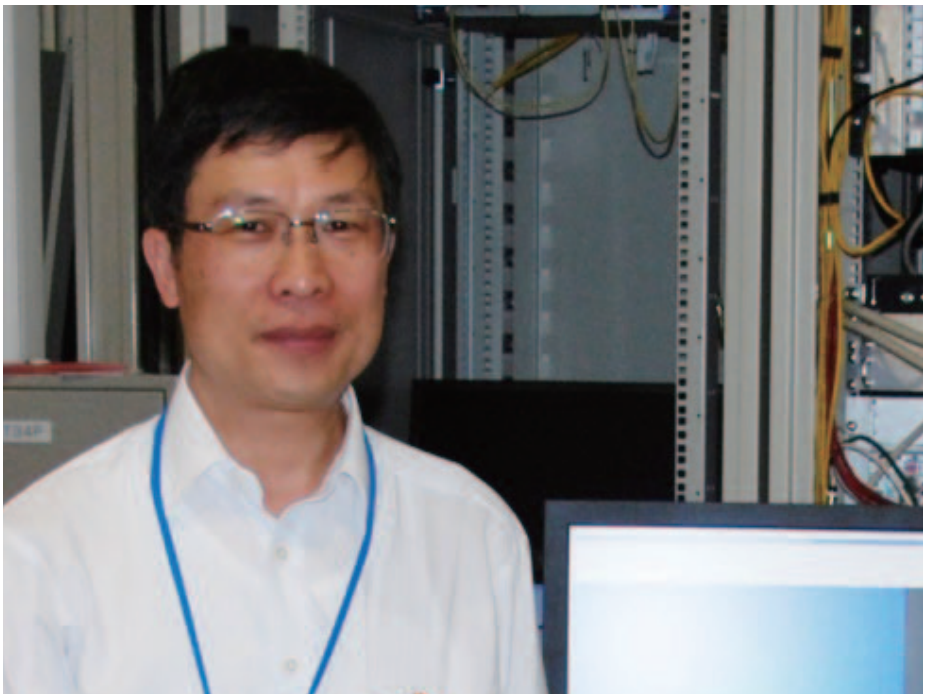
OKAYAMA UNIV. e-Bulletin



Vol. 4, September 2013

1-1-1 Tsushima-naka, Kita-ku, Okayama 700-8530 Japan

Contents

News

World's first successful living donor transplant of the middle lobe of a lung: Mother's lung saves the life of her three year old son

On 1 July 2013 surgeons at Okayama University Hospital succeeded in transplanting the middle lobe of the lung of a mother to her three year old son, who was suffering from severe lung disease. This is the world's first successful living donor transplant of the middle lobe of a lung, and the youngest lung transplant operation patient in Japan.
The operation took place because even though three years had elapsed since the revised Organ Transplant Law was passed, only two brain-dead donors under 15 had been found, giving a low chance of a lung transplant from a brain-dead donor. The doctor in charge of the boy's treatment talked with his parents, which led to the decision for the lung transplant from a living donor.

Dr. Takahiro Oto and his sugical team during the operation to transplant the middle lobe of a living donor's lung to a three year old boy.

One of the striking features of this operation is that whereas the lower lobe of the lung is normally used in living donor transplants because it has the greatest capacity, here in the case of the three old boy with only a small body, an adult lower lobe would have been too large, hence the middle lobe was chosen for transplantation.

"This achievement will give courage to other children who up until now would have been unable to have transplants, said associate professor Dr. Takahiro Oto, the respiratory surgeon who performed the operation.

News

Japan's oldest votive tablets showing monkey leading a horse, and a cow are unearthed

On May 23 the Okayama University Archaeological Research Center announced the discovery of the two oldest votive tablets in Japan, dating back to the second half of the eight century (Nara period). Unearthed at the Shikata site, the 'Ushi' tablet depicts a cow, while the 'Sarukomahiki' piece shows a monkey leading a horse.

