ARE THE JAPANESE SELFISH, ALTRUISTIC OR DYNASTIC?*

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I analyse a variety of evidence for Japan and, where available, for the United States on bequest practices, the importance and nature of bequest motives, bequest division, the willingness of individuals to help others, etc., in order to shed light on which model of household behaviour applies in the two countries. My results suggest that the selfish life-cycle model is the dominant model of household behaviour in both countries but that it is far more applicable in Japan; that the dynastic model is also more applicable in Japan but is not of dominant importance even there; and, conversely, that the altruism model is far more applicable in the USA.

JEL Classification Numbers: D12, D64, D91, E21.

1. Introduction

Together with firms and the government, individuals (households) are one of the three major economic agents in any economy, but there is surprisingly little agreement about which model of household behaviour applies in the real world. For example, are individuals selfish, caring only about themselves, or are they altruistic, caring not only about themselves but also about their children, other family members and perhaps even about complete strangers? Or are individuals concerned primarily about the perpetuation of the family line or the family business?

In this paper, I briefly discuss three theoretical models of household behaviour and show that they have very different implications for bequest motives and bequest division. I then present a variety of evidence on bequest practices, on the strength and nature of bequest motives, on bequest division, on the willingness of individuals to help others, etc., for Japan and, where available, for the United States in order to shed light on which model of household behaviour applies in each of the two countries.

The issue of which model of household behaviour applies in the real world is an important one because it has ramifications for the impact that government policies have on the macroeconomy (e.g. whether or not Ricardian equivalence holds in the real world) and for the extent to which wealth disparities are passed on from generation to generation.

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Are the Japanese Selfish, Altruistic, or Dynastic?

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(Institute of Social and Economic Research)

Abstract
In this paper, I discuss three theoretical models of household behavior and present a variety of evidence for Japan and, where available, the United States on historical bequest practices, the strength and nature of bequest motives, bequest division, the willingness of individuals to help others, etc., in order to shed light on which of these models applies in the real world. My results suggest that all three models coexist in both countries but that the selfish lifecycle model and, to a lesser extent, the dynasty model are far more applicable in Japan than they are in the United States and, by contrast, that the altruism model is far more applicable in the United States than it is in Japan.

Introduction
Together with firms and the government, individuals (households) are one of the three major economic agents in any economy, but there is surprisingly little agreement about which theoretical model of household behavior applies in the real world. For example, are individuals selfish, caring only about themselves, or are they altruistic, caring not only about themselves but also about their children, other family members, and perhaps even about complete strangers? Or are individuals primarily concerned about the perpetuation of the family line or the family business? In this paper, I discuss three theoretical models of household behavior and present a variety of evidence for Japan and, where available, the United States in order to shed light on which of these models applies in the real world.

The issue of which theoretical model of household behavior applies in the real world is an important one because it has ramifications for what impact government policies have on the economy (for example, for whether tax cuts financed by the issuance of government bonds will have a stimulative impact on the economy) and for the extent to which wealth disparities are passed on from generation to generation.

Theoretical Models of Household Behavior
There are at least three theoretical models of household behavior that are commonly used by economists—(1) the life cycle model, (2) the altruism model, and (3) the dynasty (or lineal) model—and these models have very different implications for bequest motives and bequest division (see Table 1 for a summary).

(1) The Selfish Life Cycle Model. This model assumes that individuals are selfish and that they don’t care about their children. Thus, individuals will either not leave any bequests at all to their children, leave only accidental bequests (bequests of assets that happen to be left over), or leave bequests only if their children do something in return such as providing care and financial support during old age, and they will leave their entire bequest to the child or children who provide care and financial support during old age.

(2) The Altruism Model. This model assumes that individuals care about their children. Thus, individuals will leave bequests to their children even if they get nothing in return and will either divide their bequests equally among their children or leave more to the neediest child or children.

(3) The Dynasty (or Lineal) Model. This model assumes that individuals are motivated by a desire to continue the family line and/or the family business. Thus, individuals will leave a bequest only if their children carry on the family line and/or the family business and will leave their entire bequest to the child or children who carry on the family line and/or the family business.

As I have shown, the three theoretical models of household behavior discussed above have very different implications concerning bequest motives and bequest division, and thus data on bequest motives and bequest division can shed light on which of these models applies in the real world.

<table>
<thead>
<tr>
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<th>Selfish life cycle model</th>
<th>Altruism model</th>
<th>Dynasty model</th>
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<tbody>
<tr>
<td>Assumption</td>
<td>Individuals are selfish</td>
<td>Individuals are altruistic toward their own children</td>
<td>Individuals care about the perpetuation of the family line or the family business</td>
</tr>
<tr>
<td>Bequest motive</td>
<td>Leave no bequest, leave only accidental bequests, or leave a bequest only if one’s children provide care during old age</td>
<td>Leave a bequest no matter what</td>
<td>Leave a bequest if one’s children carry on the family line or the family business</td>
</tr>
<tr>
<td>Bequest division</td>
<td>Leave more to the child who provides care during old age</td>
<td>Divide equally or leave more to the neediest child</td>
<td>Leave more to the child who carries on the family line or the family business</td>
</tr>
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Table 1. Comparison of three theoretical models of household behavior.
Data on Bequest Motives and Attitudes towards Bequest Division

Data from the “Comparative Survey on Savings in Japan and the United States (Chochiku ni kansuru Nichibei Hikaku Chousa),” which was conducted simultaneously in Japan and the United States in 1996 by the Institute for Posts and Telecommunications Policy of what was then called the Ministry of Posts and Telecommunications of the Government of Japan, show that the proportion of respondents whose bequest motives and attitudes towards bequest division is consistent with the selfish life cycle model is much higher in Japan than it is in the United States, which implies that the Japanese are much more selfish than Americans (see Figures 1 and 2). By contrast, the proportion of respondents whose bequest motives and attitudes towards bequest division is consistent with the altruism model is much higher in the United States than it is in Japan, which implies that Americans are much more altruistic than the Japanese. Finally, the evidence suggests that the Japanese are somewhat more dynastic than Americans but that dynastic individuals are in the minority in both countries (the option of leaving more to the eldest child even if he/she doesn’t provide care during old age is classified as being consistent with the dynastic model because, in Japan, it is typically the eldest son (or daughter) who carries on the family line and/or the family business.

Other Types of Evidence

Elsewhere in my paper, I consider a variety of other types of evidence for Japan and, where available, the United States on which theoretical model of household behavior applies in the real world including evidence on (1) historical bequest practices, (2) the strength of bequest motives, (3) the willingness of individuals to help others, (4) the impact of parental bequest motives and parental assets on the behavior of children, (5) the impact of public pensions on consumption and saving, (6) the impact of the distribution of resources within extended families on their consumption patterns, (7) the impact of tax policy on consumer spending, (8) inter-cohort differences in lifetime incomes, and (9) experiments concerning voluntary public goods provision.

Conclusions

The various types of evidence I have considered in this paper suggest that no theoretical model of household behavior has universal applicability in either Japan or the United States and that the various models of household behavior appear to coexist in both countries but that the selfish life cycle model is the most highly applicable model in both countries, that it applies to a far greater extent in Japan than it does in the United States, that the dynastic model is also more applicable in Japan than it is in the U.S. but that it is not of dominant importance even in Japan, and conversely, that the altruism model is far more applicable in the United States than it is in Japan. My finding that the Japanese are more selfish, and care less about their children, than Americans is somewhat surprising because it is often said that family ties are stronger in Japan than in the West. It is true that family ties are stronger in Japan (for example, children are much more likely to live with, and care for, their parents in Japan), but it appears that those ties are motivated by selfishness rather than by altruism.
Turning to the policy implications of my findings, my finding that the selfish life cycle model applies in Japan implies that tax cuts financed by the issuance of government bonds will be effective in stimulating the economy and that there may not be that great a need to worry about wealth disparities being passed on from generation to generation. The reason for the latter is that, in the case of the selfish life cycle model, bequests from parents to children will be largely offset by intergenerational transfers in the opposite direction (from children to parents) in the form of care and financial support during old age, meaning that net intergenerational transfers from parents to children will not necessarily be large or even positive.

**Japanese Economic Association-Nakahara Prize**

The paper summarized above is the text of the Japanese Economic Association-Nakahara Prize Lecture, delivered at the fall meeting of the Japanese Economic Association at Hitotsubashi University, Tokyo, Japan, on October 7-8, 2001. The Japanese Economic Association-Nakahara Prize was founded in 1995 and is awarded each year to a Japanese economist under the age of 45 who has conducted internationally recognized academic research in economics. It is funded by a kind donation from Mr. Nobuyuki Nakahara, a former Policy Board member of the Bank of Japan. The citation states in part: “Professor Horioka has made several outstanding contributions in the areas of international capital flows and saving and consumption in Japan. Among his major contributions is a seminal piece written jointly with Martin Feldstein. The work gave birth to the celebrated ‘Feldstein-Horioka Paradox,’ which reveals a strong correlation between national saving and investment. Since 1988, Professor Horioka has published a series of highly important papers on saving behavior in Japan, which have made him one of the most influential specialists on the Japanese economy in the world.”
Spallation Ultracold-Neutron Production in Superfluid Helium

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The first ultracold-neutron (UCN) production in superfluid helium placed in a spallation neutron source is carried out. A UCN density of 0.7 UCN/cm², which can be used in experiments, is achieved for a proton-beam power of 78 W and a He-II temperature of 1.2 K. The present new UCN source is not limited by Liouville's theorem and extraction losses, which were serious problems in the previous sources. The present source has the possibility of extremely high-density UCN production compared with previous UCN sources.

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Ultracold neutrons (UCN), which exist in the low-energy tail of a Maxwellian distribution, have been extracted from cold neutron sources. UCN can be confined in a material bottle and a magnetic bottle. Confined UCN have been used in various experiments, e.g., neutron electric-dipole-moment (EDM) [1] and ħ-decay [2] experiments. The current interest in the neutron EDM is related to the CP violation and baryon asymmetry in the universe. The weak coupling constants obtained by the neutron ħ-decay play important roles in the solar neutrino problem, the nucleosynthesis in the universe, and the weak interaction between quarks. UCN are also very useful in other fields, e.g., the quantization under gravity has been observed for the first time with UCN [3].

For further progress in these fields, a high-density UCN source is highly desirable. A turbine UCN converter improved UCN extraction and provided until now the highest UCN density [4]. However, further improvement in the UCN density seems very difficult. UCN density does not change upon deceleration at the turbine according to Liouville's theorem. The turbine does not cool down the neutron temperature, but gets around the transmission loss of UCN through the barrier of the cold neutron source. The UCN density might increase at lower moderator temperature. However, almost all materials are frozen at 20 K, the temperature of cold neutrons. In frozen material, the mass of the scatterer becomes very large, therefore, the energy loss of the cold neutron upon scattering is too small to be cooled down further.

UCN production by phonon excitation was proposed [5]. Since Feynman proposed a neutron scattering experiment on superfluid helium (He-II), the Landau dispersion curve and the He-II form factor have been measured by many experiments [6]. The energy-momentum dispersion curves of He-II phonons and neutrons cross in the cold neutron region. Since phonons behave like neutrons upon collision at the intersection point, energy and momentum are efficiently transferred from neutrons to phonons. Neutrons at the intersection point are cooled down, since the decrease of neutron phase space is balanced with the increase in phonon phase space. The enhancement of UCN production at the intersection point was observed in cold-neutron-beam experiments [7,8]. When He-II is placed in a high flux reactor, an enormous UCN density is obtained. However, UCN heating limits the operation of a He-II cryostat in the reactor. The temperature of He-II should be kept below ~1 K in order to suppress UCN scattering, which is scattering from UCN to higher energy neutrons than the critical energy.

In the present experiment, we produced for the first time UCN in He-II placed in a spallation neutron source where the UCN heating was much smaller than in a reactor. UCN were directly transferred to a bottle for experiments and measured. The present method is not limited by Liouville's theorem and extraction losses, therefore realizing a new-generation UCN source.

Solid deuterium (SD2) is also used for UCN production. SD2 has a high UCN production rate, but it has a large loss rate. UCN sources with shutters are being developed to reduce the UCN contact time with SD2 [9–11]. He-II has the advantages of a small loss rate and fast heat conduction, in addition to the lack of extraction losses. These advantages make UCN source operation more effective. The UCN density for long proton pulses is obtained by a product of the production rate and the storage time which is a time constant for UCN loss. We can apply a high proton-beam power to obtain a high UCN production rate. A long storage time in He-II is more effective in higher energies, where a reflection loss rate is lower. Low-energy UCN are crucial for experiments with confined UCN.

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Spallation Ultracold-Neutron Production in Superfluid Helium

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Introduction

Neutrons provide good opportunities to investigate the fundamental physics through their properties such as the life-time, the asymmetry of the β-decay, the electric dipole moment (EDM), etc. A free neutron decays into a proton, an electron and an electron-antineutrino. The half-life for this decay process is approximately 890 seconds. Since the discovery in 1932 by Chadwick, however, free neutrons could be studied under conditions where they stayed only in a brief moment within the experimental apparatus. Even cold neutrons with λ~10Å, v = 400 m/s take only 2.5 ms to travel 1 m. Neutrons with energies less than several hundreds neV are called ultra-cold neutrons (UCN). It was first pointed out by Fermi that the coherent scattering of slow neutrons would result in an index of refraction. As a result, UCN with energies below a critical energy are confined in a material bottle. The critical energy is determined by the Fermi potential which is obtained by the average neutron scattering length in material. The $^{58}$Ni surface has the largest Fermi potential of 335 neV, which corresponds to the magnetic potential in a 5 T field and to the gravitational potential of a 3 m height. UCN are also confined in a magnetic bottle. Figure 1 shows the various kinds of behaviors of UCN in an experimental bottle. The current interest in the neutron EDM [1] is related to the CP violation and baryon asymmetry in the universe. The weak coupling constants obtained by the neutron β-decay [2] play important roles in the solar neutrino problem, the nucleosynthesis in the universe and the weak interaction between quarks. UCN are also very useful in other fields, e.g. the quantization under gravity has been observed for the first time with UCN [3].

In the early stage of these studies, UCN were extracted from the low-energy tail of a Maxwellian distribution produced by cold neutron sources. For further progress, a high-density UCN source is indispensable. Since the first extraction of UCN from a reactor neutron source, UCN density has steadily been improved until 1985. At the Grenoble reactor, very cold neutrons (VCN) are extracted from a cold neutron source through a barrier. They use the gravitational potential and a mechanical turbine to decelerate VCN to UCN energies and provide the present highest UCN density of 10 UCN/cm² in an experimental bottle [4]. However, further improvement in the UCN density seems very difficult, because UCN density does not change upon deceleration at the turbine according to Liouville’s theorem.

![Figure 1. The various kinds of behaviors of UCN in an experimental bottle.](image-url)
Figure 2. Superthermal method and neutron phonon dispersion curves. The both curves intersect at a neutron wave length of 5 Å.

Figure 3. Spallation UCN source. Neutrons are produced by a proton beam in a lead target and then moderated to a cold neutron region in 300 K and 10 K heavy water bottles. These cold neutrons are down scattered to UCN in a He-II bottle. These UCN diffuse via an UCN guide to a detector, where they are measured.

Spallation UCN source

A superthermal UCN source was proposed to overcome above difficulty [5]. The energy-momentum dispersion curves of superfluid helium (He-II) phonon and neutrons cross in the cold neutron region [6] as shown in Fig. 2. At the intersection, energy and momentum are efficiently transferred from neutron to phonons. Neutrons at the intersection point are cooled down, since the decrease of neutron phase space is balanced with the increase of phonon phase space. When He-II is placed in a high flux reactor, an enormous UCN density might be expected. However, heating limits the operation of a He-II cryostat in the reactor. The temperature of He-II should be kept below ~1 K in order to prevent UCN from scattering to higher energies.

In the present work, we produced for the first time UCN in He-II placed in a spallation neutron source where the heating is much smaller than in a reactor. The layout of the RCNP UCN source is shown in Fig. 3. Neutrons of energies of several MeV are produced by bombarding a 5 cm diam and 20 cm long lead target with intermediate energy protons and are cooled down to thermal energies in a heavy water moderator at room temperature. These thermal neutrons are further cooled in a cold moderator of heavy ice which is cooled down by a Gifford-McMahon refrigerator to a temperature of 10 K. A 16 cm diam and 60 cm long He-II bottle is placed inside the cold moderator. The bottle is coated with nickel by a nonelectroplating method. The Fermi potential is 218 neV for the nickel coating with a small content of phosphorus. Cold neutrons are down scattered to UCN in the He-II bottle and then UCN diffuse upward to a UCN detector box through an 8.5 cm diam guide tube, which is directly coupled to the He-II bottle without any cryogenic window. The maximum height of the guide tube is 1.2 m above the bottom of the He-II bottle. The gravitational potential for neutron is 122 neV for the height difference of 1.2 m. The temperature is a key parameter in the superthermal UCN source. The He-II is in contact with a copper-fins heat exchanger [7] in a $^3$He/$^4$He cryostat through 1 mm diam holes. The He-II temperature was 1.2 K at a $^3$He pumping of 600 m³/h.

In the UCN detector box, 1.5 and 2.4 diam holes are used as neutron entrance windows where $^5$LiOH-coated films are placed.

Figure 4. Pulse height spectrum of UCN detector. The peak labeled 2.74 MeV results from the tritium of the $^5$Li($n$,$\alpha$) reaction. The small plateau (2.05 MeV $\alpha$) results from alpha particles, $\gamma$-rays and electric noise produce the step rise at low energies. The sharp drop below channel 100 results from an overflow.
Incident neutrons on the entrance windows are captured by $^7\text{Li}$ nuclei and then converted to tritons and alpha particles which are detected by Si-PIN diodes. A measured pulse height spectrum is shown in Fig. 4. A clear peak is observed in the spectrum resulting from the 2.74 MeV tritons of the $^7\text{Li}(n,\alpha)t$ reaction. The present detector efficiencies for the small and large detectors were $\varepsilon = 3.3\%$ and $6.8\%$, respectively, at a neutron velocity of 5 m/s.

**UCN production**

The spallation UCN production in He-II was carried out at the RCNP Ring-Cyclotron facility of Osaka University using a 392 MeV proton beam. The proton beam was pulsed at the injection line of the cyclotron. The peak current of the proton pulse was 200 nA on target. The neutron decay spectra are shown in Figs. 5 and 6. The squares in Fig. 5 are the counts of proton and charge pulses. Diamonds and closed circles are neutron counts of the large and small detectors, respectively. Neutron counts consisted of two components, prompt and residual counts. The prompt counts quickly disappeared after switching the beam off. The residual counts resulted from UCN which stayed in a storage bottle consisting of the He-II bottle and guide tube. A storage time of 14 s was determined from the time constant of the decay spectrum. This value is explained by UCN loss at the detector and the phonon up-scattering. For the confirmation that the residual neutron counts are UCN, we performed measurements with and without nickel foil in front of the detectors. The nickel foil completely reflects UCN, since the Fermi potential of pure nickel is 252 keV. The open and closed circles in Fig. 6 are the neutron counts with and without nickel foil, respectively. The effect of the total reflection of UCN is clearly shown. The UCN density at the detector position was estimated by the count rate just after switching the beam off. The UCN density was 0.7 UCN/cm$^2$ for the condition of a proton beam of 78 W, a UCN storage time of 14 s and a He-II temperature of 1.2 K.

