and a feedforward active damping technique. Our final goal is the realization of high-speed AFM which can quickly capture an image of live cells. The maximum displacement was increased up to $\sim 30\text{ }\mu\text{m}$, whereas the resonant frequency of the scanner was significantly reduced and hence prone to produce unwanted mechanical vibrations. However, the natural resonant frequency was significantly extended by a digital feedforward control technique (an inverse compensation method). As a result, the wide-displacement scanner is able to be scanned in a triangle waveform at 2 kHz without producing mechanical noise. This scan speed corresponds to an imaging rate of 50 ms/frame for 100 scan lines.

1P340 ダイナミックマイクロアレイによる異種細胞の隣接配置技術
1J1505 Pairing Two Different Types of Cells with a Dynamic Microarray

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We propose a microfluidic device to pair two different types of cells. The microfluidic technology to pair two different types of cells has recently garnered attentions for their potential applications in biochemical science and biotechnology such as cell fusion or the analysis of cell-cell interaction. In the conventional technologies, samples are handled and arrayed by using complicated process such as using magnetic forces or passive hydrodynamic trapping, so that we must improve the devices to be more robust and easier to fabricate and handle for the biological research. We have developed a dynamic microarray to pair different types of microbeads in a simple and convenient way to trap each sample sequentially in the trapping sites. This dynamic microarray device enables us not only to pair hydrogel beads and to observe the interaction between them, but also reduce the necessary amount of them. By using this device, we have successfully trapped different types of cells: NIH/3T3 cells and HepG2 cells cultured onto the collagen hydrogel beads in one trapping site. In this report, we will also discuss the device for trapping and pairing different types of single cells. We found that our dynamic microfluidic device is applicable for the observation of interactions between the paired cells such as molecular diffusion. We expect that this device will play an important role in the continuous observation of cell-cell interaction in the future.

1P341 昆虫背脈管を駆動源とする耐環境性マイクロバイオリボットの創成と制御
Creation and regulation of environmentally robust bio-actuator by insect dorsal vessel

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Living muscle cells can be considered as a micro linear actuator with high efficiency which can work only with chemical energy. Several hybrid devices using mammalian cardiomyocytes were reported so far [1-3]. However, the mammalian cardiomyocytes can survive and contract spontaneously only under the optimal culture conditions at 37 °C and at pH of around 7.4. On the other hand, an insect cell can generally survive and proliferate at 20 to 30 °C and at pH 6 to 8. We already proposed to utilize insect dorsal vessel (DV) tissue and cells as an environmentally robust actuator [4] and reported a micropillar actuator driven by DV tissue [5].

In the present study, we attempted to regulate the micropillar actuation by electrical stimulation or adding neuroactive chemicals. A micro robot actuated by the DV tissue was also created, which moved autonomously at velocity of 2.3 $\mu\text{m}/\text{sec}$. Furthermore, we succeeded in fabricating DV cell sheet using temperature-responsive culture dishes. The results show possibility of bio-robotic field by insect muscle cell.

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1P342 収縮によるフェムトリットル油中液滴の生成とモデリング
1J1520 Diffusion Modeling of Controlled Shrinkage for Femtoliter Water-in-oil Emulsion

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To experimentally model biochemical reactions in a volume of bacterial size, we attempt to construct monodisperse nano-size reactors using water-in-oil

(W/O) emulsions. We employ a novel approach to generate femtoliter (fL) aqueous droplets in oil using controllable shrinkage, featured with facile control, high throughput and high efficiency. Aqueous droplets shrink due to the slight solubility of water in some kinds of oil while various solutes can remain. When adding sufficient solutes or surfactants (referred as particles), water diffusion can be blocked. The governing equation for shrinkage is derived based on Fick's laws, by introducing a new parameter *block fraction*. It predicts the linear surface shrinkage for water with dilute particles, and the successive nonlinear one for concentrated particles.