The tablet of the monkey leading a horse is rectangular measuring 23cm x 12cm. The leftward facing horse is drawn with a flowing line from head to tail, and carries a saddle and stirrups. The monkey leading the horse has a rounded back and is quite small. From ancient times in Japan, monkeys have been thought to look after horses. Notably, the oldest example to date of such a scene was a late 13th century sketch.

This is the first unearthing of votive tablets showing monkey leading a horse in Japan, and raises the possibility of a relationship between monkeys and horses stretching back to the Nara era.

The votive tablet of the cow

Reconstructed drawing from the votive tablet of the cow

The votive tablet of the monkey leading the horse

Reconstructed drawing from the votive tablet of the monkey leading the horse

The tablet of the cow is also rectangular measuring 21.5cm x 12.3cm. The body is drawn in detail, including its hooves, and is shown with a sash. Three other votive tablets of cows, including one votive tablet possibility of the cow, exist in Japan, but this one discovered by scientists at Okayama University is the oldest.

From ancient times, votive tablets—known as 'ema' in Japanese—have been dedicated at shrines and appear in scrolls from the Heian era. The researchers hope that the votive tablets found at Okayama University will shed light on the hopes, beliefs and customs of people in the Nara period of Japanese history.

Further information

Okayama University Archaeological Research Center
http://www.okayama-u.ac.jp/user/arc/archome.html

News

Launch of the Photosynthesis Research Center at Okayama University

Okayama University held an inauguration ceremony on April 11th for the launch of its Photosynthesis Research Center located within the Graduate School of Natural Science and Technology. The Center—officially established on April 1st 2013—aims to elucidate the biochemical mechanisms of photosynthesis, especially that of the light-induced water-splitting reaction, and their applications to artificial photosynthesis that may lead to an unlimited source of clean energy.

(From left) Professor Shen, director of the center, Dean Seno, and President Morita hold up the sign of the university during the ceremony

Okayama University has a long history of research into photosynthesis, having produced world famous researchers including Dr. Hiroshi Fujishige and Dr. Kimiyuki Sato, both emeritus professors of Okayama University who are internationally renowned for their researches on the fundamental mechanisms of photosynthesis. Recently, the research results on the mechanisms of light-induced water-splitting by Professor Jian-Ren Shen, director of the center, were selected as one of the ten 'Breakthroughs of the Year 2011' by AAAS *Science Magazine*.

President Morita giving his address.

In his inauguration address President Kiyoshi Morita said that the center would be one of the core elements of Okayama University as a research-based university, and that the entire university would work to ensure the center becoming a driving force in innovation from natural to artificial photosynthesis.

Address by the Professor Shen, director of the center.

Professor Shen emphasized that his group will continue the cutting-edge research on elucidating all the mechanisms of photosynthetic water-splitting that lead to the evolution of oxygen and the conversion of light-energy into chemical energy. He also mentioned that the center will strengthen the already existing, and explore new, international collaborations, and to fully transfer the fruits of this research to society.

Fifty faculty members attended the opening ceremony of the center, including Professor Shinichi Yamamoto, Executive Director (research), Professor Masaharu Seno, Dean of the Graduate School of Natural Science and Technology, and Professor Yoko Yamamoto, Director of the Institute of Plant Science and Resources.

Members of the Center participating in at the inauguration ceremony.

News

Launch of mega-hospital consortium: Okayama University Hospital is selected as one of 10 core hospitals for clinical research in Japan

On April 19th Japan's Ministry of Health, Labour and Welfare announced that Okayama University Hospital was selected as one of 10 core hospitals for clinical research in Japan with the goal of improving the process and quality of clinical studies by medical doctors in accordance to the Japanese Pharmaceutical Affairs Law and clinical research given by Japanese Medical Act for hospitals. This initiative is expected to be more efficient approval of applications for new drugs in Japan.