**Conclusions**

We have presented the first UCN production in He-II placed in a spallation neutron source. A UCN density of 0.7 UCN/cm$^2$, which can be used in experiments, is achieved for a proton-beam power of 78 W and a He-II temperature of 1.2 K. The new UCN source is not limited by Liouville’s theorem and extraction losses. The present setup can be further optimized for higher UCN densities. By surrounding the spallation neutron source with a neutron reflector, the UCN production rate can be increased by a factor of 2 according to the Monte Carlo simulation [9]. A UCN loss rate upon the phonon up-scattering strongly depends on the He-II temperature and becomes much smaller than a $\beta$-decay rate at the temperature of 0.5 K. A $^3\text{He}$ dilution refrigerator is under preparation to lower the He-II temperature. A UCN density of greater than 100 UCN/cm$^2$ is expected by these improvements together with a higher proton beam power of 400 W.

References
Superconductivity in compressed lithium at 20 K

Katsuya Shimizu, Shinya Ishikawa, Daigero Takato, Takehiko Yagi & Kichi Amaya

Superconductivity at high temperatures is expected in elements with low atomic numbers, based in part on conventional BCS (Bardeen–Cooper–Schrieffer) theory. For example, it has been predicted that when hydrogen is compressed to its dense metallic phase (at pressures exceeding 60 GPa), it will become superconducting with a transition temperature above room temperature. Such pressures are difficult to produce in a lab setting, so the predictions are not easily confirmed. Normal conditions lithium is the lightest metallic element, and may become superconducting at lower pressures. A tentative observation of a superconducting transition in Li has been previously reported. Here we show that Li becomes superconducting at pressures greater than 30 GPa, with a pressure-dependent transition temperature (Tc) of 20 K at 48 GPa. This is the highest observed Tc of any element; it confirms the expectation that elements with low atomic numbers will have high transition temperatures, and suggests that metallic hydrogen will have a very high Tc. Our results confirm that the earlier tentative claim of superconductivity in Li was correct.

Previous theory has predicted that dense Li will undergo a new structural transition towards a ‘pairing-atom’ phase at pressures near 20 K. This phase would be superconducting, with a Tc of 20 K at 48 GPa. To test this prediction, we synthesized dense lithium at pressures of 48 GPa and temperatures of 18 K, using the technique of high-pressure diamond-anvil cell (DAC) synthesis. We found that the material was superconducting at 20 K, with a transition width of 0.3 K. We also measured the electrical resistivity of the sample, which showed a sharp drop at the transition temperature. This result confirms the theoretical prediction and provides evidence for the existence of a new superconducting phase in Li.

Figure 1 shows the sample and electrodes used in the experiment. A photograph of the sample is shown in the inset. The sample is a thin slice of lithium, cut from a larger crystal. The sample is placed between two diamond anvils, which are used to generate high pressures. The anvils are held in place by a gasket made of hafnium oxide. A platinum-iridium wire is used to make electrical contact to the sample. The sample is cooled to 18 K using a closed-cycle refrigerator. The resistivity of the sample is measured using a four-probe method.

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Competing interests statement
The authors declare that they have no competing financial interests.

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ANNUAL REPORT OF OSAKA UNIVERSITY—Academic Achievement—2002-2003
Superconductivity in Lithium at 20 K
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Introduction
Investigation of highly compressed Low-Z elements provides a wealth of information on fundamental properties of condensed phases of elements. Especially their high Debye temperatures may bring high-temperature superconducting transition according to conventional BCS theory [1]. Hydrogen, the lightest element is predicted [2] the highest superconducting transition of near room temperature under its possible metallic state at extremely high-pressure above 400 GPa. The metallic hydrogen has been long challenging subject for high-pressure physicists. Lithium is the third element in the periodic table and the lightest metal under ambient condition. The metallic hydrogen may be a similar metal to light alkaline metal of lithium, however lithium does not show superconducting at ambient pressure. When we look at the periodic table, there almost 30 elements are superconductive at ambient pressure, however, if we apply pressure, more than 20 elements join the superconductor. Figure 1 shows the superconductors in the periodic table which include the latest results in lithium. One of our goals is to paint the table all red.

Paired Phase in Lithium
There another interest in Li exists; Neaton and Ashcroft [3] predicted high-pressure structure of Li at around 100 GPa as a pairing state of a tendency of Cmca structure similarly to dense hydrogen. The results are interest of not only finding a new crystal structure but of picture the opposite scenario under high-pressures; all molecular solid may undergoes metallization with molecular dissociation (molecular-to-monatomic transition). Forming the paired structure means lithium become a molecular under its dense phase. We expect that the dense lithium just before paired phase is similar to the dense hydrogen just before metallic phase, and perform the experiments searching for superconductivity in dense lithium.

Superconducting Elements

Figure 1. Superconducting elements in the periodic table. The elements paint in pink are superconductor under normal condition (P = 0 bar); 29 elements. The ones in red are superconductors under pressure (P > 1 bar); 23 elements, in which author group has found 7 elements.
Alkaline Metals

In alkaline metals, Cs was only reported [4] to become superconductive under pressure of 7 GPa at 1.5 K. Alkaline metals are all very chemical active and especially Li has been known to be highly reactive with water, oxygen, and also diamond which used in high pressure equipment, DAC (diamond-anvil cell) and often break the anvil. This high chemical activity seems to be the reason of small number of previous reports for high-pressure study even after such interest predictions [2, 3].

Experimental Details

The sample was cut into a suitable size from the high purity ribbon obtain from Jonson-Matthey of 99.999% and loaded into a DAC. Figure 2 shows our conventional DAC designed specially for searching superconductivity. To prevent the leak of the Li sample, we made a small pit on the surface of diamond-anvil as shown in Figure 3. The “pit-anvil” is prepared by a focused by a pulsed KrF-excimer laser beam with ultra violet wavelength, 248 nm. We put the sample into the pit and placed the measuring electrodes of thin platinum-films into the pit with in touch to the sample. The thin insulator layer succeeded to keep the electrical insulation between the sample and gasket in all of present runs. All of these treatments of the sample were done in the argon atmosphere in the water- and oxygen-free grove-box. We applied pressure not exceed 10 GPa in the grove-box, and then the pressure-cell was connected to the cryostat. Further pressure was applied under low-temperature at temperature lower than 50 K in order to minimize or preventing the chemical reactions. We controlled the pressure and measured with a conventional ruby-fluorescence method at low temperature.

Results

We measure electrical resistance of lithium with 4 different samples. Temperature dependence of the resistance is shown in Figure 4. Pressure was controlled at around 50 K and resistance versus temperature curves were obtained at fixed pressures. At pressure of 3.5 and 23 GPa the measured resistance showed a normal metallic behaviour. Residual resistance increased on compression which explained by thinning of sample and/or a possible chemical reactions at the contact between sample and electrodes. A drop of the
resistance was observed at around 13 K above 35 GPa as shown in the figure (run #1). The onset temperature of the drop slightly shifted to higher temperature at 36 GPa. In the next sample (run #2), the pressure reached up to 48 GPa and the onset of the drop of the resistance shifted higher and reached 20 K. The loss of the resistance of exceeding 50% suggested the drop caused by superconducting transition.

According to the applied field dependence of the resistance drop of Li which indicates the strong evidence of superconducting transition; the drop shifted to lower temperature by applying the magnetic field and fully suppressed above 3 T. Then we conclude that the drop is from the onset of superconductivity of Li. After releasing the pressure down to near of atmospheric pressure at low-temperature, the pressure-cell was extracted from the cryostat and opened. The sample showed the original reflection of the light that indicated no chemical reaction in the sample was occurred during the experimental process. Figure 5 shows the pressure dependence of the superconducting onset temperature of Li observed in four different runs (#1~#4). Data were scattered but clearly showed an average rise with pressure.

**Discussion and Summary**

According to the recent structural investigation [5], the drop of the resistance we observed does not originate of the structural transition but of superconducting transition. Lin and Dunn [6] reported high-pressure and low-temperature electrical resistance of Li. They showed a sudden drop of resistance around 7 K, suggesting a phase transition and possibly onset of superconducting. We showed that their previous claim was correct.

We summarize that Li undergoes superconducting transition under pressure above 25 GPa having a critical temperature exceeding 20 K at 48 GPa which is the highest value observed in the element in the periodic table. The superconductivity appeared in a wide pressure region from fcc-phase through c116-phase. Low-temperature investigation of the structure will clarify the exact structure of Li of the high-\(T_c\) superconducting phase. The c116-phase is calculated to be stable up to 165 GPa and transform to a paired structure. The further experimental investigation for higher-pressure behaviour of Li should help the total understanding of the fundamental property of metals and possible room-temperature superconductivity in metallic hydrogen.

**References**

Video Database Retrieval Based on Gestures and Its Application
Manabu KURAMOTO, Toshihiro MASAKI, Yoshifumi KITAMURA, and Fumio KISHINO

Abstract—This paper describes a retrieval technique for video databases that is based on gestures. The proposed technique gives users a method to create various video content by intuitive interaction. This database system can extract feature parameters from video, perform automatic indexing, retrieve an appropriate result, and replace a presented object with the retrieval result in real time. Furthermore, we implement the fundamental functions of the proposal database. The retrieval accuracy and computational cost of the system are also described.

Index Terms—Contents creation, gesture, interaction, video image database.

I. INTRODUCTION

The evolution of hardware for picture and video media has been remarkable. The trend of multimedia source digitization has accelerated the combining of many multimedia processing techniques, such as storage, editing, and presentation on computers. Accordingly, techniques are expected for new methods of presenting and creating multimedia content.

In order to construct an advanced multimedia processing environment, a huge multimedia database system is required. One of the most important considerations for such a database system is how to reflect the intention of a user in data retrieval. In a typical system, a user retrieves character data by inputting a key word. In other database systems, a user uses numeric values on similar images as the key for retrieval. However, in the retrieval of video data with motion shapes, the retrieval method of a user is not necessarily in agreement with the particular data to be retrieved even when the database system provides graphic user interface (GUI) tools.

This paper describes a retrieval technique based on gestures for video images. By using gestures, a user can input spatial-temporal information intuitively. For example, a gesture can be used to input the motion of an object’s direction, the motion of the camera; pan and tilt; the shape of an object; to represent the degree of a scale, and so on. Furthermore, it can objectively match keys and indices because both the motion of gestures and the motion of objects in a video can be obtained automatically.

We propose the "Interactive Video Database," which enables the creation and presentation of scenes with gestures by replacing the objects that are extracted. By using this technique, a user can create varied and highly realistic video content via intuitive interaction in real time.

II. VIDEO RETRIEVAL BASED ON GESTURES

Fig. 1 presents factors between a user and a database in video retrieval. In this paper, the key is defined as the user’s input itself or the processed input information, and the index is defined as some information about video data such as key word, color histogram, title, or shooting day. In this section, we discuss the features conventional video retrieval. The factors of constructing these features are a stored video and related information, the user’s input information as a retrieval key, and a method of matching the index and the key.

A. The Conventional Video Retrieval Method

1) Stored Video and Related Information: In providing an image database system, information such as the shooting day can be allocated as indices. A few other examples are color histograms, edge components, and the automatic extraction of the area of a moving object and its motion vector [1]. With such an image database system, a user seldom aborts his/her retrieval caused by a conflict between the user’s conceptual model and the design model.

When a proper noun in a video is used as the key and “natural language” is used as an index, it is effective to retrieve data by key words [2]. However, excluding movies containing such content as news [3], it is difficult to extract indices automatically. Therefore, the system provider must give indices manually.

Furthermore, in image database retrieval, it is considered that the objects of the unit to be retrieved are in an object unit, or in a frame unit. In this paper, we think about the database system consisting of object units. This database system gives indices...
Video Database Retrieval Based on Gestures and Its Application

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Introduction

The evolution of hardware for picture and video media has been remarkable. The trend of multimedia source digitization has accelerated the combining of many multimedia processing techniques, such as storage, editing, and presentation on computers. Accordingly, techniques are expected for new methods of presenting and creating multimedia content.

In order to construct an advanced multimedia-processing environment, a huge multimedia database system is required. One of the most important considerations for such a database system is how to reflect the intention of a user in data retrieval. In a typical system, a user retrieves character data by inputting a key words. In other database systems, a user uses numeric values on similar images as the key for retrieval. However, in the retrieval of video data with motion or shapes, the retrieval method of a user is not necessarily in agreement with the particular data to be retrieved even when the database system provides GUI (Graphical User Interface) tools.

This paper describes a retrieval technique based on gestures for video images. By using gestures, a user can input spatio-temporal information intuitively. For example, a gesture can be used to input the motion of an object’s direction; the motion of the camera; pan and tilt; the shape of an object; to represent the degree of a scale, and so on. Furthermore, it can objectively match keys and indices because both the motion of gestures and the motion of objects in a video can be obtained automatically.

We propose “Interactive Video Database”(Fig.1) which enables the creation and presentation of scenes with gestures by replacing the real objects that are extracted. This database system can extract feature parameters from video, perform automatic indexing, retrieve an appropriate result, and replace a presented object with the retrieval result. By using this technique, a user can create varied and highly realistic video content via intuitive interaction in real time.

Figure 1. Goal of interactive video database
Interactive Video Database

By using gestures, a user can input spatio-temporal information intuitively. For example, a gesture can be used to input the motion of an object’s direction. Furthermore, it can objectively match keys and indices because both the motion of gestures and the motion of objects in a video can be obtained automatically. In the following, we describe the methods involved in our retrieval technique based on gestures (Fig.2).

1. Extract feature parameters from video images (store),
2. Extract feature parameters from the user’s gesture (retrieval),
3. Perform matching between (1) and (2) (matching),
4. Present the retrieval result and presented objects visually (presentation),
and
5. Present the retrieval result in real time (all processes).

There is ongoing research on recognizing of gestures and user intentions [1] for (1). In this case, it is necessary to extract feature parameters from a user’s input information. The feature parameters in (2) include, for example, histograms of colors, motion vectors, borderline information, and geometry information. It is necessary to extract these feature parameters exactly. For (3), it is effective to segment each object and to perform matching in the units of each segment in the case of motion [2]. When an object that already exists in a video image is replaced with an object from the retrieval result, it is necessary to choose the replacement from two or more retrieval candidates or start the frame to make the difference smaller (4). Interaction requires a real-time response. Therefore, the procedure from the input of a gesture to the presentation of the retrieval result needs to be processed in real time (5). We have to analyze the user input information, extract the target object in a video image, and retrieve and create a new scene from these results all in real time.

We propose virtual video scenes that are different from events in the real world, but the scenes are composed of real objects only. We have implemented “Interactive Digital Fishtank” as a concrete example. This was made possible by achieving a series of processes such as extracting a moving object in a picture, converting it to the same data structure as a virtual object, and performing real-time interaction. The interactive digital fishtank is investigated as a real-time video content creation system for a single object captured by a fixed camera. The placed object is a gold fish in the fish tank. In this system, retrieval with the motion and direction of an object by a gesture is implemented.

Image Database Retrieval Based on Gestures

The interactive digital fishtank is described as one example application of the proposed technique. The flow chart of the interactive video database we have discussed is shown in Fig.2. The interactive digital fishtank is set in a virtual environment in which live video of real fish is displayed together with virtual fish. A user can manipulate various attributes of this fish tank. Examples of such interaction include cutting/copying/pasting real fish, moving virtual objects (e.g., rocks) into the real environment, and interacting with the real fish (e.g., observing, catching, feeding, and communicating with them).

For these purposes, robust algorithms for the extraction, storage, and retrieval of, and interaction with video content and graphical objects in image sequences have to be developed. In particular, each object contained in a video sequence has to be able to be extracted at a reasonable speed, and a moving object able to be tracked within a sufficient accuracy. The extracted video image is converted into an object that consists of polygons and textures. Moreover, the direction of the moving vector of the fish is added to each sequence of the frame, not to each frame. If the direction is given to each frame, the retrieved sequence is selected in a here and there, and the motion of the fish in the reproduced scene dif-
fers from that of the real fish. The direction of one sequence used as an index is the average of one frame and is classified as a limited direction. Each sequence overlaps the others.

In order to extract feature vectors from gestures, a vector tracer method is applied. The feature points in a trajectory are extracted with a threshold of angle, and the vectors made from connecting these points become the feature vectors. These feature vectors are used as retrieval keys. In the same way, a motion vector’s direction is labeled by the degree of limitation as an index of sequences. As the number of classified directions increases, the number of retrieval candidates decreases.

In the matching process, the sequences having the same direction as the first feature vector are first selected. Next, the shape of the first frame of sequences is compared with the shape of the object in the current scene. In the shape comparison, the aspect ratio of the bounding box of the object and the parameter that represents the degree of tilt of the object’s posture are used. The details of the interactive digital fishtank are described in the published paper and [3,4].

**Conclusion**

This paper proposed a retrieval technique based on gestures and a retrieval technique using a similar object for a database system used in video content creation. The user’s gesture obtained by a magnetic sensor is divided into feature vectors. The system retrieves some candidates and observes an index (smoothed vector) with the feature vectors. Finally, the sequence having the most similar shape is selected as the retrieval result. This database system can automatically retrieve feature parameters of video, perform indexing, retrieve an appropriate result, and replace a presented object with the retrieval result, all in real time.

The threshold value of the vector tracer method, the number of classified directions, and the length of the frames of one segment are determined by the results of experiments. Furthermore, the precision in the retrieval of similar objects is estimated. The proposed technique gives users a method to create various video content by gestures.

![Another example of the proposed system](Figure 4)

**References**

Ideal Pure Shear Strength of Aluminum and Copper

Shigenobu Ogata,1,2,3 Ju Li,1,4 Sidney Yip1,*

Although aluminum has a smaller modulus in (111)(112) shear than that of copper, we find by first-principles calculation that its ideal shear strength is larger because of a more extended deformation range before softening. This fundamental behavior, along with an abnormally high intrinsic stacking fault energy and a different orientation dependence on pressure hardening, are traced to the directional nature of its bonding. By a comparative analysis of ion relaxations and valence charge redistributions in aluminum and copper, we arrive at contrasting descriptions of bonding characteristics in these two metals that can explain their relative strength and deformation behavior.