W/O droplets are generated by vortex and microchannels for experimental verification. A pure water droplet in soybean oil undergoes rapid shrinkage, while after adding solutes (e.g. Dextran) or surfactants (e.g. Span 80), the shrinkage rates significantly slow down, and droplet sizes can become stable at fL order. Monodisperse droplets are generated using microfluidics to study the concentration effects of particles. With higher particle concentration, shrinkage rates are slower and final sizes become larger. Experimental data of typical W/O shrinkage with/without various particles are normalized and well fitted by the proposed model, showing that various shrinkages can be predicted with two fitting parameters.

1P343 キネシン・微小管を動力源とする微小回転素子
A micro-rotary device powered by kinesin-microtubule

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Motor proteins are fascinating molecular machines that convert chemical energy into mechanical works in high efficiency. We aim to create novel bio-hybrid micro-mechanical devices that integrate motor proteins with micro fabrication techniques. In this study, we challenged to make a micro-rotary device driven by kinesin, which is a kind of motor proteins and has an ability to transport micro/nano cargo along a microtubule. This micro-rotary device was built on three steps. First, the direction of kinesin-driven microtubule movement was rectified to unidirectional circulating by using micro circular track fabricated on glass surfaces. Second, we fabricated a micro-rotor (20 μm in diameter) by lithography, and then immobilized linker molecules over the rotor surface for connecting to microtubules. Finally, we placed the rotor into the circular track using micromanipulator, and combined the rotor with the moving microtubules. Typically, rotors started to rotate within a few second. Most rotors rotated for several minutes at speed of 0.3 rpm into the expected direction (same direction of the microtubule circulation). This is first successful micro-rotary device that integrates synthesized micro-parts with motor protein. We believe that this study contributes to the development of future micro-devices designed and built from molecular components.

1P344 Hierarchical Organization From Noise To Spontaneous Signal-Dynamics Of Oosawa Model-

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Living cells often generate signals spontaneously in the absence of external stimuli. Those signals play an important role in their tactic behaviors. A theoretical treatment on the mechanism of spontaneous signal generation has been proposed by Fumio Oosawa in 1990. The Oosawa model consists of two steps. The first step is to produce the basic fluctuation of intracellular electric potential by the stochastic open and close of ion channels. The second step is to generate the spike-like fluctuation of membrane potential induced by the positive shift in the basic fluctuation. The first step is described by an equation of the Langevin type, where the random force is proportional to the circulating ion current across the membrane. The second step is described by a rate equation of transition of field-sensitive channel gates which contains the fluctuating electric field in the exponential term. In the present study, we performed numerical simulations of the Oosawa model. The model successfully produced spike-like fluctuations. We then study the model from the nonlinear dynamics viewpoint. We found that the large spike-like fluctuation can be observed when the system shows excitability. For the excitability, the circulating ion current is necessary to be small and the ion current of the field-sensitive channel, which is almost closed, should be large. In addition, the correlation time of basic fluctuation needs to be long enough, whereas that of the field-sensitive channel needs to be short.

1P345 NMR メタボロミクスの医療への応用：透析患者血漿と廃液の解析
Biomedical Application of ¹H NMR Metabolomics to Plasma and Waste-fluid from Hemodialysis Patients

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Metabolic profiling using ^1H NMR spectroscopy combined with pattern recognition analysis was used. It is a non-targeted method, and possible to capture un-expected marker candidates. Plasma from patients of pre- and post- hemodialysis together with their waste-fluid during dialysis treatment were collected, the informed consent were obtained from the patients, and measured by 600 MHz NMR spectroscopy. Proton NMR spectral patterns of plasma between pre- and post- dialysis were clearly discriminated together with significant fluctuations in the level of metabolites. Several metabolites such as lactate and alanine have decreased with the different ratio from that of creatinine, which suggested *de novo* genesis during treatment. Waste-fluid is adequate for quantitative ^1H NMR analysis because of almost only low-molecular-weight metabolites included. It ensures multiple and time-course measurement for its collection is completely non-invasive for patients

