logics are important to logical operations of the organisms. True slime mold *Physarum polycephalum* plasmodium is a unicellular and multinuclear organism. The plasmodium is considered to perform some logical operations. These operations are considered to be driven by protoplasmic oscillations. The motion of the plasmodium seems to reflect the results of the logical operations. We classified the different parts of the body of the plasmodium. These classifications correspond to equivalent relations and reflect the behavior of the plasmodium. Lattices were constructed from this classification. We discuss the relation between motion of the plasmodium and its logical structure.

- 1P-246 混雑した細胞内環境における分子機械システムの振舞い
Reaction-Diffusion Behavior of a Molecular Machinery in the Crowded Environment of the Cell

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Biochemical processes in the cell have been often modeled and investigated as behavior of a reaction-diffusion system. With recent advances in systems biology and omics studies, even simulations of a whole cell have been intended. However, biological cells have some significant features not considered in classical reaction-diffusion equations.

In a biological cell, there are complicated membrane structures, and a variety of macromolecules are either embedded in such membranes or included in the space