The minimum shear stress necessary to cause permanent deformation in a material without imperfections is fundamental to our concept of materials strength and its theoretical limits under large strains (1, 2). With the possible exception of recent nanoindentation measurements (3), it has not been feasible to directly measure the ideal shear strength of crystals. The demonstration that this property can be reliably determined by first-principles calcula-

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Calculations therefore would have important implications for the understanding of the behavior of solids at the limit of structural stability. Results on stress-strain behavior of Al and Cu in (111)(112) shear, calculated with density functional theory (DFT) and accounting for full atomic relaxation, have been reported (4), where Cu was found to have a higher ideal shear strength than that of Al. Using various DFT methods and systematically cross-checking the results, we further investigated the shear strength and deformation of Al and Cu and found instead that Al has the higher strength. Here, we report and substantiate our findings by detailing the energetics of shear deformation, the pressure-hardening behavior, and valence charge redistribution during deformation. These considerations show that the ideal shear strength and related...
The minimum shear stress to cause permanent deformation in a material without imperfections is fundamental to our concept of materials strength and its theoretical limits under large strains \([1,2]\). With the possible exception of recent nanoindentation measurements\([3]\), it has not been feasible to directly measure the ideal shear strength of crystals. The demonstration that this property can be reliably determined by first-principles calculations therefore would have significant implications for the understanding of behavior of solids at the limit of structural stability or mechanical failure. Results on stress-strain behavior of Al and Cu in \([111]/[112]\) shear, calculated using density functional theory (DFT) and accounting for full atomic relaxation, have been reported\([4]\), where Cu was found to have a higher ideal shear strength than Al. Using VASP DFT code\([5,6]\), we have investigated further the shear strength and deformation of Al and Cu and found instead that Al has the higher strength. Here we report and substantiate our findings by probing in detail the energetics of shear deformation, the pressure hardening behavior, and valence charge redistribution during deformation. These considerations show that the ideal shear strength and related properties such as stacking fault energies of Al and Cu can be accurately calculated and that the results rationalized by the underlying electronic structure. We suggest that bonding in Al is much more "hinged" like and emphasize the importance of the breaking and re-formation of directional bonds as compared to the isotropic "sphere-in-glue" like behavior in Cu.

The intrinsic stacking fault energy, a measure of the energy penalty when two adjacent atomic planes in the crystal lattice are sheared relative to each other, is known to play an important role in the structure and energetics of dislocations formed by slip processes. While it is known experimentally that the intrinsic stacking fault energy is much larger in Al than in Cu, this fact has not been related to their ideal shear strengths. For this purpose, we introduce a general function (see Fig. 1(A)),

\[
\gamma_n(x) = \frac{E_n(x)}{nS_0}, \quad n=1,2,\ldots
\]

where \(x\) is the relative displacement in the slip direction between two adjacent atomic planes (we focus on \([111]/[112]\) slip here), \(E_n(x)\) is the increase in total energy relative to its value at \(x=0\), with \(n+1\) being the number of planes involved in the shearing and \(S_0\) being the cross-sectional area at \(x=0\). The series of functions \(\gamma_1(x), \gamma_2(x), \ldots, \gamma_\infty(x)\), may be called the multi-plane generalized stacking fault energy, with \(\gamma(x)\) being the conventional generalized stacking fault energy (GSF)\([7]\), and \(\gamma_\infty(x)\) being the affine strain energy. The intrinsic stacking fault energy \(\gamma_n(x)\) is \(\gamma(x)\), where \(\delta_n=[112]a/6\) is the partial Burgers vector. The unstable stacking fault energy \(\gamma_\infty\) is an important parameter in determining the ductility of the material\([8]\), is \(\gamma(x)\), where \(d\gamma(x)/dx(x=0,b)\)=0. It is instructive to compare different \(\gamma_n(x)\) of the same slip system as \(n\) varies.

![Figure 1](image_url)

**Fig. 1.** (A) Multi-plane generalized stacking fault energy: \(n=1,2,\ldots\). (B) Pure shear stress-displacement responses of Al (solid square) and Cu (open square) and (C) ion relaxation patterns in Al and Cu. (D) Simple shear stress-displacement curves \(d\gamma(x)/dx\) (square) compared to \(d\gamma(x)/dx\) (circle) in Al (solid symbols) and Cu (open symbols).
The difference should be relatively small from a local "glue" (shaded region in Fig. 1(A)) viewpoint where we take the valence electron cloud to be the glue. We also have the asymptotic behavior at large $n$,

$$\gamma_n(x) = \gamma_\infty(x) + \frac{2\gamma^{\text{twin}}(x)}{n} + \mathcal{O}(n^{-2}),$$

(2)

where $\gamma^{\text{rel}}(b_p)$ is the unrelaxed twin boundary energy. The rate of convergence to (eqn.2) reflects the localization range of metallic bonding in a highly deformed bulk environment.

For affine deformation calculations we consider pure shear ($\sigma\|\neq 0$ except $\sigma_\perp$) and simple shear ($x \neq 0$) with no relaxations. The corresponding stress-displacement curves are shown in Fig. 1(B) and 1(D), respectively.

At equilibrium Cu is considerably stiffer than Al, its bulk, simple and pure shear (along $(111)(112)$) moduli being greater by 80%, 65% and 25%, respectively. However, Al ends up with a 32% larger ideal pure shear strength because it has a longer range of elastic strain before softening (see Fig. 1(B)): $x_{\text{max}}/b_p=0.28$ or $\epsilon_{\text{max}}=0.20$ in Al, versus $x_{\text{max}}/b_p=0.19$ or $\epsilon_{\text{max}}=0.13$ in Cu. The ion relaxations in these two metals are entirely different as shown in Fig. 1(C). In Al, when the top atom slides over the bottom atoms, the former hops in the $z$-direction, while the latter contract in the $y$-direction (relaxation in $x$ is almost zero). In Cu there is almost no relaxation in the $z$-direction; the top atom translates essentially horizontally while the bottom atoms expand and contract in the $y$- and $z$-directions, respectively.

<table>
<thead>
<tr>
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<th>Al (GPa)</th>
<th>Cu (GPa)</th>
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<tr>
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<td>2.16</td>
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<td>3.54</td>
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<tr>
<td>$\sigma_{zz} = -3$ (GPa)</td>
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<td>2.03</td>
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<td>$\sigma_{zz} = \sigma_{yy} = -10$ (GPa)</td>
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<td>4.38</td>
</tr>
<tr>
<td>$\sigma_{zz} = \sigma_{yy} = -20$ (GPa)</td>
<td>5.26</td>
<td>6.52</td>
</tr>
</tbody>
</table>

Table 1. Maximum shear stress under external loading.

The difference in relaxation patterns has important implications for the shear strength hardening behavior, as shown in Table 1, which has also been noted and discussed in terms of third-order elastic constant[9]. When pressurized in the $(110)$-direction, Cu hardens while Al softens significantly. But if pressurized in the $(111)$-direction, Al hardens significantly while Cu softens slightly. These results show that the pressure-hardening effect is highly orientation dependent. A rough estimate of the stress state at the displacement burst observed in nanoindentation experiments[3] shows that the pressure components are indeed at the level indicated in Table 1. Thus a large effect on the shear strength is to be expected. However, since the actual stress state is a complicated triaxial condition, and given that the pressure-hardening behavior is very anisotropic, one cannot ascertain its real effect without an accurate stress analysis. For this purpose a method combining atomistic and finite-element calculation[10] is useful.

Since Al has no core $d$-states, its partially occupied valence $d$-bands are abnormally low in energy, which gives rise to directional bonding. Fig. 2(A) shows that at the 6-atom interstice in Al, the pocket of charge density has cubic symmetry and is very angular in shape, with a volume comparable to the pocket centered on every ion. Fig. 2(B) shows that in Cu there is no such interstice pocket, the charge density being nearly spherical about each ion. Thus, Al has an inhomogeneous charge distribution in the interstitial region because of bond covalency$[11]$ and directional bonding$[12]$, while Cu has relatively homogeneous distribution and little bond directionality. To probe further these bonding characteristics we look at how the valence charge density $p(r, x)V(r, x)$ varies along a path in cell, a-b-c, during pure shear, as atom b moves away from its initial nearest neighbor atom a (at $x=x_1$) and takes on a new nearest neighbor atom c (at $x=x_2$). The $\Delta p(r, x)V(r, x)$ patterns, with Vcell being the cell volume, for Al and Cu again show significant contrast. In Al (Fig. 2(C)), the maximum change occurs at half way between two nearest ions which indicates that when atoms change neighbors the breaking and re-formation of directional bonding is an important activity. Fig. 2(D) shows there is little such activity in Cu. $\Delta p(r, x)V(r, x)$ mainly reflects an accommodation process, like soft spheres squeezing past each other by
distorting their own shape.

The charge density behavior just discussed, along with the relaxation patterns seen in Fig. 1(C), suggest a “hinged-rod” model to describe the shear strength for Al, in contrast to the conventional “muffin-tin” or “sphere-in-glue” model for Cu. It is reasonable to think that when the bonding is directional (rod-like), a longer range of deformation can be sustained before breaking than when the bonding is spherically symmetric, due to different geometrical factors of charge density decay with bond length. In covalent systems like Si and SiC, we have verified that during shear, the bonds generally do not break until shear strain reaches 25-35%, which is significantly larger than those of metallic systems. Conversely, when the bonds do break, a directionally bonded system can be expected to be more frustrated and less accommodating, as manifested in a larger intrinsic stacking fault energy, among other things.

To quantify our interpretation, we return to the behavior of the multi-plane generalized stacking fault energies in the form of stress-displacement functions \( d\phi (x)/dx \) and \( d\psi (x)/dx \), as shown in Fig. 1(D). First we note that for \( d\phi (x)/dx \) and \( d\psi (x)/dx \) are not very different across the entire range of shear, so the local “glue” picture is indeed appropriate. The fact that the sliding of a layer is effectively decoupled from that of adjacent layers indicates that bonding in Cu has nearly no bond-angle dependence. On the other hand, the same functions behave much more differently in Al, especially when \( x \approx x_{\text{max}} \), at which the gradient reaches a maximum.

Even in the range of \( x \approx x_{\text{max}} \), the relative magnitudes of \( d\phi (x)/dx \) and \( d\psi (x)/dx \) are opposite in order in Al compared to in Cu, suggesting a possibly different nature of bonding. Secondly, \( x_{\text{max}} \) is almost identical between \( d\phi (x)/dx \) and \( d\psi (x)/dx \) in both Al and Cu, with Al having the longer \( x_{\text{max}} \) implying that the longer-range directional bonding in Al could be a more general feature than being specific to affine strain energy \( \gamma_{\text{af}} \). Third, we see that when \( x \approx x_{\text{max}} \) and the directional bonds in Al are broken (confirmed by a depleted charge at the interstice in Fig. 2(C)), \( d\phi (x)/dx \) in Al stays positive for an extended range, whereas \( d\psi (x)/dx \) in Cu becomes negative quickly. Thus, while Al and Cu have approximately the same unstable stacking fault energy, we see that when the displacement \( x \) reaches \( b \), and the configuration becomes an intrinsic stacking fault, Cu has recovered most of its losses in the sense of a low value of \( \gamma_{\text{af}} \), whereas Al has recovered very little as its \( \gamma_{\text{af}} \) remains close to \( \gamma_{\text{af}} \). The implication is that when a directional bond is broken, it is more difficult for the electrons to re-adapt. In contrast, for “sphere-in-glue” type systems, even if the bond angles are wrong, as long as the volumes fit as in the intrinsic stacking fault, the electrons can redistribute well and the system does not incur a large energy penalty.

Fig. 2. Charge density iso-surface in (A) Al and (B) Cu and \( \Delta \rho (r, \epsilon) V_{\text{cell}}(\epsilon) \) (compared to perfect crystal) along path a-b-c (\( \epsilon \) is normalized path length variable) during pure shear in (C) Al and (D) Cu. We can see box-shaped extra charges in interstitial volumes and their active evolutions in Al, but not in Cu. The max arrows point to positions of maximum \( \gamma_{\text{af}} (r) V_{\text{cell}} \) along a-b-c at \( \epsilon = 0 \), to indicate the size of the “atomic spheres” centered at a, b and c.

References
Fabrication of Fresnel zone plate embedded in silica glass by femtosecond laser pulses

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Abstract: We fabricated the Fresnel zone plate by embedding voids in silica glass. We investigated the focusing properties by launching a He-Ne laser beam into the zone plate. The spot size of the primary focal point was 7.0 μm and agreed with the theoretical value of 6.1 μm. The diffraction efficiency was 2.0%. This technique enables us to make alignment-free micro-scale lenses inside bulk materials.

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OCTIS codes: (320.7110) Ultrafast nonlinear optics, (140.3330) Laser damage; (190.7110) Ultrafast nonlinear optics, (140.5440) Laser-induced breakdown; (050.1970) Defective optics; (130.3120) Integrated optical devices

References and links
Fabrication of Fresnel Zone Plate Embedded in Silica Glass by Femtosecond Laser Pulses

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Introduction
Large amount of data processing to construct information/telecommunication infrastructure will be necessary for the future information age. One of the possible solutions is optical integration of optical elements inside a small glass. When femtosecond laser pulses are focused inside the bulk of a transparent material, the intensity in the focal volume can become high enough to cause nonlinear absorption, which leads to localized modification in the focal volume, while leaving the surface unaffected. The modification enables us to fabricate a variety of three-dimensional photonic devices in glass, such as binary data storage devices and waveguides. Although several researchers have fabricated the microscopic optical elements in transparent materials, as described above, fabrication of a lens has not yet been reported. Although Fresnel zone plate is an attractive device for integrated photonic circuits because of its focusing ability and compactness, the zone plate are fabricated on the surface of the sample by lithographic or molding technique. We realized fabrication of a lens in the form of a 400×400-μm Fresnel zone plate inside silica glass by femtosecond laser pulses.

Microscopic modification
Tightly focusing femtosecond laser pulses with high numerical-aperture (NA) lenses produce submicron-damage inside a wide variety of transparent materials including glass, crystal, and plastics. Figure 1 shows the schematic of modification in transparent materials with femtosecond laser pulses. The damage appears as cavities or voids with diameters of only 200 nm to 1 μm, surrounded by densified material. An important feature of the void is the large difference of refractive-index change between a cavity and the surrounding region.

![Fig. 1. Microscopic modification inside transparent materials with femtosecond laser pulses.](image-url)
**Design of Fresnel Zone Plate**

Figure 2 shows the schematic of the designed Fresnel lens. Fresnel zone plate consists of a series of disks centered at one point with a radius of the order of the wavelength. When we block either all the even or all the odd zones, this zone plate has a focusing property. In our layout, light passes through only the odd zones in the zone plate, and light cannot transmit in the even zones. Even zones are fabricated by embedding the array of the voids to block light.

**Fabrication of Fresnel Zone Plate**

Using a 130-fs Ti:sapphire laser, we alternately embedded rings of empty space and void-structures into the glass. One layer of void rings was formed in 1-μm, two-dimensional dot-by-dot increments by focusing the 800-nm, 0.4-μJ pulses through the 0.55-numerical-aperture objective lens. Figure 3 shows an optical image of the fabricated Fresnel zone plate produced by embedding voids at the depth of 300 μm beneath the sample of silica glass which was 3 mm thick. The image was observed under halogen lamp illumination. The voids were embedded only in the even zones. Because light cannot transmit through the even zones embedded by voids, the amplitude of light transmitted through the zone plate was modulated.

**Focusing Properties**

We investigated the focusing properties of the lens by directing a He-Ne laser beam at a wavelength of 632.8 nm into the zone plate. The beam incident on the lens is diffracted and converges at the primary focal spot on the optical axis. Figure 4 shows the intensity distribution in the primary focal point. The primary focal point was located in air. The spot size of the primary focal point was 7.0 μm, which agrees with the theoretical value of 6.1 μm. The diffraction efficiency was 2.0%. The theoretical diffraction efficiency at the primary focal point is approximately 10.1% in the amplitude-type zone plate.

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**Fig. 2.** Schematic of the fabrication of Fresnel zone plate. We constructed the zone plate that passes only the odd zones and obstructs the even zones. Even zones are fabricated by embedding the array of the voids with steps of 1 μm.

**Silica glass**

**Focal length: 3 mm**

**Fig. 4.** Intensity distribution in the primary focal point when a He-Ne laser beam at the wavelength of 632.8 nm is transmitted through the zone plate. The spot size was 7.0 μm and agrees well with the theoretical value of 6.1 μm. The diffraction efficiency was 2%.
Discussion

In order to increase the diffraction efficiency a phase-reversal Fresnel zone plate was created. The phase-reversal zone plate consists of rings of glass with an altered refractive index that shifts the phase of light. This process allows us to produce alternate zone rings directly by inducing a local refractive-index modification on the order of $10^3$. A diffraction efficiency of 39% was achieved by a phase-reversal zone having a thickness of 30 μm. Fabrication of lenses in the bulk of glass will promote the integration of micro-scale optical elements inside a small area of a material. This method could have a wide variety of applications, such as alignment-free coupling of lenses to waveguides and compact imaging systems for charge-coupled device (CCD) cameras.

Conclusion

We fabricated the Fresnel zone plate, which size was 400 μm x 400 μm by embedding voids in silica glass. The collimated He-Ne laser beam was launched into the zone plate and investigated the focusing properties. The spot size of the primary focal point was 7.0 μm and agreed well with the theoretical value of 6.1 μm. The diffraction efficiency was 2.0%. This technique enables us to make alignment-free micro-scale lenses inside bulk materials.

Acknowledgment

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Identification of a Factor that Links Apoptotic Cells to Phagocytes


**letters to nature**

Selective enrichment of DALIS

Neutrophils attracted by DCS were submitted to a 30-min 195Tl-3000X extraction at 4°C before a 30-min DIA1 (100 ng/ml) treatment at 37°C in 20 mmol/L Tris pH 7.4, 1.15 mmol/L MgCl\(_2\), 10 mmol/L NaCl. Nuclear material extraction was performed on 30 min at 4°C with a solution of 20 mmol/L Tris pH 7.4, 1.15 mmol/L MgCl\(_2\), 2 mmol/L NaCl. Remaining material was washed with PBS and submitted to immunocytochemistry and biochemical analysis.

Radio-labelling, immunoprecipitation and immunoblot

Roughly 2 × 10\(^6\) DCs were pulse-labelled with 10 ng/ml of "51-labelled Prona or "8"-labelled protease (both from Amersham Pharmacia Biotech) in labelling media for 5 min, and chased for various times at 37°C as described. Radio-labelled DALS-enriched samples were harvested at 95°C for 5 min in SDS/PSD extraction buffer in the absence of 10 mmol/L 1,50 mmol/L NaCl, 15% glycerol, and 1% NP-40. Proteins were precipitated with protein A Sepharose (Amersham Pharmacia Biotech) at 4°C and immunoprecipitated overnight with the Fc2 antibody. Immunoprecipitates were analysed onto 2-10% gradient SDS-PAGE gels and quantified with a Fuji phosphorimager. Gel bands were excised out and submitted for Western-blot analyses with W3/13 and W3/12.2 (after surface biotinylation) performed as described for 24 h before immunoblot analysis.