**1P346 光化学的 DNA 操作による DNA コンピューティング
DNA computing based on photochemical DNA manipulation**

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A major challenge in molecular computing is to construct logic gates that are devices that perform the fundamental logic operations NOT, AND, and OR. In particular, DNA has proven to be highly useful as building blocks for the construction of logic gates because DNA offers immense information-encoding capacity and predictable recognition through Watson-Crick base pairing. Here, we report the construction of a photochemical logic circuit made entirely of DNA and implemented by using sequence-specific photocleavage (SSPC) of photocrosslinked sites in the gate strands. We prepared six photocrosslinked gate strands and six carbazolemodified ODNs (input strands) to examine the sequence specificity of the SSPC reaction. The gate strands consisted of a 23-mer gate moiety that possessed the photocrosslinked site, an address sequence at the 5' end and a biotin at the 3' end for output detection by using streptavidine-Cy3. All gate strands and one input strand were mixed in a single test tube, and then photoirradiated at 366 nm. The results of the SSPC reaction were visualized by fluorescence imaging after sequence-specific hybridization between a probe attached to a DNA chip and the address sequence at the 5' end of the gate moiety. The results show that fluorescence output was observed except for gates that matched the input sequence; this indicates that the SSPC reaction is suitable to construct DNA logic circuits.

**1P347 昆虫サイボーグ創製に向けた体液中トレハロースによる発電の検証
Power generation from trehalose in insect hemolymph: an experiment for development of insect cyborgs**

Kan Shoji, Yoshitake Akiyama, Takayuki Hoshino, Keisuke Morishima, (Tokyo University of Agriculture and Technology)

In the present day, there are a lot of issues to create insect cyborgs such as miniaturization, weight reduction, equipment of electrical stimulators and sensors. One of the big issues is the energy source for devices embedded in the insect's body. Insect cyborgs used for exploration and sensing have been developed by controlling electricity to stimulate muscles and brain. In order to increase the device performance, the energy source used in these devices should have long lifetime, high power capacity, compact and light-weighted. In addition, unlike conventional fuel cells, power generation using glucose oxidation does not need noble metal like platinum catalysts. Also, there are many studies on power generation by glucose which are almost in practical phase. Insect blood contains disaccharide trehalose which can be decomposed into two glucose molecules by trehalase enzyme. In this study, we proposed a novel power generation by trehalose in insect hemolymph. Madagascar hissing cockroach was selected because of their characteristics; appropriate body size to accommodate devices, long life-span and environmental adaptability. Approximately 7.5 mM trehalose in insect hemolymph was detected by LC/MS. Trehalose decomposition gives about 15mM glucose, which is three times of glucose concentration in human blood. Trehalose electrodes with trehalase enzyme were constructed as an attempt to generate electricity by hemolymph. In conclusion, the feasibility of a novel power generation using insect hemolymph can be reached.

**1P348 チャネルロドプシン 2 遺伝子導入キイロショウジョウバエの
1J1535 筋肉を用いた光制御バイオマイクロアクチュエータの創成
Creation of photo-regulated Bio-Micro-Actuator using Channelrhodopsin-2 transgenic *Drosophila melanogaster* muscles.**

Keisuke Takizawa, Yoshitake Akiyama, Takayuki Hoshino, Hidenobu Tsujimura, Kikuo Iwabuchi, Keisuke Morishima, (Tokyo University of Agriculture and Technology)

Drosophila melanogaster is known as a model organism and its genome

project has already been conducted. In this study, we propose a novel photo-regulated Bio-Micro-Actuator (BMA) using transgenic *Drosophila* muscle tissues. Insect cells are robust over a wider range of culture conditions, compared to mammalian cells. Therefore, micro-actuator using *Drosophila* muscle cells can be driven without precise environmental control. In addition, GAL4/UAS enhancer trap method enables them to express transgenes in specific sites. As a transgene, we focused on Channelrhodopsin-2(ChR2), which is a photo-activated cation channel identified in *Chlamydomonas reinhardtii* and is activated by blue light illumination. Action potentials and muscle contractions elicited by blue light illumination are confirmed on *Drosophila* neurons and *C. elegans* muscles expressing ChR2. Then, *Drosophila* expressing ChR2 in muscle cells or neurons can be observed and motions of their muscle tissues can be measured either with or without blue light. Capability to create photo-regulated BMA by using genetically modified *Drosophila melanogaster* muscle tissues is shown in this study.