Identification of a factor that links apoptotic cells to phagocytes

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Apoptotic cells are rapidly prevented by phagocytes to prevent the release of potentially anxious or immunogenic intracellular materials from the dying cells, thereby preserving the integrity and function of the surrounding tissue. Phagocytes engulf apoptotic bodies but not healthy cells, indicating that the apoptotic cells present a signal to the phagocytes, and the phagocytes recognize the signal using a specific receptor. Here, we report a factor that links apoptotic cells to phagocytes. We found that milk fat globule-EGF factor 8 (MFG-E8), a secreted glycoprotein, was produced by thiglogyocyte-elicited macrophages. MFG-E8 specifically bound to apoptotic cells by recognizing amphotolithosphipids such as phosphatidylserine. MFG-E8, when engaged by phagolysosomes, bound to cells via its RGD (arginine-glycine-aspartate) motif—it bound particularly strongly to cells expressing \(\alpha_\text{v}\beta_3\) integrin. The NIH3T3 cell transplants that expressed a high level of \(\alpha_\text{v}\beta_3\) integrin, were found to engulf apoptotic cells when MFG-E8 was added. MFG-E8 carrying a point mutation in the RGD motif behaved as a dominant-negative form, and inhibited the phagocytosis of apoptotic cells by peritoneal macrophages in vivo and in vitro. These results indicate that MFG-E8 secreted from activated macrophages binds to apoptotic cells, and brings them to phagocytes for engulfment.

Cells expressing a caspase-resistant ICAD (inhibitor of caspase-activated DNase) do not undergo apoptotic DNA fragmentation, but their DNA can still be cleaved when the cells are phagocytosed by macrophages. This system was used to examine the phagocytosis of apoptotic cells. As shown in Fig. 1a, when thymocytes from transgenic mice carrying caspase-resistant ICAD mutant (ICAD-\(\text{Sim}\)) were treated with dezamethasone, about 90% of the cells became annexin V-positive within 4 h, but they were not stained by TUNEL (TdT-mediated DUTP nick end labelling). Co-culture of macrophages with apoptotic thymocytes, but not with freshly

**Supplementary Information**

The authors declare that they have no competing financial interests.

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**Acknowledgments**

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Identification of a factor that links apoptotic cells to phagocytes

**NAGATA Shigekazu**

(Graduate School of Frontier Biosciences and Graduate School of Medicine)

**Introduction**

Apoptosis is a principal mechanism by which unwanted or potentially harmful cells are eliminated in metazoans. Apoptotic cells are rapidly engulfed by phagocytes to prevent the release of potentially noxious or immunogenic intracellular materials from dying cells. Phagocytes engulf apoptotic but not healthy cells (1), indicating that the apoptotic cells present an "eat me signal" to the phagocytes, and the phagocytes recognize the signal using a specific receptor. In the early stage of apoptotic process, the surface of plasma membrane changes, and phosphatidylserine (PS) on the inner leaflet of plasma membranes is exposed to the cell surface, suggesting that PS can be an "eat me signal" presented in the apoptotic cells (2). As a receptor for apoptotic cells, various molecules expressed in phagocytes have been proposed (1). However, it is not clear how these receptors recognize apoptotic cells, and how the engulfment is triggered. In this report, we established an assay method to qualify the engulfment of apoptotic cells, and identified a monoclonal antibody (mAb) that enhances the engulfment of apoptotic cells. Purification of the protein recognized by the mAb revealed that the previously identified protein called milk fat globule-EGF-factor 8 (MFG-E8). MFG-E8 was found to be specifically expressed in the activated macrophages. The recombinant MFG-E8 bound to apoptotic cells by recognizing PS, and stimulated fibroblasts to engulf apoptotic cells. Furthermore, MFG-E8 carrying a point mutation in the integrin-binding motif prevented the macrophages to engulf apoptotic cells. These data indicate that MFG-E8 works as a bridge between the apoptotic cells and phagocytes.

**Identification of MFG-E8 that regulates phagocytosis of apoptotic cells**

Apoptosis is often accompanied by degradation of chromosomal DNA (3), which is mediated by CAD (caspase-activated DNase). CAD is complexed with its inhibitor (ICAD) in proliferating cells. When cells are induced to undergo apoptosis, caspases cleave ICAD to release CAD. The cells expressing a caspase-resistant ICAD mutant (ICAD-Sdm) do not undergo apoptotic DNA fragmentation, but their DNA can be cleaved when the cells are engulfed by macrophages (4, 5). This finding was used to examine phagocytosis of apoptotic cells by macrophages. As shown in Fig. 1, when thiglycollate-elicited peritoneal macrophages were incubated with freshly-prepared thymocytes, a small percentage (7.3%) of macrophages became TUNEL-positive. On the other hand, when macrophages were co-cultured with apoptotic ICAD-Sdm thymocytes, about 40% of macrophages became TUNEL-positive. Treating macrophages with baflomycin that prevented acidification of lysosomes inhibited the appearance of TUNEL-positive macrophage. These results indicated that macrophages specifically engulfed apoptotic cells and digested their chromosomal DNA.

Thiglycollate-elicited mouse peritoneal macrophages were then

![Graphs showing TUNEL and Mac-1 positive cells](image-url)
used to immunize Armenian hamsters. Hybridomas were screened for the antibody that modulates the ability of macrophages to engulf apoptotic cells. One antibody, designated as 2422 mAb, was found to enhance the phagocytosis. That is, when the above phagocytosis assay was carried out in the presence of 2422 mAb, the percentage of macrophages that engulfed the apoptotic cells significantly increased. A FACS analysis showed that 2422 mAb stains weakly thyoglycollate-elicted peritoneal macrophages and strongly a macrophage cell line P388D1. P388D1 cells were then cultured in a large scale and the antigens recognized by 2422 mAb were affinity-purified. The purified proteins were digested with Aeromobacter proteases, and the generated peptides were subjected to a mass spectrometry analysis. The sequences of all peptides corresponded to those in mouse MFG-E8 (6). Northern blotting indicated that MFG-E8 is expressed in thyoglycollate-elicted but not resting peritoneal macrophages. MFG-E8 is comprised of 463 amino acids with an expected Mr of 51,180. It has a signal sequence at the N-terminus. When thyoglycollate-elicted peritoneal macrophages were cultured, the culture supernatant contained a large amount of MFG-E8 of 74 kDa. These results indicate that MFG-E8 is a glycoprotein secreted from activated macrophages.

Enhancement of engulfment of apoptotic cells by MFG-E8

To examine the ability of MFG-E8 to bind to apoptotic cells, the Flag-tagged recombinant MFG-E8 was produced in human 293 cells. As shown in Fig. 2, MFG-E8 did not bind to the freshly isolated thymocytes, but very strongly bound to the apoptotic thymocytes. Annexin V binds to PS exposed on the apoptotic cells. When apoptotic thymocytes were pretreated with MFG-E8, the binding of annexin V to apoptotic cells was severely inhibited, and vice versa. These competitive effect of MFG-E8-L on annexin V-binding to apoptotic cells suggested that MFG-E8-L bound to PS.

In fact, when microtiter plates coated with various synthetic phospholipids were incubated with MFG-E8, MFG-E8 bound to PS-coated plates in a saturating manner. Whereas, it did not significantly bound to phosphatidylincholine (PC)- or phosphatidylinositol (PI)-coated plates.

MFG-E8 carries two EGF-like domains, of which the second domain contains an RGD motif that should be recognized by some members of the integrin family. We therefore considered a possibility that MFG-E8 works as a bridge between apoptotic cells expressing PS and phagocytes expressing integrins. Mouse NIH3T3 fibroblast cell line was transformed with α5 and β1 integrins. When microtiter plates coated with PS were incubated with various concentrations of MFG-E8, a significant number of NIH3T3 adhered to the PS-coated wells in the presence of MFG-E8. This effect of MFG-E8 was dependent on its RGD motif, because the D89E mutant carrying the Asp to Glu mutation at the amino acid position of 89 was incapable to mediate the adhesion of NIH3T3 to the PS-coated wells.

We then examined whether MFG-E8 can stimulate NIH3T3 to engulf apoptotic cells. When freshly prepared thymocytes from ICAD-Sdn mice were co-cultured with NIH3T3, no thymocytes was engulfed by NIH3T3 in the presence or absence of MFG-E8 (Fig. 3). On the other hand, when NIH3T3 cells were co-cultured with the apoptotic thymocytes in the presence of MFG-E8, about 50% of NIH3T3 engulfed more than 4 thymocytes, and more than 20% NIH3T3 cells carried more than 7 thymocytes inside the cells. In contrast to the wild-type MFG-E8, D89E inhibited the phagocytic activity of NIH3T3 and thyoglycollate-elicted peritoneal macrophages. From these results, we concluded that MFG-E8, produced by activated macrophages, works as a bridge between apoptotic cells and phagocytes to enhance the engulfment of apoptotic cells (Fig. 4).
**Discussion**

Many proteins expressed in phagocytes have been proposed to be receptors involved in the engulfment of apoptotic cells (1). However, whether these receptors directly bind to apoptotic cells has been elusive. In this report, we showed that MFG-E8 specifically binds to apoptotic cells by recognizing PS. PS localized to the inner leaflet of the plasma membrane in healthy proliferating or resting cells is exposed on the cell surface when cells are triggered to undergo apoptosis (2). Cells repleted with PS through liposome transfer can be recognized by phagocytes as targets to be engulfed (7). These results indicate that the exposed PS fulfills the criteria for an “eat me” signal. Most of the molecules proposed to be receptors for apoptotic cells bind not only PS but also PI (1). On the other hand, MFG-E8 exclusively bound PS, supporting the idea that MFG-E8 specifically recognizes apoptotic cells. Integrins have been suggested as receptors for apoptotic cells in several systems (8). However, because neither α5β1 or αvβ3 integrin can bind PS, it has not been clear how these integrins recognize apoptotic cells. MFG-E8 seems to solve this dilemma, and establish integrins as receptors for apoptotic cells in thiglycollate-elicited macrophages.

MFG-E8 was originally identified as one of the most abundant proteins in the membranes of milk fat globules (6). Mammary glands undergo massive involution when suckling or milking ceases (9). During this process, a large number of epithelial cells are killed by apoptosis, and those apoptotic cells need to be cleared by infiltrating macrophages or viable epithelial cells to insure the remodeling of the gland in preparation for the next wave of lactation. Identification of MFG-E8 as a molecule that recognizes the apoptotic cells would help to elucidate the molecular mechanism behind involution and remodeling of mammary gland at the end of lactation.

**References**

Determination of left-right patterning of the mouse embryo by artificial nodal flow


**letters to nature**

they responded to forskolin stimulation, and (CAD) transcripts were scored only between 150 and 500-nucleotide fragments in opposite directions. Statistical analysis was performed using the Kolmogorov–Smirnov non-parametric test: values are presented as mean ± s.e.m. and were considered significantly different for P < 0.05.

**Computation**

Contrasts in the model are annotated in Supplementary Information: MATLAB 6.0 (Mathworks) was used for numerical calculations. Motor activity analysis was performed using the Morlet wavelet from the standard numerical `wavelet` analysis package (MatWorks). 900-nucleotide fragments were used as a set of coefficients. CAD, calculated using the formula: 

\[ CAD(U) = \frac{|U| + |V|}{|U| - |V|} \]

where U is the analysis function referred to as the wavelet, a representative time localization and V is the scale, which is inversely proportional to the local frequency. To avoid edge effects, only the central 40 min of each hour were considered. No periodic structure was evident when this method was tested with white noise.

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**Competing interests statement**

The authors declare that they have no competing financial interests.

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**Determination of left-right patterning of the mouse embryo by artificial nodal flow**

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Substantial insight has recently been achieved into the mechanisms responsible for the generation of left-right (L–R) asymmetry in the vertebrate body plan1,2. However, the mechanism that underlies the initial breaking of symmetry has remained unclear. In the mouse, a leftward fluid flow on the ventral side of the node caused by the vortical motion of cilia (referred to as nodal flow) is implicated in symmetry-breaking, but direct evidence for the role of this flow has been lacking3,4. Here we describe the development of a system in which mouse embryos are cultured under an artificial fluid flow and with which we have examined how an artificial nodal flow affects L–R patterning. An artificial rightward flow that was sufficiently rapid to reverse the intrinsic leftward nodal flow resulted in reversal of situs in wild-type embryos. The artificial flow was also able to direct the situs of mutant mouse embryos with immobile cilia. These results provide the first direct evidence for the role of nodal flow in the establishment of L–R asymmetry.

The breaking of symmetry during vertebrate development is thought to occur in or near the node. In the mouse embryo, the ventral surface of the node (nodal pit) possesses several hundred monolayers that rotate in a clockwise direction, and this rotational movement somehow generates a leftward laminar flow5. The lack of this nodal flow as a result of impaired cilial development leads to randomization of body axis6. Nodal flow has thus been proposed to trigger a signaling cascade responsible for L–R patterning by transporting an unidentified molecule towards the left side of the body. This nodal flow hypothesis has remained unreproved. It raises many questions, the most important of which is: what is the genuine symmetry-breaking event or simply a manipulation of such an event?

One approach to test directly the role of nodal flow would be to manipulate the flow mechanically and to examine how such manipulation affects L–R patterning. To achieve this goal, we developed a culture system (flow culture) which allows embryos to develop under a constant flow of culture medium driven by a peristaltic pump. In this system, octopus-trap-like pots hold embryos in their proximal region (Fig. 1b, c), so that the distal region, including the node, is exposed to the flow. The artificial flow can be controlled in two ways: First, the flow can be leftward (Fig. 1b) or rightward (Fig. 1c) with respect to the L–R axis of the embryo, depending on how the embryos are placed in the pot. Second, the rate of the flow can be adjusted to either fast or slow.

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The following is a comment on the published paper shown on the preceding page.

**Determination of left-right patterning of the mouse embryo by the artificial nodal flow**

**NONAKA Shigenori**  
(Graduate School of Frontier Biosciences)

**Left and right are determined in early development**

Human body looks superficially symmetric, while arrangement of internal organs (situs) is highly asymmetric. Heart and spleen position at the left whereas liver and gallbladder at the right, and the left lung is separated in two lobes and the right in three, etc.

Our central question is how this left-right asymmetry is determined in mammalian development. In mouse, the earliest morphological asymmetry appears as heart looping and embryonic turning at 8.5- and 9-day in gestation. By the former the primitive heart transforms its shape from a straight duct to S-shaped loop, and by the latter the tail moves from the back, through the right side, to the front of face (Figure 1).

Prior to the asymmetric morphogenesis, several genes are expressed in side-specific manner (Figure 1). Previous studies by HAMADA Hiroshi’s group have revealed that these ‘asymmetric genes’ define the leftness and the rightness of the tissue. For example, if one left-specific gene, *nodal*, is ectopically expressed on the right, the right tissue will develop to have the left characters. Similarly if *nodal* expression is depleted in the left tissue, it will grow to have the right characters [1].

You may still wonder what switches on/off the asymmetric genes. In other words, what is the origin of the left-right asymmetry? Regarding this topic, involvement of tiny moving hair, called as cilia or flagella, had been suspected for long years. Kartagener syndrome is a congenital disease characterized by clinical features including bronchiectasis, chronic sinusitis, men infertility and mirror-image reversal of internal organ positioning (situs inversus) [2]. Curiously, situs inversus occurs only in half of the patients. In 1976, Swedish scientist Björn Afzelius discovered ciliary defect in the patients [3]. This finding explained the symptoms except one: defect of mucociliary transport at airway caused respiratory symptoms, and sperm immotility resulted in men infertility. Mechanism for situs inversus had remained mystery.

![Figure 1. Left-right development of murine embryo.](image-url)
Nodal flow hypothesis

Studies of the asymmetric genes in the middle of 1990s highlighted importance of the node, a temporary structure in 8-day mouse embryo [4]. The node has hundreds of cilia on its surface (figure 2) [5], but researchers in this area had believed that the cilia would not move.

In 1998, HIROKAWA Nobutaka’s group including me in University of Tokyo found the cilia actually moving clockwise. The swirling movement generated microscopic fluid flow from right to left on the surface of the embryo (referred as nodal flow). Moreover, mutants lacking cilia or motion of cilia in the node developed reversed heart loop in about half of the population like Kartagener syndrome [6, 7]. From these results a hypothesis was raised that the nodal flow would trigger the asymmetric gene cascade perhaps by transporting some soluble factor to the left, and that absence of the flow would randomize this process.

Artificial nodal flow experiment

This report surprised many developmental biologists, but did not convince them. They were yet skeptical to the role of the flow partly because they believed that all vertebrates should share the common system while they hadn’t discovered similar cilia in other species those days. In their view, the flow should be a side effect of whatever truly determined the left and the right.

So I joined Hamada’s group and we started to test the role of the nodal flow by physical approach. At last we invented a simple device, namely “flow culture” system (figure 3). This system allows mouse embryos to grow in constant flow of culture medium. The embryos receive the external flow on their surface. Our aim was whether the nodal flow could be mimicked by the artificial flow.

After setting the device that the artificial flow overwhelmed the

Figure 2. Scanning electron micrographs of an 8-day embryo. (a) Whole embryo from ventral view. (b) The node. (c) The node cells. Each cell has single cilium.

Figure 3. Flow culture device. (a) Diagram of the device. Peristaltic pump and depulsators supply constant fluid flow in the chamber (red arrowheads). (b) Embryos are held in pots and receive the flow on their surface. Orientation of the artificial nodal flow is adjustable by orienting the embryo in the pot. Filter is inserted at the inlet of the chamber to prevent turbulence. (c) Picture of the device.
Figure 4. Embryos grown with artificial nodal flow. In the fast leftward flow they developed normal situs while in the fast rightward flow they formed reversed situs. Red arrows show expression of a left-specific gene at the wall of heart tube.

ciliary force to give rightward flow in the node (referred as fast flow), we tested its developmental effect. The result was plausible: the embryos developed with reversed situs (Figure 4) while they grew with normal situs in rightward but slower flow which was inadequate to reverse the leftward nodal flow (referred as slow flow) and in leftward flow conditions. Mutant embryos with immotile cilia gave somewhat different result: they developed normal situs in the leftward flow and reversed in the rightward flow, regardless of the external flow speed (Table 1).

In summary, left-right development of the embryos always obeyed the direction of the flow in the node. The leftward and the rightward nodal flow gave normal and reversed situs, respectively.

Table 1. Summary of the artificial nodal flow experiments

<table>
<thead>
<tr>
<th>Mouse</th>
<th>Wild type (ICR strain)</th>
<th>iviv mutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciliary force</td>
<td>Leftward</td>
<td>None</td>
</tr>
<tr>
<td>Imposed flow</td>
<td>left, fast</td>
<td>left, fast</td>
</tr>
<tr>
<td>Resultant flow</td>
<td>left, slow</td>
<td>left, slow</td>
</tr>
<tr>
<td>in the node</td>
<td>right, slow</td>
<td>right, slow</td>
</tr>
<tr>
<td>L-R development</td>
<td>left</td>
<td>left</td>
</tr>
<tr>
<td></td>
<td>normal</td>
<td>normal</td>
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<tr>
<td></td>
<td>reversed</td>
<td>reversed</td>
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</table>

Questions remaining

This experiment clearly confirmed the critical role of the nodal flow. Toward full understanding of left-right development, yet several fundamental questions are to be solved.

One is the ultimate origin of the left-right asymmetry, which determines the direction of nodal flow. While the other vertebrates turned to have equivalent cilia [8], initial process of left-right determination of avian and amphibian development appear quite different from that of mammals [9]. Is the node the place where laterality arises de novo from molecular chirality, or just relays earlier asymmetric cue?

And the mechanism how the flow conveys the asymmetric information is also important question. As our first model assumed that nodal flow conveys secreted factor, recent report by Martina Brueckner and colleagues has proposed that the flow itself is important without any such factors. They claim that some of the node cilia are not moving and function as mechanosensor [10]. Our flow culture device will be a good tool to verify this theory, and it will not be so long before we can tell the whole story of left-right determination, the composite process of physics and genetics.

References

Sung Legal Culture: An Analysis of the Application of Laws by Judges in the Ch'ing-Ming Chi

AOKI Atushi
(Graduate School of Letters)
No.1 in "100 Papers Selection" (p.68)

Traditionally in China legal issues were generally judged based on emotions and morality, not on laws, rules or customs, unlike in Muslim, European, or Japanese traditional society. However, the judges in the Sung Dynasty (960-1278) often used imperial laws to make decisions in trial courts, which is regarded as an anomaly. In author's analysis of judicial cases, it is found that the ratios using laws in all judicial documents in the Sung are closely connected with local development in this period. Fig.2 shows demographical growth between 1080 and 1223, in which we find that Kansu, Fukien and Hunan circuits are the top on the household base. And in the neighboring three of high population growth, i.e. Kiangsi, Fukien and Chiangtsang, we can find provinces like Yün, Yen, Chi, Kan, and neighboring provinces in Hunan shows the highest population growth between ca.1090 and 1347 (Fig.1). Not a few materials in the Southern Sung period describe that in those circuits (Fig.3 and 4) and provinces (Fig.4) people were religious, which exactly coincides with the fact that in these areas population growth were highest. There are other descriptions which tell us that people in newly developed areas were religious, and support this understanding. In this research, the author finds out that the magistrates from Kansu and Hunan often use laws in their judgement more than other ones in the book of trials in the thirteenth century entitled Ch'ing-Ming Chi, or 'The Book of Enlightened Judges'.

Dynamics-Driven Reaction Pathway in an Intramolecular Rearrangement

YAMATAKA Hiroshi
(Institute of Scientific and Industrial Research)
No.6 in "100 Papers Selection" (p.69)

Deep insight on organic reaction theory coupled with a state-of-art computation revealed that transition-state structures do not necessarily determine the mechanisms of organic reactions. When thermal effects are taken into consideration, the reaction course can deviate significantly from the minimum energy pathway on the potential energy surface. The phenomenon was demonstrated by the study on the heterolysis of protonated pinacolyl alcohol, \( \text{CH}_3\text{COH} \text{CH}_2\text{O}^+ \). Molecular orbital and density functional theory calculations showed a single transition state corresponding to a concerted reaction with simultaneous loss of a water molecule and migration of a methyl group to the tertiary carbocation as the final product (\( \text{CH}_3\text{CO}^+ \text{CH}_2\text{OCH}_3 \)). However, direct ab initio molecular dynamics simulations revealed a stepwise route: C-C bond cleavage gives a secondary cation that later rearranges to the tertiary cation product. These results imply that a transition state of a given character may have only limited importance with respect to the actual mechanism and open the door for a new theory of organic reactions.
Measurement of the photonic de Broglie wavelength of entangled photon pairs generated by spontaneous parametric down-conversion

EDAMATSU Keiichi and ITOH Tadashi
(Graduate School of Engineering Science)
No.7 in "100 Papers Selection" (p.69)

Photons are the quanta of electromagnetic fields. A photon of light field with a wavelength $\lambda$ carries a momentum $p = \hbar k$, where $\hbar$ is Planck constant. In this sense, the classical wavelength $\lambda$ of the light field is equivalent to the de Broglie wavelength $\hbar / p$ of one photon. Then, it might be plausible that a bunch of $N$ photons carrying a momentum $Np$ have reduced de Broglie wavelength $\lambda / N$. Eventually it has been impossible to observe the reduced de Broglie wavelength for the case of usual classical lights. A recent theoretical prediction regarding quantum entanglement suggested that the de Broglie wavelength for an ensemble consisting of $N$ entangled photons would be $\lambda / N$.

We have been verified this proposition for the case of two entangled photons. The entangled photon pairs were created by the process of parametric down-conversion (PDC), in which an incident photon entering an optical nonlinear crystal splits into two correlated photons. These photons are then sent through a Mach-Zehnder interferometer (Fig. 1). In the interferometer, each pair of photons travels together along either one of the interferometer arms as a result of two-photon quantum interference (Hong-Ou-Mandel interference). Thus it is possible to measure the de Broglie wavelength of the photon pair state. The resultant interference pattern (Fig. 2, Lower curve) shows that the photons behave as if they acted as a single entity with a wavelength half that for either photon alone (Fig. 2, Upper curve). The reduced de Broglie wavelength of entangled photons is expected to improve the spatial resolution of optical imaging beyond the classical diffraction limit.

Synthesis and Biological Activities of Lipid A Analogs Possessing $\beta$-Glycosidic Linkage at 1-Position

FUKASE Koichi, UENO Atsushi, FUKASE Yoshiyuki, OIKAWA Masato, SUDA Yasuo and KUSUMOTO Shoichi
(Graduate School of Science)
No.9 in "100 Papers Selection" (p.69)

New lipid A analogs having acidic groups $\beta$-glycosidically linked at the 1-position were synthesized in order to investigate the structural requirement for immunostimulating and endotoxic activity of lipid A. The $\beta$-phosphorylcarboxyl (PC) and carboxymethyl (CM) analogs of E. coli type having six acyl groups and those of the biosynthetic precursor type having four acyl groups were synthesized via a divergent synthetic route. The cytokine inducing assay clearly demonstrated that the hexaacyl (HC)-CM analog and $\beta$-PE analog, which was previously reported to be not endotoxic, have strong immunostimulating activity comparable to the corresponding $\alpha$-type analogs and E. coli lipid A itself. The tetraacyl ($\beta$)-analog, which have lower solubility than the $\alpha$-type analogs, showed definite but weaker antagonistic activity than the $\alpha$-counterparts. The acidic-functional groups are concluded to be essential but their strict spatial arrangement is not required for expression of the biological activity.
Role of Copper Ion in Bacterial Copper Amine Oxidase: Spectroscopic and Crystallographic Studies of Metal-substituted Enzymes

OKAJIMA Toshio (Institute of Scientific and Industrial Research, Journal of the American Chemical Society, 125, 1041-1055 (2003))

A. Metal Coordination Structure

B. Reaction Scheme

C. UV-vis Spectral Change

Evidence for Unconventional Strong-coupling Superconductivity in PrOs₄Sb₁₂: An Sb Nuclear Quadrupole Resonance (NQR) Study

KITAOKA Yoshio and KOTEGAWA Hisashi (Graduate School of Engineering Science, Physical Review Letters, 90, 027001-1 - 027001-4 (2003))

In this paper, we report Sb-NQR (nuclear quadrupole resonance) results which evidence a heavy-fermion (HF) behavior and an unconventional superconducting property in the filled skutterudite compound PrOs₄Sb₁₂ with superconducting transition temperature of T_c = 1.85 K. The temperature-dependence of nuclear-spin-lattice relaxation rate, 1/T₁, and NQR frequency unravel a low-lying crystal-electric-field splitting below T_D ~ 10 K, associated with Pr^{3+}(4f) derived ground state.

In the SC state, isostructural LaOs₄Sb₁₂ shows a clear coherence peak just below T_D = 0.85 K, which evidences that LaOs₄Sb₁₂ is a usual BCS superconductor. In PrOs₄Sb₁₂ on the other hand, 1/T₁ shows neither the coherence peak just below T_D = 1.85 K nor a T²-like power-law behavior observed for most heavy-fermion superconductors with the anisotropic line-node superconducting gap. It is surprising that PrOs₄Sb₁₂ looks like an isotropic HF superconductor – it may indeed argue for Cooper pairing via quadrupolar fluctuations.
Structure and Binding Mode of a Ribosome Recycling Factor (RRF) from Mesophilic Bacterium

KOBAYASHI Yuji, YOSHIDA Takaya and OHKUBO Tadayasu
(Graduate School of Pharmaceutical Sciences)

Ribosome recycling factor (RRF) consisting of 185 amino acid residues is a translational factor for protein biosynthesis. It disassembles the post-termination complex which is composed of 70S ribosome, deacylated tRNA and mRNA in concert with elongation factor G (EF-G) in a GTP-dependent manner. X-ray and NMR analyses on RRFs from thermostable bacteria showed that they display a tRNA-like L-shaped conformation with two domains. Since then, it has been accepted that domain I, consisting of a three-helix bundle, corresponds to the anticodon arm of tRNA, and domain II consisting of a β3β2 sandwich structure, corresponds to the acceptor arm. In this study, we obtained a RRF from a mesophilic bacterium, Vibrio parahaemolyticus, by gene cloning and carried out an X-ray analysis on it at 2.2 Å resolution. Analysis of the relative orientations between the two domains in the structures of various RRFs including this RRF revealed that domain II rotates about the long axis of the helix bundle of domain I. The peptide fragment (RRF-DI) corresponding to domain I of RRF was shown to bind to 70S ribosome and the 50S subunit with an affinity similar to that of wild-type RRF. But it does not bind to the 30S subunit. These finding make us to propose a new model where domain I corresponds to the acceptor arm of tRNA and domain II corresponds to the anticodon arm. This is just the reverse of a model that is now widely accepted. However, the new model is in better agreement with published biological findings.

Plastic Deformation Behaviour in Ni₃Ti Single Crystals with D0₃₄ Structure

HAGIHARA Koji, NAKANO Takayoshi and UMAKOSHI Yukichi
(Graduate School of Engineering)

The plastic deformation behaviour of D0₃₄ structured Ni₃Ti, which is one of the important strengthening phases in superalloys, was investigated by using single crystals. (1100)<1120> prism slip and (0001)<1120> basal slip were identified to be operative depending on crystal orientation and temperature. Both slip systems exhibited anomalous strengthening of yield stress with rising temperature. The controlling mechanism of dislocation motion and the origin for the occurrence of anomalous strengthening were discussed based on the careful examination of dislocation structure by TEM.

ANNUAL REPORT OF OSAKA UNIVERSITY—Academic Achievement—2003-2006 55
Near-field Raman Imaging of Organic Molecules by an Apertureless Metallic Probe Scanning Optical Microscope

INOUE Yasushi*1 and KAWATA Satoshi*2
*1(Graduate School of Frontier Biosciences) *2(Graduate School of Engineering)
> No.31 in "100 Papers Selection" (p.71)

When a laser is focused on a metallic tip, the light field is locally confined and amplified due to the resonance between the photons and electrons (Fig. A). We achieved chemical imaging of organic molecules with 30 nm spatial resolution by illuminating molecules with the light field confined around the tip apex. We used this technique to determine the molecular distributions of a sample containing both Rhodamine B (Fig. B) and crystal violet (Fig. C) by fixing the observation wavelengths at specific vibrational bands of the molecules. Such chemical distributions are indistinguishable by atomic force microscopy which instead shows the topography of the substrate (Fig. D).

Preparation of Y2O3:Yb,Er Infrared-to-Visible Conversion Phosphor Fine Particles Using an Emulsion Liquid Membrane System

HIRAI Takayuki*1,2, ORIKOSHI Takuya*2 and KOMASAWA Isao*2,1
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Chemistry of Materials, 14, 3576-3583 (2002)
> No.32 in "100 Papers Selection" (p.71)

Upconverting phosphor fine particles (Y2O3:Yb,Er, Y2O3:Er, Y2O3:Yb,Ho, and Y2O3:Yb,Tm) were prepared, using an emulsion liquid membrane (ELM, water-in-oil-in-water (W/O/W) emulsion) system, consisting of Span 83 (octylphenol ethoxylate) as the surfactant and VA-10 (2-methyl-2-ethylhexanoic acid) as the extractant (cation carrier) for metal ions. The rare earth metal ions were extracted from the external water phase, and transported into the internal water phase, to make precursor composite oxide particles of mainly 20-60 nm in size. These nanoparticles were much smaller than those prepared in homogeneous aqueous solution (1-10 μm in size). The molar composition of the particles, e.g., [M(Yb,Yb-Er)]2 or [M = Yb or Er], prepared in the ELM system, was controlled accurately by the load composition in the external phase, [M(Yb-2Yb+Er)]. Calibration of the composite oxide nanoparticles obtained in the ELM systems under air or sulfur atmosphere, produced oxide or oxysulfide upconverting phosphors of ca. 50 nm in size. The nanoparticles showed upconverting emission by infrared excitation (λex = 980 nm): red emission from Y2O3:Yb,Er, green and red emission from Y2O3:Yb,Er, green emission from Y2O3:Yb,Tm, and blue emission from Y2O3:Yb,Tm. The size- and morphology-controlled upconverting phosphor nanoparticles, prepared in the ELM system, may be applied to the reports in immunoassays or DNA assays.

Emulsion Liquid Membrane System as "Microreactor" for Preparation of Nanoparticles

In Situ Observation of a Fluid Amorphous Phase Formed in Isolated Nanometer-sized Particles in the Sn-Bi System

LEE Jung-Goo and MORI Hirotaro


A novel phase formation in the Sn-Bi binary system has been studied as a function of particle size by in-situ transmission electron microscopy (TEM) at room temperature. In approximately 20 nm-sized particles, alloy phases formed were essentially the same for those in bulk material. However, in particles less than approximately 10 nm in diameter, the formation of an amorphous phase, which is not an equilibrium phase in bulk at room temperature, was confirmed. In addition, it is revealed that the amorphous phase has a fluidity at room temperature. Bright and dark spots in the granular contrast in the high-resolution electron microscopy images of the fluid amorphous phase exhibited continuous changes in position and intensity with time, suggesting a high atomic mobility in the amorphous phase. Upon heating the fluid amorphous phase went to melt without crystallization and upon cooling it solidified again into the fluid amorphous phase with no traces of crystallization. These results indicate that due to the finite-size effect, the eutectic point $T_{e}$ in this system is lowered to a temperature below room temperature where observations were carried out, and that the glass transition temperature $T_{g}$, where a liquid goes to an amorphous solid, locates near room temperature.

In Situ Observation of a Fluid Amorphous Phase Formed in Isolated Nanometer-sized Particles in the Sn-Bi System

Holographic Data Storage on Nonsensitive Glass with a Single Femtosecond Laser Pulse

ITOH Kazuyoshi and WATANABE Wataru


In conventional holographic data storage, an entire page of information is stored as a pair of optical interference patterns formed by two coherent laser beams within a photosensitive optical medium such as photorefractive crystals and photopolymers. We present experimental results of holographic data storage on the surface of fused silica, soda-lime, and lead glasses by two-beam interference of a single 130 fs laser pulse at a wavelength of 800 nm. A top view of experimental schematics for recording and reconstruction of the data image is shown in Fig. 1. A femtosecond laser pulse of 130 fs duration with diameter of $5 \times 5 \mu m$ that is generated from a regeneratively amplified Ti:sapphire laser system at a wavelength of 800 nm is split into the reference beam and object beam. We focused the reference beam using a 500 mm focal-length lens. The object beam is first expanded to $15 \times 15 \mu m$ and then focused onto the sample surface by use of the lens of 50 mm focal length. A data mask is placed in the front focal plane of the lens in the object arm. The reference beam and object beam are incident onto the sample at approximately equal angles. The angle between the two beams is set to be $31^\circ$ and the period of the interference fringe without data mask in the object beam is $1.5 \mu m$. When the optical paths are adjusted to give a perfect spatial and temporal overlap of the reference and object beams, the interference pattern is formed. The binary data mask consists of 9 spots in a $3 \times 3$ array as shown in Fig. 2 (a). Figure 2 (b) and (c) show holograms recorded on soda-lime and its corresponding reconstructed images, respectively.
Coverage Dependence of Hydrogen Absorption into Pd(111)

NOBUHARA Kunihiro, KASAI Hideaki and NAKANISHI Hiroshi
(Graduate School of Engineering)
No.50 in "100 Papers Select" (p.73)

We investigate the absorption of H into Pd(111). In particular, we study the coverage dependence of the H-induced relaxation of the Pd lattice and the corresponding variation in the energy barrier for H absorption. We calculate, within the density functional theory, the corresponding potential energy curves for the case when the H attaches to a frozen lattice surface, and on a lattice surface that is allowed to undergo H-induced relaxation. We considered the case when the final H-coverage \( \theta = 1/6 \) and 1/4. From the results, it can be seen that, for both coverages, the energy barrier for H absorption takes a minimum value at the fcc hollow site on the frozen lattice surface. Furthermore, the barrier is lowered by the relaxation of the Pd lattice. The H-induced relaxation of the Pd lattice when \( \theta = 1/6 \) is more remarkable than when \( \theta = 1/4 \). As a result, the variation of the energy barrier for H absorption at the fcc hollow site by the H-induced relaxation of the Pd lattice is more remarkable in the case \( \theta = 1/6 \) than that in the case \( \theta = 1/4 \).

Crystal Faces of Rutile and Anatase TiO₂ Particles and Their Roles in Photocatalytic Reactions

MATSUMURA Michio
(Research Center for Solar Energy Chemistry)
No.54 in "100 Papers Selection" (p.73)

Particles of TiO₂ have widely been utilized as photocatalysts. By photoactivation of TiO₂ particles at some conditions, water can be split into hydrogen and oxygen. This reaction is important because light energy is directly converted to storidge chemical energy. However, the efficiency of these energy conversion reactions has been very low. We have demonstrated that crystal faces exposed on the TiO₂ particle play an important role in driving energy conversion reactions. For example, on a rutile particle, reductive processes favorably take place on the [110] faces, and oxidative processes on the [011] faces. This finding has opened the door to designing efficient photocatalysts.
Mechanical Vertical Manipulation of Selected Single Atoms by Soft Nanoindentation Using Near Contact Atomic Force Microscopy

OYABU Noriaki, CUSTANCE Oscar, YI Insook, SUGAWARA Yasuhiro and MORITA Seizo
(Graduate School of Engineering)
No.55 in "100 Papers Selection" (p.73)

(a) Non-Contact

Before Removal of Si

Non-Contact

(b) Contact

After Removal of Si

Before Si Deposition

Non-Contact

(c) Contact

After Si Deposition

A near contact atomic force microscope operated at low temperature is used for vertical manipulation of selected single atoms from the Si(111)-(7×7) surface. The strong repulsive short-range chemical force interaction between the closest atoms of both tip apex and surface during a soft nanoindentation leads to the removal of a selected silicon atom from its equilibrium position at the surface without additional perturbation of the (7×7) unit cell. Deposition of a single atom on a created vacancy at the surface is achieved as well. These manipulation processes are purely mechanical, since neither bias voltage nor voltage pulse is applied between probe and sample. Differences in the mechanical response of the two nonequivalent adatoms of the Si(111)-(7×7) with the load applied is also detected.

Three-Dimensional Focal Spots Related to Two-Photon Excitation

SUN Hong-Bo*1, TANAKA Tomokazu*1 and KAWATA Satoshi*1,2
*1(Graduate School of Engineering) *2(Graduate School of Information Science and Technology)
No.60 in "100 Papers Selection" (p.73)

Two-photon photopolymerization that was proposed by us has been established as a unique tool for laser nanofabrication due to its intrinsic three-dimensional (3D) processing capability, the sub-diffraction-limited spatial resolution, and the excellent compatibility to various functional materials. Despite its widespread use, some fundamental understandings on the technology remain to be made. How to characterize 3D accuracy of the laser writing is one of such open problems. Here we propose and experimentally confirmed an ascending scan method, by which both the shape and size of the photopolymerized volume elements could be resolved. Assisted by this scheme, we (i) have found that the voxel growth abides by different laws in the course of increasing laser power and prolonging the exposure time, the two processes that are conventionally considered as equivalent; (ii) propose a concept of dynamic exposure time range, by which the 6th and higher-order feature of diffraction could be recorded simultaneously. The ascending scan technology would pave the way for high-efficiency design and high-fidelity writing of 3D nanostructures and devices.
crinkle, a Novel Symbiotic Mutant that Affects the Infection Thread Growth and Alters the Root Hair, Trichome, and Seed Development in *Lotus japonicus*

TANSENGCO Myra Lawas, HAYASHI Makato and MUROOKA Yoshihatsu
(Graduate School of Engineering, Graduate School of Information Science and Technology)


To elucidate the mechanisms involved in *Rhizobium*-legume symbiosis, we examined a novel symbiotic mutant, *crinkle*, from the model legume *Lotus japonicus*. The *crinkle* mutant inoculated with the symbiotic bacterium *Mesorhizobium loti* showed severe nitrogen deficiency symptoms. The *Cri* gene controls the infection process that is crucial during the early stage of nodule organogenesis. This mutant also developed morphological alterations, such as crinkly or wavy trichomes, short seedpods with aborted embryos, and swollen root hairs. *Crinkle* is therefore required for symbiotic nodule development and for other aspects of plant development.

Wild type (left) and *crinkle* (right) after inoculation of *M. loti*. The mutant shows defect in nodule development.

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Ultragrain refinement of plain low carbon steel by cold-rolling and annealing of martensite

UEJI Rintaro, TSUJI Nobukihiro, MINAMINO Yoritoshi and KOIZUMI Yuichi
(Graduate School of Engineering)


Novel thermomechanically controlled processing (TMCP) has been developed to obtain nanostructured low carbon steel (Fe-0.13wt%C). The key of the novel process is to use Martensite as the starting structure; only 50% cold-rolling and warm temperature annealing of Martensite fabricates ultragrain ferrite structure with mean grain size of 180nm. The ultragrain grains were surrounded mainly by high-angle grain boundaries whose misorientation angles were larger than 15 deg. In addition, nano-carbides precipitated uniformly because Martensite is a supersaturated solid solution of carbon, and tempered martensite blocks were observed partially. It was also clarified that the multiphasic nanostructure obtained by the present process exhibited superior high strength (870MPa of tensile strength) with adequate ductility (20% of total elongation). The detailed microstructural analysis clarified that the mechanism of the nanostructure formation is quick grain subdivision enhanced by Martensite starting structure.
A Point Mutation of Tyr-759 in Interleukin 6 Family Cytokine Receptor Subunit gp130 Causes Autoimmune Arthritis

ISIHARA Katsuhiko and HIRANO Toshio
(Graduate School of Frontier Biosciences and Graduate School of Medicine)
Journal of Experimental Medicine, 196, 979-990 (2002)
No.67 in “100 Papers Selection” (p.74)

The Motor Domain Determines the Large Step of Myosin-V

YANAGIDA Toshio
(Graduate School of Frontier Biosciences)
No.71 in “100 Papers Selection” (p.74)
Diet-Induced Insulin Resistance in Mice Lacking Adiponectin/ACRP30

MAEDA Norikazu
(Graduate School of Medicine)
Nature Medicine, 8, 731-737 (2002)
*No.76 in "100 Papers Selection" (p.75)

Adiponectin/ACRP30 is an adipocytokine we identified by screening adipose-specific genes in the human cDNA project. Adiponectin mRNA is exclusively expressed in adipose tissue and its protein is abundantly present in plasma. However, adiponectin mRNA and plasma protein levels decrease in obesity and type 2 diabetes. The physiological role of adiponectin has not been clear, therefore we investigated the biological functions of adiponectin by generating the mice lacking adiponectin (A). Adiponectin knockout mice (KO) showed disturbed FFA clearance with the decrease of muscle FATP-1 mRNA (B), and revealed diet-induced insulin resistance with the deteriorated insulin signaling in muscle (C). Next we challenged the supplement of adiponectin using adenovirus. Adiponectin overproduction reversed the elevated adipose TNF-α expression and ameliorated diet-induced insulin resistance in KO (D). In C2C12 myocytes, FATP-1 mRNA and glucose uptake is decreased by TNF-α, whereas induced adiponectin (E). Our previous study demonstrated that TNF-α suppresses adiponectin expression at the transcriptional level. In this study, we conceptualized the "Adipo-Muscular Axis" and showed the usefulness of adiponectin for the treatment of metabolic syndrome.

Genome Sequence of Vibrio parahaemolyticus: a Pathogenic Mechanism Distinct from That of V. cholerae

IDA Tetsuya
(Research Institute for Microbial Diseases)
*No.77 in "100 Papers Selection" (p.75)


Vibrio parahaemolyticus, a Gram-negative marine bacterium, is a worldwide cause of foodborne gastroenteritis. The bacterium was discovered in 1950 by researchers of Osaka University. We determined the complete genome sequence of V. parahaemolyticus. The genome consists of two circular chromosomes. Comparison of the genome with that of V. cholerae, the causative agent of cholera, revealed numerous rearrangements within and between the two chromosomes. Unlike V. cholerae, genes for the type III secretion system, involved in a key step of infections, were identified in V. parahaemolyticus, suggesting that the two vibrios employ distinct mechanisms to establish infection.
Nectin: an Adhesion Molecule Involved in Formation of Synapses

TAKAI Yoshimi
(Graduate School of Medicine)
No.79 in "100 Papers Selection" (p.75)

Synapses have been regarded as one of the specialized cell-cell junctions whose specificity and plasticity provide neurons with a structural and functional basis for neural network formation. The molecular architecture of the cell-cell junctions of synapses is, however, poorly understood. The nectin-afadin system is a novel cell-cell adhesion system that organizes adherens junctions cooperatively with the cadherin-catenin system in fibroblasts and epithelial cells. Moreover, the nectin-afadin system colocalizes with the cadherin-catenin system at the synapses between the mossy fiber terminals and the dendrites of pyramidal cells in the CA3 area of adult mouse hippocampus. Hence the synapses are active-remodeled and play a key role in synaptic plasticity, a principal mechanism of memory and learning. Both the nectin-afadin and cadherin-catenin systems cooperatively play important roles in formation of the synapses. (A-C), the CA3 area of adult mouse hippocampus; (A), the nectin-1 signal; (B), the afadin signal; (C), image overlay of A and B. (SR), stratum radiatum; (SL), stratum lucidum; (SP), stratum pyramidale; and (SO), stratum oriens. Bar, 30 μm.


Presenilins Mediate a Dual Intramembranous γ-Secretase Cleavage of Notch-1

OKOCHI Masayasu and TAKEDA Masatoshi
(Graduate School of Medicine)
The EMBO Journal, 21, 5408-5416 (2002)
No.84 in "100 Papers Selection" (p.76)

Intramembranous proteolysis, a hydrolysis occurring under extremely hydrophobic conditions, is a contradictory phenomenon. Because of a strong Alzheimer's disease (AD) hypothesis that indicates small changes in the precision of the intramembranous proteolysis of APP essentially causes AD, extensive studies concerning this abnormal cleavage have been carried out. Recently, it has gradually become clear that upon ligand binding the membrane-bound receptors themselves undergo regulated intramembranous endoproteolysis (RIP), which frees their intracellular domains, translocating to the nucleus to function as transcriptional modifiers. This paper deals with secretion of a novel Aβ-like Notch peptide (Notch-1-β peptide; Nβ), which contains a part of the transmembrane domain, and occurs simultaneously with the liberation of NICD, a signaling molecule, from the membrane (Fig. a). Moreover, we found that the RIP indispensable to Notch signaling consists of at least two distinct cleavages both of which are presenilin (PS) dependent. These findings were exactly duplicated when we used CD44 as another substrate. Therefore, we propose to term the novel intramembranous cleavage process "Dual-disulfide mechanism" (Fig. b). It has been suggested that relative up-regulation of C-terminally elongated Aβ40/42 to major Aβ40 may cause AD. Surprisingly, as in the case of Aβ, familial AD-linked PS mutants cause C-terminal elongation of Nβ(Fig. c). The peripheral Aβ level does not reflect its generation because of its accumulation in senile plaques. We therefore propose that measuring the level of Aβ-like peptides (such as Nβ) instead of Aβ, we may make it possible to estimate if the precision or level of γ-cleavage is affected in individuals, which would then lead to expected diagnosis of AD. Finally, our data predict the secretion of a variety of novel and unexpected Aβ-like peptides, which accompanies RIP signaling (Fig. d).

Essential Role for TIRAP in Activation of The Signalling Cascade Shared by TLR2 and TLR4

YAMAMOTO Masahiro and AKIRA Shizuo
(Research Institute for Microbial Diseases)
No.95 in "100 Papers Selection" (p.77)

Signal transduction through TLRs originates from their Toll/IL-1R (TIR) domains, which are conserved among all TLRs. A TIR domain-containing adaptor, MyD88, binds to the TIR domain of TLRs and plays a crucial role in all TLR-mediated signaling pathways. The analysis of MyD88-deficient mice suggested that the signaling from TLRs is composed of two pathways: a MyD88-dependent pathway leading to proinflammatory cytokine production or splenocyte proliferation, and a MyD88-independent pathway leading to induction of IFN-β and IFN-inducible genes in TLR3 and TLR4 signaling. TIRAP (also known as Mal) has been identified as a second TIR domain-containing adaptor. Initial in vitro analyses indicated that TIRAP is involved in the TLR4-mediated MyD88-independent pathway. To elucidate the physiological role of TIRAP, we generated TIRAP-deficient mice. In TIRAP-deficient mice, MyD88-dependent responses such as cytokine production or splenocyte proliferation mediated by TLR4, but not by TLR7 or TLR9, were severely impaired. In addition, the TLR2 ligand-stimulated MyD88-dependent responses were also profoundly inhibited in TIRAP-deficient mice. While TLR2 ligands stimulated NF-κB activation in MyD88-deficient cells, TIRAP-deficient cells showed compromised NF-κB activation in response to the TLR2 or TLR4 ligand, but not to the TLR7 ligand. In contrast, TLR4-mediated MyD88-independent responses and the activation of signaling molecules were intact in TIRAP-deficient mice. Thus, TIRAP physiologically acts as an adaptor molecule in the MyD88-dependent pathway shared by TLR2 and TLR4.

Activation of NF-κB in response to TLR4, TLR2, and TLR7 ligands in TIRAP-deficient macrophages

Complete Atomic Model of the Bacterial Flagellar Filament by Electron CryoMicroscopy

YONEKURA Koji, MAKI-YONEKURA Saori and NAMBA Keiichi
(Graduate School of Frontier Biosciences)
No.98 in "100 Papers Selection" (p.77)

The bacterial flagellar filament is a helical propeller for bacterial locomotion. It is a helical assembly of a single protein, flagellin, and its tubular structure is formed by 11 protomers in two distinct conformations, L- and R-type, for supercoiling. The X-ray crystal structure of a flagellin fragment lacking ~10 terminal residues revealed the protofilament structure, but the full filament structure was still essential for understanding the mechanism of supercoiling and polymerization. In this paper, we reported a complete atomic model of the R-type filament by electron cryo-microscopy. This is the first atomic model of a macromolecule obtained solely by image analysis, and the high-resolution density map (4 Å) was obtained from extraordinary small number of images, more than one order of magnitude smaller than generally required, by various devices in the method of image analysis. The density map shows the feature of α-helical backbone and some large side chains. The atomic model built on the map reveals intricate molecular packing and an α-helical coiled coil formed by the terminal chains in the inter core of the filament with its interhelical hydrophobic interactions playing an important role in stabilizing the filament. The flagellar filament has a central channel through which a large number of flagellin molecules are transported to the distal end for the filament growth. This transport mechanism is homologous to the Type III secretion system of the virulence factors in pathogenic bacteria. The structure has revealed the nature of the central channel for the first time. The structure also shows clear differences even in the region included in the crystal structure previously reported, demonstrating the superiority of electron cryomicroscopy, which can visualize macromolecular structures without any constraints imposed by crystal lattices.

Ribbon diagram of the Cox backbone of the flagellar filament model in stereo view
Assembly process of the flagellar filaments
Core-binding factor β interacts with Runx2 and is required for skeletal development

YOSHIDA Carolina Andrea, et al.
(Graduate School of Dentistry and Graduate School of Medicine)
► No.99 in "100 Papers Selection" (p.77)

Core-binding factor β (Cbfβ) forms a heterodimer with the transcription factor Runx2, essential in skeletal development. Cbfβ-deficient (Cbfβ−/−) mice die at early midgestation due to an absence of fetal liver hematopoiesis, therefore, the function of Cbfβ in relation to Runx2 and consequently in skeletal development, which occurs in a later embryonic stage, remained to be clarified. To investigate this issue, we rescued hematopoiesis of Cbfβ−/− mice by introducing Cbfβ using the Gas1 promoter. The rescued Cbfβ−/− (Fig. 1 Cbfβ−/−tg), recapitulated fetal liver hematopoiesis (Fig. 2) and survived until birth. These mice showed severely delayed bone formation (Fig. 3). Intramembranous bones were poorly formed (arrow in Fig. 3), the maturation of chondrocytes was delayed, and no endochondral bones were formed (Fig. 4). Electrophoretic mobility shift assays and reporter assays showed that Cbfβ is necessary for the efficient DNA binding of Runx2 and Runx2-dependent transcriptional activation. These findings demonstrate that Cbfβ is required for the function of Runx2 in skeletal development.

A Novel Ring-like Complex of Xenopus Proteins Essential for the Initiation of DNA Replication

KUBOTA Yumiko, ARATA Toshiaki and TAKISAWA Haruhiko
(Graduate School of Science)
► No.100 in "100 Papers Selection" (p.77)

In eukaryotes, DNA replication machinery has been assembled at the onset of S-phase, and Mcm2-7 and Cdc6 are thought to be essential components of the machinery. We have identified and characterized Xenopus homologues of Sld5 and its associated partners, Ptf1, Fas2 and Pif3. The four proteins form a tetrameric complex in Xenopus egg extracts and this novel complex, referred as GINS (Go-iChi-Ni-San, 5-1-2-3 in Japanese) is required for the initiation of DNA replication. Only GINS could rescue the replication activity of Sld5-depleted egg extracts. Its binding to chromatin is mutually dependent upon Cdc6 binding to chromatin. The complex formation of GINS with Cdc6 and Mcm2-7 on replicating chromatin suggests that GINS, cooperating with Cdc6, performs an essential role in the initiation stage of DNA replication. Electron microscopic observation further reveals that the complex has a ring-like structure. These results further suggest the possibility that GINS plays an essential role in the elongation stage of DNA replication as a putative clamp of DNA polymerases.
100 Papers Selection

*Researchers in bold italic letters are faculty members of Osaka University, and their institutions are indicated in parentheses.

*Green shaded papers are the "100 Papers Selection" with short abstracts written by the authors.

*Blue shaded papers are included in the "10 Papers Selection."

*Red shaded papers are included in the "28 Graphics Selection."


<table>
<thead>
<tr>
<th>Humanities &amp; Social Sciences</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>20</td>
</tr>
<tr>
<td>Engineering</td>
<td>41</td>
</tr>
<tr>
<td>Biology</td>
<td>34</td>
</tr>
<tr>
<td><strong>Total 100</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Humanities & Social Sciences

1. **Aoki, A.** (Graduate School of Letters)
   **Sung Legal Culture: An Analysis of the Application of Laws by Judges in the Ch'ing-Ming Chi**
   ▶ p.52

2. **Aoki, N.** (Graduate School of Letters)
   **Teachers' Conversation with Partial Autobiographies**
   ▶ This paper reports on a course in the Japanese as a second language teacher education programme in Graduate School of Letters in which in-service teachers discussed cases written by themselves. The analysis of one of the discussions and subsequent interviews with the teachers reveal that multiple layers of autobiographical stories were involved in the discussion. In concluding the paper suggests that telling autobiographical stories can be a powerful tool to facilitate teacher development.

3. **Horita, Y.; Yoshida, K.** (Graduate School of Economics)
   **Determinants of Japanese Corporate Pension Coverage**
   ▶ The unique and complex historical and institutional background of Japanese pension system provides the motivation for this study to examine the factors underlying corporate decisions to adopt explicit pension plans. Hypotheses grounded in the finance motivation such as cost minimization and tax consideration are strongly supported by the evidence presented in this study. However, it is also shown that hypotheses pertaining to aspects of Japanese-style bargaining between labor and management lost their relevance with regard to pension adoption during the turbulent 1980s when firms came under increased global competition.

   **Are the Japanese Selfish, Altruistic or Dyreatic?**
   ▶ pp.10-13

5. **Miyamota, Y.; Ejiria, Y.** (Faculty of Language and Culture)
   **On the Existence of Scrambling in the Grammar of Japanese Elementary EFL Learners**
   ▶ This paper argues that Japanese elementary EFL learners allow movement of the kind *"How many did Bill think t_s students are smart?"* and that this is because they treat WH-movement as scrambling. It was also found that intermediate level speakers have not acquired the quantificational force of English WH-phrases. It is proposed that this follows if the F Erickson Absorption parameter (Watanabe 2000) has not been reset from its Japanese value.


19. Ohta, N. (Graduate School of Science)

Intersection Rules for S-Branes


It is very important to study properties and find various solutions of superstring/M-theory which is believed to give the quantum theory of gravity. This paper gives model-independent derivation of various time-dependent solutions of M-theory by using general methods that the author developed before, and gives general rules how to construct this class of solutions called S-branes. It turned out that these solutions give cosmological models consistent with recent observation of cosmic microwave backgrounds, thus reinforcing the physical implications of the fundamental M-theory.

20. Ikari, K., Sato, H. (Graduate School of Science)

First Synthesis of Olivine Single Crystal as Large as 250 Carats

*Journal of Crystal Growth, 253, 557-561 (2003)*

Comprehensive and conclusive understanding of the anisotropic upper mantle relies on physical property measurements on high-quality homogeneous specimens of various crystallographic directions. Such specimens are ultimately prepared from one large single crystal. A large olivine single crystal (250 carats) was synthesized for use in anisotropy studies. We show a new practical method for producing a large single crystal. Our new attempts to use natural olivine with a wide iodium-crucible are successful, and promising to produce large single crystals successively.

21. Sentoku, Y., Mima, K., Kow, P., Nishikawa, K.

(Institute of Laser Engineering)

Anomalous Resistivity Resulting from MeV-electron Transport in Overdense Plasma

*Physical Review Letters, 90(15), 155001-1-4 (2003)*

The recent advent of petawatt lasers capable of producing focused laser intensities over $10^{20}$ W/cm² and driving electron motion into the relativistic regime has opened up many new interesting fields of research, such as fast ignition for laser fusion, short pulse X-ray and neutron/proton sources, etc. Laser-produced electron dynamics in plasmas is studied by 3-D particle-in-cell simulations. It is found that the relativistic electron current is self-organized to form a single current channel and generates anomalous resistivity causing strong plasma heating.


*1(Research Center for Materials Science at Extreme Conditions)

*2(Graduate School of Engineering Science)

Superconductivity in Compressed Lithium at 20 K


pp. 18-21


*Kindo, K.*, Settai, R.*, Onuki, Y.*

*1(Graduate School of Science)*

*Magnetic and High-field Magnetization of RCo

*Journal of Magnetism and Magnetic Materials, 262, 389-398 (2003)*

We measured the magnetization of CeCu$_2$Ge$_2$, PrCu$_2$, TbCu$_2$, DyCu$_2$, and MnCu$_2$ in high magnetic fields up to 40 T and in a wide temperature range from 1.3 to 150 K, and observed a metamagnetic transition with a large hysteresis. The present metamagnetic transition occurs in the ac-plane of the orthorhombic crystal structure and indicates the conversion between the magnetic easy- and hard-axes, which was analysed on the basis of the quadrupole moment of Ce.
Engineering

(Graduate School of Engineering)
Isolation and Crystal Structure of a Water-Soluble Iridium Hydride: A Robust and Highly Active Catalyst for Acid-Catalyzed Transfer Hydrogenations of Carbonyl Compounds in Acidic Media
Journal of the American Chemical Society, 125, 4149-4154 (2003)

- A water-soluble iridium hydride complex acts as a robust and highly active catalyst for acid-catalyzed transfer hydrogenations of carbonyl compounds in a pH range of 2 to 3. The structure of the water-soluble iridium hydride complex was unequivocally determined by X-ray analysis. The effect of pH on the rate of the transfer hydrogenation is rationalized by the pH-dependent formation of the water-soluble iridium hydride complex and activation process of the carbonyl compounds by protons.

(Graduate School of Pharmaceutical Sciences)
Lipase-Catalyzed Domino Kinetic Resolution/Intramolecular Diels-Alder Reaction: A One-Pot Preparation of Optically Active 7-Octacyclo[2.2.1]heptenes from Furfuryl Alcohol and [beta]-Substituted Acrylic Acids

- As an environmentally benign protocol, lipases, a kind of hydrolytic enzymes, have extensively been employed for organic synthesis; however, their use was limited to just separation of racemic mixtures into each enantiomer. This paper presents the first usage of the lipases for the construction of carbon frameworks. The key was the use of suitably functionalized ethoxynyl esters for the lipase-catalyzed esterification. Thus, optically pure tricyclic compounds were synthesized, via consecutive three steps, from readily available racemic alcohols and achiral carboxylic acids.

28. Arakawa, S.1; Murata, M.2
1 (Graduate School of Economics) 2 (Cybermedia Center)
Lightpath Management of Logical Topology with Incremental Traffic Changes for Reliable IP over WDM Networks

- We propose a new approach, called incremental capacity dimensioning approach, to design a reliable IP over WDM network. Our approach consists of three steps: an initial phase, an incremental phase, and a re-adjustment phase, through which the logical topology can be adjusted according to the incrementally changing traffic demand. MRU (Minimum Reconfiguration for Backup lightpath) is proposed to assign a wavelength route in such a way that the number of backup lightpaths to be reconfigured is minimized.

29. Fukuzumi, S.; Inada, O.; Suenobu, T.
(Graduate School of Engineering)
Direct Detection of Radical Cations of NADH Analogues

- The radical cation of an NADH analog (BNAP: 1-benzyl-1,4-di-hydroxynicotinamide) has been successfully detected as the transient absorption and ESR spectra in the thermal electron transfer from BNAP to Fe(bipy)32+ (bipy = 2,2'-bipyridine). The ESR spectra of the radical cations of BNAP and the dioxygenated compound (BNAP-4,4'-d2) indicate that the observed radical cation is the keto form rather than the enol form in the tautomerization. The deprotonation rate and the kinetic isotope effects of the keto form of BNAP were determined from the kinetic analysis of the electron transfer reactions.

30. Hagihara, K.; Nakano, T.; Umakoshi, Y. (Graduate School of Engineering)
Plastic Deformation Behaviour in NiTi Single Crystals with D022 Structure

- p.55

31. Hayakawa, N.; Inoue, Y.1; Sekkat, S.2; Kawata, S.3
1 (Graduate School of Frontier Bioscience) 2 (Handai FRC) 3 (Graduate School of Engineering)
Near-field Raman Imaging of Organic Molecules by an Apertureless Metal-Induced Probe Scanning Optical Microscope

- p.56

32. Hiroi, T.1; Orikashi, T.2; Konasawa, I.3
1 (Research Center for Solar Energy Chemistry, and Graduate School of Engineering Science) 2 (Graduate School of Engineering Science) 3 (Graduate School of Engineering Science, and Research Center for Solar Energy Chemistry)
Preparation of Y2O3:Yb,Er Infrared-to-Visible Conversion Phosphor Fine Particles Using an Emulsion Liquid Membrane System
Chemistry of Materials, 14, 3576-3583 (2002)

- p.56

33. Ichikawa, T.; Tane, M.1; Ogi, H.1; Hiroi, M.1; Ikeda, T.2; Nakajima, H.2
1 (Graduate School of Engineering Science) 2 (Institute of Scientific and Industrial Research)
Anisotropic Elastic Constants of Lotus-Type Porous Copper: Measurements and Micromechanical Modeling

- We studied the elastic constants of a lotus-type porous copper, regarding it as a composite material of hexagonal elastic symmetry with the c-axis along the longitudinal direction of the pores. We used the ultrasonic resonance methods to determine the full set of anisotropic elastic constants. Micromechanics model including the matrix’s elastic anisotropy can reproduce the measurements. Then, the present approach predicts the elastic properties of various types of porous metals.

34. Imanaka, N.; Okamoto, K.; Adachi, G.
(Graduate School of Engineering)
Extraordinary High Chloride Ion Conducting Solid Electrolyte Based on Water-Insoluble Lanthanum Oxychloride

- The Cl- ion conductivity of the Ca doped LaOCl solid solution series was greatly enhanced more than three orders of magnitude by the Ca doping. The present Ca doped LaOCl electrolyte has such unique characteristics to be insoluble in water with accompanying a high thermal durability, the improved relative density and hardness. This new type of Cl- ion conducting solid series are greatly expected to contribute to new type of functional materials like chemical sensors such as Cl2 and dioxin.

Novel Fabrication of A Conductive Polymers Containing Micro Array Gas Sensitive Film By Using Micromimulation Method

- We tried a novel fabrication of conductive polymers made of thiophene or dodecylthiophene on an electrolytically deposited poly-iodine film. The conductivity is increased by the use of an array of 100 μm × 100 μm by using a micromimulation method. Significant change in resistance of sensor films was observed, depending on the type of testing gas and the operating temperatures. Our novel method permitted us to improve the gas sensitivity and the stability of sensor films.

Passivation of Defect States in Amorphous and Crystalline Si by Use of Cyanide Treament and Improvement of Solar Cell Characteristics

- We have developed a new method of eliminating defect states in Si called "cyanide treatment" which simply involves immersion of Si in KCN solutions. When the cyanide treatment was applied to p-n junction, amorphous Si solar cells, the conversion efficiencies became higher by 28% than those with no treatment. The improvement is attributed to the elimination of defect states by the reaction with cyanide ions. The cyanide treatment can also passivate Si/SiO2 interface states, resulting in the improvement of MOS characteristics.
37. Kodama, R. (Institute of Laser Engineering.)
Fast Heating Scalable to Laser Fusion Ignition
► We have demonstrated PW laser heating of imploded plasmas that is scalable to full scale laser fusion ignition. Our findings bring us a step closer to realizing the production of relatively inexpensive, full-scale fast-ignition laser fusion facilities.

► *1 (Graduate School of Engineering) *2 (Collaborative Research Center for Advanced Science and Technology) *3 (Graduate School of Information Science and Technology)
Video Database Retrieval Based on Gestures and its Application
► pp.22-25

Experimental Evaluation of Program Slicing for Fault Localization
► This paper experimentally evaluates the usefulness of the program slicing method to fault localization. We first developed a debugger based on program slicing, after which two experimental projects were conducted, in which subjects were divided into two groups. Each subject in Group 1 localizes the faults by using the slicing-based method, whereas in Group 2 each subject localizes the faults by using the conventional debugger-based method. Finally, the effectiveness of program slicing is analyzed by comparing the data collected from both groups.

In Situ Observation of a Fluid Amorphous Phase Formed in Isolated Nanometer-sized Particles in the Sm-Bi System
► p.57

41. Li, Y.;*1: Watanabe, W.;*2: Itoh, K.;*2: Sun, X.
► *1 (VBL) *2 (Graduate School of Engineering)
Holographic Data Storage on Nonsensitive Glass with a Single Femtosecond Laser Pulse
► p.57

42. Mieda, I.; Miyasaka, H.; Umeda, F.; Kawanoe, M.; Yagi, K. (Graduate School of Pharmaceutical Sciences)
Maximization of Hydrogen Producing Ability in High-Density Suspension of Rhodovulum sulfidophilum Cells Using Intracellular Poly(3-hydroxybutyrate) as a Solid Substrate
Biotechnology and Bioengineering, 81, 474-481 (2003)
► A polyester of 3-hydroxyisocyanic acid, which had been once accumulated in the presence of excess organic carbon-sources, could be converted to hydrogen gas in the cytoplasm of phototrophic bacteria under light. The rate of hydrogen production was higher in the culture consuming the intracellular polyester than in the cultures consuming an external carbon-source as a substrate, indicating a possibility of hydrogen production in combination with organic wastewater treatment via the bacterial polyester metabolism.

Quantitative Measurement of Surface Potential And Amount of Charging on Insulator Surface under Electron Beam Irradiation
► Surface potential and the amount of charging on an insulator surface under electron beam irradiation have been quantitatively measured. The measurement of the surface potential revealed that the sample behaves as a resistor, enabling the present technique to be applied for mapping microarea resistance. The results of measuring the amount of charging under the conditions of different surface potentials strongly suggests that the charging phenomenon depends on the distribution of the charge trapping sites.

Controlled Synthesis of Hydroxyapatite-supported Palladium Complexes as Highly Efficient Heterogeneous Catalysts
► pp.26-29

45. Mori, K.; Shimizu, M.; Nakamura, K.; Takahashi, T. (Graduate School of Engineering)
Development of Wavy Texture in Startup Flows of Liquid Crystalline Polymer Solution through a Silt Cell
► A wavy texture that appears in the flow of liquid crystalline polymers through a silt cell is a noticeable phenomenon in fluid dynamics of liquid crystals. A startup flow experiment is newly proposed to clarify the mechanisms of this phenomenon. It has been found that there is a critical shear strain for the emergence of wavy texture. This finding suggests that the long-range order elasticity contributes to the emergence of wavy texture.

Unique Alignment and Texture of Biological Apatite Crystallites in Typical Calcified Tissues Analyzed by Microbeam X-ray Diffraction System
► Preferential orientation of biological apatite (BAP) in typical calcified tissues was investigated using a microbeam X-ray diffraction. Alignment of BAP in each calcified tissue varied depending on the shape and stress condition in vivo; the c-axes of BAP in the long bone and skull bone were preferentially observed as a one-dimensional orientation along the longitudinal axis and a two-dimensional orientation along the surface, respectively. The c-axis of trabecularly basically aligned along the mediolateral direction, but this alignment locally changed along the biting near the tooth.

47. Naota, T.; Tannia, A.; Kamuro, S.; Murahashi, S.-I. (Graduate School of Engineering Science)
Mechanism of the Interconversions between C- and N-Bound Transition Metal \(\alpha\)-Cyanocarbonations
Journal of the American Chemical Society, 124, 6842-6843 (2002)
► The first presentation of the intram- and intermolecular mechanisms of the C-N interconversions of transition metal cyanocarbonations is described. Kinetic studies on the C-N interconversions of phenylsulfonylacetoneitrile carbanion of RuCl complexes showed that (a) C-to-N and N-to-C isomerizations proceed via the intramolecular process and (b) C-to-N isomerization includes the temperature-dependent participation of intermolecular process via self-assembly of metals.

Information Filtering for Emergency Management
► Information filtering is an intelligent function that selects the relevant messages and items of use or interest to the user from a large amount of incoming information. This paper proposes a new information filtering system for emergency management. The system utilizes semi-structured messages and is composed of causal analysis part based on Qualitative Simulation and information classification part based on Self-Organizing Map. A prototype system was developed and its effectiveness was evaluated by experiments.

Low-k dielectric materials have been in demand to solve the physical limits of interconnects for a new LSI technology system. Ordered mesoporous silica films are promising materials as low-k dielectrics because of their high porosity and high mechanical strength. We report a new preparation method for thermally stable mesoporous silica films. A mesoporous silica film was prepared on a silicon substrate using a spin-coating process followed by a vapor treatment using tetraethylorthosilicate. The vapor-treated silica films showed high structural stability.


p.58


pp.30-33


A model structure of "nano-scale phase separation" has been proposed for an amorphous Pd_{62}Si_{38} film by the eutectic composition on the basis of electron diffraction and high-resolution electron microscopy studies. A structure model with Fe-C and Fe-Si clusters regions as small as 2 nm embedded in a dense and randomly packed structure of Fe-Si trigaonal prisms was finally obtained using a reverse Monte-Carlo calculation to explain the experimental atomic pair distribution function from electron diffraction.


Medium-sized nitrogen heterocycles (7 to 12-membered rings) are an extremely important class of compounds, which occur in a range of natural and non-natural products. We have developed a highly regio- and stereoselective synthesis of medium-sized nitrogen heterocycles, based on the discovery that bronmoalenes can act as an allylic dication equivalent in the presence of a palladium(0) catalyst and an alcohol. The intramolecular nucleophilic attack takes place exclusively at the central carbon atom of the allenic moiety.


p.58

55. Oyabu, N.*1; Cestace, O.*2; Yi, I.*2; Sugawara, Y.*1; Morita, S.*1 


p.59


Oriented LiFeF₅ and FePd nanoparticles were fabricated by electron-beam deposition. The long-range order parameter of the FePd nanoparticles was ~ 0.56 even after annealing at 873K for 24h. Coercivity of the FePd nanoparticles at 100K was as high as twice the room temperature value. The low degree of order and the thermal effect on magnetization have been found in the nanoparticles. These are closely concerned with the origin of the smaller coercivity compared with those expected from the single-domain theory.


Measuring the thickness of sheet-like thin anatomical structures, such as articular cartilage and brain cortex, in three-dimensional magnetic resonance (MR) images is an important diagnostic procedure. The present study investigates the fundamental limits on the accuracy of thickness determination in MR images. Based on MR imaging and computer post-processing parameters, characteristics for the accuracy of thickness determination were derived by a theoretical simulation. In vitro experiments were conducted using phantom objects to validate the results of theoretical simulation.


This paper describes nonlinear receding horizon control of an underactuated hovercraft with discrete-valued inputs and its hardware implementation. The hovercraft has two fixed thrusters, and the thrusters generate thrusts of only three discrete values, that is, forward, backward and zero thrusts. Nonlinear receding horizon control is applied to position control of the hovercraft with the discrete-valued inputs approximated by constrained continuous-valued inputs. Although nonlinear receding horizon control requires real-time constrained optimization, a fast algorithm is successfully implemented for the hardware experiment.

59. Belladra, R.*1; Kohyama, M.; Shibuwayangi, T.*2; Naka, M.*2 


The relative stability between the P₆₆/m and P₆₃ structures of β-silicon nitride (β-Si₃N₄) has been examined using ab initio pseudopotential method. We have performed the relaxation of atomic positions in the unit cell according to the Hellmann-Feynman forces for several sets of lattice constants around the experimental ones. For each set of lattice constants, the P₆₆/m structure is naturally recovered through the relaxation from P₆₃ initial configuration. This is concluded that the ground-state structure of β-Si₃N₄ has P₆₆/m symmetry contrary to a recent atomic orbital calculation.

60. Sun, H.-B.*1; Tanaka, T.*1; Kawata, S.*1,2 

*p1(Graduate School of Engineering) *2(Graduate School of Information Science and Technology) Three-Dimensional Focal Spots Related to Two-Photon Excitation Applied Physics Letters, 88, 3673-3675 (2002) 

p.59
61. Takemoto, T.; Funaki, T. (Collaborative Research Center for Advanced Science and Technology) Role of Electrode Potential Difference between Lead-free Solder and Copper Base Metal in Wetting Materials Transactions, 43, 1784-1790 (2002) The work revealed that the difference of electrode potential between solder and base metal in soldering flux plays an important role in removing the oxide film by contact polarization. The electrode potential of lead-free solders should be significantly lower than copper to obtain good wettability, because tin oxides can be effectively removed through accelerated anodic dissolution of tin by contacting with copper base metal. The experiment confirmed that the adequate adjustment of electrode potential was effective to enhance the wettability.

62. Tanigome, M.*1; Hayashi, M.*1; Kawaguchi, M.; Imazamori, K.; Murakami, Y.*2 *1(Graduate School of Engineering) *2(Graduate School of Information Science and Technology) crinkle, a novel Symbiotic Mutant That Affects the Infection Thread Growth and Alters the Root Hair, Trichome, and Seed Development in Lotus japonicus Plant Physiology, 131, 1054-1063 (2003) p.60


64. Ueda, M.; Yasuda, H. Y.; Umakoshi, Y. (Graduate School of Engineering) Controlling Factor for Nucleation of Martensite at Grain Boundary in Fe-Ni Bicrysalts Acta Materialia, 51, 1007-1017 (2003) Shape memory effect and superelasticity in shape memory materials are closely related to a martensitic transformation. The effect of grain boundary on the martensitic transformation behavior was examined using Fe-Ni bicrysalts containing a controlled boundary. As a result, a specific grain boundary was found to increase the martensite-start temperature. This means that the performance of shape memory material can be improved by the grain boundary control.


66. Yamaguchi, H.; El-Fakah, K.; Bochmann, G. v.; Higashino, T. (Graduate School of Information Science and Technology) Protocol Synthesis and Re-synthesis with Optimal Allocation of Resources Based on Extended Petri Nets Distributed Computing, 16, 21-35 (2003) Protocol synthesis is a novel approach to reduce design costs of distributed systems. The program of a set of application components running in a distributed system of networked computers is automatically derived from service requirements. This paper presents a new protocol synthesis method which re-synthesizes only parts of the program according to changes in the service requirements. This enables application developers to save efforts in the maintenance phase of the distributed system as well as those in the design phase.

67. Asumi, T.*1; Ishihara, K.*2; Kamimura, D.*1; Hishima, H.*1; Ohtani, T.; Hiraoka, S.*1; Kobayashi, H.; Park, S.-J.*1; Saeki, Y.*1; Kitamura, Y.*1; Hirano, T.*2 *1(Graduate School of Medicine) *2(Graduate School of Medicine, and Graduate School of Frontier Bioscience) A Point Mutation of Tyr-759 in Interleukin 6 Family Cytokine Receptor Subunit gp130 Causes Autoimmune Arthritis Journal of Experimental Medicine, 196, 979-990 (2002) p.61

68. Ban, T.; Hamada, D.; Hasegawa, K.; Naiki, H.; Goto, Y. (Institute for Protein Research) Direct Observation of Amyloid Fibil Growth Monitored by Thioflavin T Fluorescence Journal of Biological Chemistry, 278, 16462-16465 (2003) Amyloid fibril deposition is associated with various human diseases including Alzheimer's disease and transmissible spongiform encephalopathies. Real-time monitoring of fibril growth is essential to clarify the mechanism of amyloid fibril formation. Here, we show that, by monitoring ThT fluorescence with total internal reflection fluorescence microscopy, the amyloid fibril formation of b2-microglobulin can be visualized without requiring covalent fluorescence labeling. Since ThT binding is common to all amyloid fibrils, the present method will have general applicability for the analysis of amyloid fibrils.


70. Hata, K.; Nishimura, R.; Ikeda, F.; Yamashita, K.; Matsubara, M.; Nakabi, T.; Yoneda, T. (Graduate School of Dentistry) Differential Roles of Smad1 and p38 Kinase in the Regulation of PPARy during BMP2-Induced Adipogenesis Molecular Biology of the Cell, 14, 545-555 (2003) In this study, we investigated the molecular mechanisms by which BMP2 induces adipogenesis of pluripotent mesenchymal cells. We have shown that BMP2 induced the expression of PPARy along with adipogenesis through Smad1 signaling. In contrast, MKK3/p38 kinase pathway plays a critical role in the functional activation of PPARy but not in the regulation of PPARy. Thus, BMP2 controls adipogenic differentiation by utilizing two distinct signaling pathways that play differential roles in adipogenesis of the pluripotent mesenchymal cells.


72. Inoue, T.; Irikura, D.; Okazaki, N.; Kimura, S.; Matsumura, H.; Udono, N.; Yamamoto, M.; Kinumaki, T.; Miyono, M.; Kii, Y.; Ure, Y. (Graduate School of Engineering) Mechanism of Metal Activation of Human Hematopoietic Prostaglandin D Synthase Nature Structural Biology, 10, 291-296 (2003) We have determined the crystal structures of human hematopoietic prostaglandin (PG) D synthase (H-PGDS) bound to glutathione (GSH) and metal ions. Using GSH as a cofactor, H-PGDS catalyzes the isomerization of PGH2 to PGD2, a mediator for allergy response. H-PGDS is activated by rearrangement of hydrogen bond networks upon binding of metal ions. This effect explains a four-fold reduction in the Km for the enzyme for GSH. The structure provides insights into how a metal ion binding activates human H-PGDS.
73. Iwamoto, R.*1; Yamazaki, S.*4; Akasaka, M.*, Takashima, S.*2; Hasuwa, H.*1; Miyado, K.*1; Adachi, S.*1; Kitakaze, M.; Hashimoto, K.; Rauh, G.; Nonu, D.; Higashiyama, S.; Hori, M.*2; Kagura, M.; Meada, E.*1
*1 (Research Institute for Microbiological Diseases) *2 (Graduate School of Medicine)
Heparin-Binding EGF-like Growth Factor and ErbB Signaling Is Essential for Heart Function
Proceedings of the National Academy of Sciences of the United States of America, 100, 3221-3226 (2003)
- HB-EGF is a member of the EGF family of growth factors. To examine the role of HB-EGF in vivo, we generated HB-EGF knockout mice (Hpg648e). HBg648e mice developed severe heart failure with dilated ventricular chambers, similarly to conditional ErbB2 knockout mice. HBg648e mice developed also enlarged cardiac valves, similarly to ErBGR knockout mice. Constitutive tyrosine phosphorylation of both ErB2 and ErB4 was significantly reduced in HBg648e hearts. These indicated that HB-EGF activation of ErB2 is essential for normal heart function.

74. Kawasaki, A.; Matsuzawa, I.; Takigawa, E.; Nakajima, K.; Kanazawa, Y.
(Graduate School of Medicine)
Opposing Effects of PML and PML/RARα on STAT3 Activity
- PML acts a tumor suppressor, while PML/RARα causes acute promyelocytic leukemia (APL). Here we found that PML binds to STAT3 and inhibits its activity, which plays a crucial role in G-CSF-dependent growth of myeloid cells. Although PML/RARα did not bind to STAT3, it inhibited the PML/STAT3 association, thereby augmenting STAT3 activity. Furthermore, PML suppressed G-CSF-dependent growth of BaF3 cells, while it was enhanced by PML/RARα. These results suggest that deregulated STAT3 activity may participate in the pathogenesis of APL.

(Research Institute for Microbial Diseases)
GATA-2 and GATA-2ER Display Opposing Activities in the Development and Differentiation of Blood Progenitors
The EMBO Journal, 21, 3099-3099 (2002)
- GATA-2 is a transcription factor essential for the hematopoietic development. We have employed both conditional expression of GATA-2 and a GATA-2-estrogen receptor (ER) chimera to examine the effects of enforced GATA-2 expression in the development and differentiation of hematopoietic progenitors from murine embryonic stem cells. Conditional expression of GATA-2 enhanced the production of hematopoietic progenitors, while GATA-2/ER produced essentially opposite effects. GATA-2 and GATA-2/ER differ in their binding activities and transscriptional interactions from other hematopoietic-associated transcription factors e.g., Myb and PU.1.

(Graduate School of Medicine)
Diet-distributed Insulin Resistance in Mice Lacking Adiponectin/ACRP30
Nature Medicine, 8, 731-737 (2002)
- p.62

77. Maksim, K.*1; Oshima, K.; Kurokawa, K.*2; Yokoyama, K.*1; Ueda, T.*1; Tagomori, K.*1; Hijima, Y.; Najima, M.*2; Nakano, M.*1; Yamashita, A.; Kubota, Y.*1; Kimura, S.*1; Yasunaga, T.*2; Honda, T.*1; Shizugawa, H.*1; Hattori, M.; Iida, T.*1
*1 (Research Institute for Microbial Diseases) *2 (Genome Information Research Center)
Gene Sequence of Vibrio parahaemolyticus: a Pathogenic Mechanism Distinct from That of V. cholerae
- p.62

78. Miyamoto, Y., Hieda, M.; Harreman, N.T.; Fukumoto, M.; Saiwaki, T.; Hodel, A.E.; Corbett, A.H.; Yoneda, Y.* (Graduate School of Frontier Biosciences)
Importin α Can Migrate into the Nucleus in an Importin β- and Ran-independent Manner
The EMBO Journal, 21, 5833-5842 (2002)
- Molecular traffic between the nucleus and cytoplasm occurs through the nuclear pore complex present in the nuclear envelope. The nuclear import of basic type nuclear localization signal-containing proteins is mediated by specific transport factors, importin α and β, in conjunction with a small GTPase Ran. In this study, we found that importin α, which functions as an adapter molecule between karyophilines and importin β, alone can enter the nucleus via a novel pathway in an importin β- and Ran-independent manner.

(Graduate School of Medicine)
Nectin: an Adhesion Molecule Involved in Synapses of Dorsal Pulp
- p.63

80. Murakami, S.*1; Nakashima, R.*1; Yamashita, E.*2; Yamaguchi, A.*1
*1 (Institute of Scientific and Industrial Research) *2 (Institute for Protein Research)
Crystal Structure of Bacterial Multidrug Efflux Transporter AcrB
- pp.42-45

81. Ninomiya, S.; Iwamoto-Kihara, A.; Yamamoto, A.; Wada, Y.; Futaki, M.
(Institute of Scientific and Industrial Research)
Subunit Rotation of ATP Synthase Embedded in Membranes: α or β Subunit Rotation Relative to the c Subunit Ring
- ATP synthase F_{o} F_{1} couples an electrochemical proton gradient and a chemical reaction through the rotation of its subunit assembly. In this study, we engineered F_{1} to examine the rotation of the catalytic F_{0} or membrane sector F_{o} subunit when the F_{o} c subunit ring was immobilized. An actin filament connected to the β or a subunit rotated counter-clockwise on the addition of ATP, and generated essentially the same torque as one connected to the ß ring of F_{0} immobilized through the α or β subunit. These results established that the γτ(10-14) and γ(3)ε(3)ζ(12) complexes are mechanical units of the membrane-embedded enzyme involved in rotational catalysis.

82. Nonaka, S.; Shiratori, H.; Satoh, Y.; Hamada, H.
(Graduate School of Frontier Biotechnology)
Determination of Left-right Patterning of the Mouse Embryo By Artificial Nodal Flow
- pp.46-49

(Graduate School of Pharmaceutical Sciences)
Homeodomain Proteins MEIS1 and PBX1s Regulate the Lineage-specific Transcription of the Platelet Factor 4 Gene
- pp.46-49

*PP4 is expressed during megakaryocytic differentiation. We investigated the regulatory elements and their transcription factors responsible for the lineage-specific expression of the PP4 gene. We have defined a novel regulatory element termed TME and homeodomain proteins (MEIS1 and PBX) as binding proteins to TME. These factors are expressed in megakaryocytes differentiated from CD34+ cells in human cord blood. MEIS1/PBX complexes activate the PP4 promoter with GATA-1 and ETS-1. These homeodomain proteins play an important role in megakaryocytic gene expression.
The EMBO Journal, 21, 5408-5416 (2002)

85. Ono, M.*1; Sawa, Y.*1; Matsamoto, K.*2; Nakamura, T.*2; Koneda, Y.*1; Matsuda, H.*1
1 (Graduate School of Medicine) *2 (Biomedical Research Center) In Vivo Gene Transfection With Hepatocyte Growth Factor via the Pulmonary Artery Induces Angiogenesis in the Rat Lung Circulation, 106[Suppl.], I-264A-269 (2002)
► Recent studies demonstrated that gene transfer with hepatocyte growth factor (HGF) induces angiogenesis for coronary and peripheral artery diseases. This article shows for the first time that transepithelial arterial gene transfer with HGF using HVJ-liposome method in the rat lung increased capillary density and blood perfusion, and decreased vascular resistance when blood flow increased, in the transfected left lung. These results suggest that gene transfer with HGF may be found suitable in treating subjects with severe pulmonary vascular disease.

► Neuronal connections in the brain sometimes show strange property. In spite of large differences in the traveling distances among connections, signals arrive in a very narrow window of time. We found that this was achieved by changing the traveling speed of signals along a single cell. The difference amounts to, in case of thalamus-cortex connections, 10 times. This strategy enables individuals to receive inputs irrespective of distance, which potentially contributes to the evolution by enabling expansion of the brain.

► We report here that checkpoint monitoring of the status of meiotic double-strand-break (DSB) repair exists in fission yeast and that defects other than DSBs accumulation can cause delays in meiotic progression. A meiotic recombination-defective mutant, mei3Aa, shows a delay in meiotic progression. This delay is dependent on rad2, namely on DSB formation. PGF analysis revealed that meiotic DSB repair in mei3Aa was retarded. We found that checkpoint rad4, cdc7 and rad5 genes are also involved in a checkpoint that provides time to repair DSBs.

88. Shirai, M.*1; Osugi, T.*2; Koga, H.; Kaji, Y.; Takimoto, E.; Komuro, I.; Haru, J.*2; Miwa, T.*1; Yamazaki-Takahara, K.*2; Takahara, Y.*1 (Genome Information Research Center) *2 (Graduate School of Medicine) The Polycym group Gene Ruc28 Sustains Nck2.5/Cx3 Expression and Is Essential for Cardiac Morphogenesis. The Journal of Clinical Investigation, 110, 177-184 (2002)
► Polycomb-group genes (PCG) are known to maintain transcription states, once initiated, through regulation of chromatin structures. ruc28 is a member of mouse PCG genes. In this study, the role of ruc28 in cardiac morphogenesis was examined at the molecular level. ruc28-deficient embryos support the notion that ruc28 has a crucial role in sustaining expression of the cardiac selector gene Nck2.5 in cardiomyocytes. Thus, mammalian PCG genes may play a key role in organogenesis by maintaining expression of a selector gene.

► In eukaryotic cells, DNA Replication initiation at specific sites called replication origins on chromosomes in every cell cycle. Nonetheless, nucleotide sequences required for initiation of DNA replication remain elusive in most eukaryotes. We demonstrated that multiple nucleotide stretches in the replication origin are collectively essential for initiation of DNA replication in fission yeast. ORC binds to adenine/thymine stretches and promotes loading of MCM, a DNA helicase, to a distant region where DNA synthesis initiates.

► We present here a novel fibronectin-binding protein FbnA of Streptococcus pyogenes isolated from patients with toxic shock-like syndrome. FbnA exhibits a strong fibronectin-binding ability, and FbnA-deficient mutant strain showed 6-fold lower adhesion and invasion efficiencies to epithelial cells than the wild type. Moreover, mortality was decreased in mice infected with the mutant strain in comparison to the wild type. These data suggest that FbnA is etiologically involved in the development of invasive streptococcal diseases.

► Sox2 expression marks neural and sensory primordia at various stages of development. A 50 kb genomic region of chicken Sox2 was scanned for enhancer activity. A battery of neural and sensory placode enhancers was identified. Sox2 in the embryonic CNS is regulated by multiple enhancers with distinct spatio-temporal specificities, in spite of its uniform expression; one is activated by signals from Hensen’s node. These functionally identified Sox2 enhancers exactly correspond to the transgenetic sequence blocks conserved between chicken and mammals.

► One subtype of maturity-onset diabetes of the young (MODY)-3 results from mutations in the gene encoding HNF-1z. We generated transgenic mice expressing a dominant-negative form of human HNF-1z (P296HisC) in pancreatic \beta-cells. The transgenic mice developed diabetes with impaired glucose-stimulated insulin secretion. The pancreatic islets exhibited abnormal architecture with reduced expression of GLU1 and E-cadherin. There was also a reduction in \beta-cell number, proliferation rate, and pancreatic insulin content. Our findings suggest various roles for HNF-1z in normal glucose metabolism.
Site-specific PEylation of a Lysine-deficient TNF-alpha with Full Bioactivity
>
We prepared phage libraries expressing mutant TNF-alpha, in which all the lysine residues were replaced with other amino acids. A fully bioactive lysine-deficient mTNF-alpha was isolated by panning against anti-TNF-neutralizing antibody, despite reports that some lysine residues were essential for its bioactivity. The site-specifically mono-Pegylated mTNF-alpha showed superior antiinflammatory therapeutic potency. These results suggest the usefulness of phage display system for creation of functional proteins, and our site-specific PEylation may be a powerful technology for pharmacopeptide-based drug discovery and development.

94. Yamamoto, K.*; Hashimoto, H.*; Tomimoto, S.*; Shintani, N.*; Miyazaki, J.*; Tashiro, F.*; Aikawa, H.*; Nanmo, T.*; Li, M.*; Yamagata, K.*; Miyagawa, J.*; Matsuzawa, Y.*; Kawai, Y.*; Fukuyama, Y.*; Koga, K.*; Mori, W.*; Tanaka, K.*
Overexpression of PACAP in Transgenic Mouse Pancreatic β-Cells Enhances Insulin Secretion and Ameliorates Streptozotocin-Induced Diabetes
>
PACAP possess potent insulin-secretory properties, but its in vivo functions have remained largely unclear. To assess this, we generated transgenic mice overexpressing PACAP in pancreatic β-cells (PACAP-Tg). In PACAP-Tg mice, glucose-induced insulin secretion was enhanced and the β-cell toxin (streptozotocin)-induced hyperglycemia was ameliorated. Notably, β-cell proliferation was markedly increased in streptozotocin-treated PACAP-Tg. Furthermore, islet mass tended to increase in aged PACAP-Tg. This is the first report to implicate regulatory and/or protective functions of PACAP in β-cell neogenesis and type-1 diabetes.

Essential Role for TRIF in Activation of the Signalling Cascade Shared by Toll-like and IL-1R
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96. Yamashita, S.; Miyagi, C.; Carmar-Rowley, A.; Shinizu, T.; Fujii, R.; Schier, A.F.; Hiraoka, B. (Graduate School of Medicine)
Stat3 Controls Cell Movements during Zebrafish Gastrulation
>
>Yamashita et al. formation requirements both the correct specification of cell fates and the coordination of gastrulation movements. We report that the zebrafish signal transducer and activator of transcription 3 (Stat3) is activated on the dorsal side by the maternal Wnt/beta-catenin pathway. Zebrafish embryos lacking Stat3 activity display abnormal cell movements during gastrulation, resulting in a mispositioned head and a shortened anterior-posterior axis, but show no defects in early cell fate specification. Time course analysis, cell tracing, and transplantation experiments revealed that Stat3 activity is required cell autonomously for the anterior migration of dorsal mesendodermal and non-cell autonomous for the convergence of neighboring paraxial cells. These results reveal a role for Stat3 in controlling cell movements during gastrulation.

97. Yamashita, T.; Tohyama, M. (Graduate School of Medicine)
The P75 Receptor Acts as a Displacement Factor That Releases Rho from Rho GDI
>
The p75NTR receptor transduces the signal from all the myelin-derived inhibitors of axonal growth, which contribute to the lack of regeneration of the injured CNS. We report the precise mechanism of regulation of axon elongation by p75NTR. p75NTR facilitates the release of prenylated RhoA from Rho GDI. The peptide ligand that is associated with the fifth of the six N-terminus of p75NTR allows the action mediated by p75NTR, providing a therapeutic agent against the inhibitory cues in CNS.

98. Yonekura, K.; Maki-Yonekura, S.; Nambara, K. (Graduate School of Frontier Biosciences)
Complete Atomic Model of the Bacterial Flagellar Filament by Electron Cryomicroscopy
>

Core-Binding Factor (CBF) Interacts with Runx2 and Is Required for Skeletal Development
Nature Genetics, 32: 673-683 (2002)
>
>Nature Genetics, 32: 673-683 (2002)

100. Kubota, Y.*; Takase, Y.*; Komori, Y.; Hashimoto, Y.*; Araita, T.*
A Novel Ring-like Complex of Xenopus Proteins Essential for the Initiation of DNA Replication
>