Okayama University Hospital - selected as one of 10 core hospitals for clinical research

Compared with the USA and EU the process of commercializing the seeds of medical findings is both time consuming and expensive thereby creating significant barriers for the participation of pharmaceutical and medical device manufacturing companies.

In order to alleviate the current situation the Japanese government recently designated a total of 15 medical centers which consist of five hospitals for speeding up early stages of clinical study and 10 core hospitals for clinical research, where industry and research will collaborate to commercialize medical research under more favorable conditions to enable faster procedures for obtaining approval for the manufacture of drugs and medical devices.

Now, the relevance of this news is that Okayama University Hospital was selected one of the 10 core hospitals for clinical research in Japan for translational clinical research. As a result Okayama University Hospital is going to establish the 'Mid-West Japan Clinical Study Consortium'—consisting of 83 hospitals in the Chugoku/Shikoku region of Japan, each with a capacity of more than 200 beds—wherein it will be a 'core hospital' to check the safety and effectiveness of the clinical law and conduct trials that will enable treatment covered by the national health insurance through this consortium.

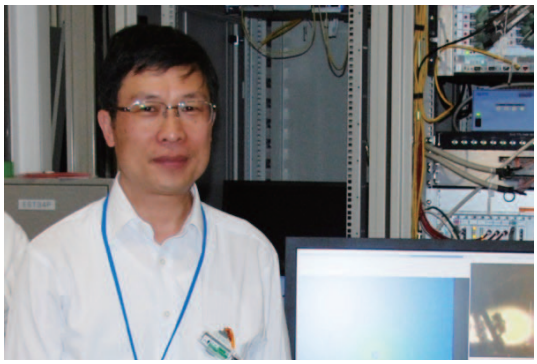
Notably, the consortium is a 'virtual mega-hospital' that plans to have a total of approximately 3300 beds within the next five years.

As one of 10 core hospitals for clinical research in Japan, Okayama University Hospital will establish a network for pediatric / rare intractable diseases in the next 5 years. It will assume a central role in the support of research that is hard to implement. The Hospital will restructure its organization to improve links with pharmaceutical development regulatory agencies including the Pharmaceuticals and Medical Devices Agency (PMDA), and train personnel to conduct research on drugs aimed at pharmaceutical approval, working on the early practical application of medical goods and medical equipment, and acceleration of the commercialization of medical research in Japan.

Feature

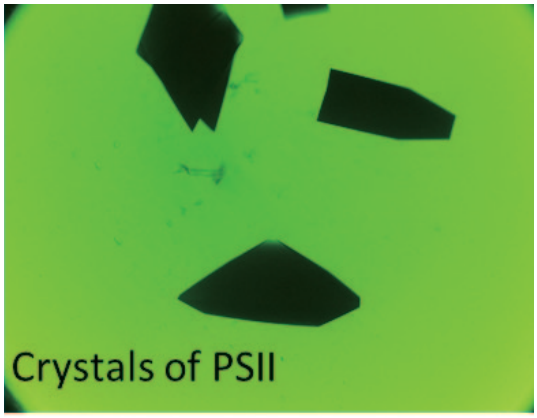
Tofu-like crystalline catalysts: Demystifying the reaction mechanisms of photosynthesis and the potential for an unlimited source of clean energy

Professor Jian-Ren Shen is recognized for his pioneering research on clarifying the fundamental reaction mechanism that governs photosynthetic water splitting, a process with fundamental importance in understanding how oxygenic photosynthetic organisms, such as plants, use energy from sunlight, water, and CO_2 to survive.



Professor Jian-Ren Shen

"I first started research on photosynthetic proteins in the beginning of my doctorate project," says Shen. "Our findings published in 2011 were based on x-ray diffraction experiments of large, high quality single crystal of so-called 'photosystem II' (PS II) at Japan's SPring-8 synchrotron radiation facility at Harima. The ability to produce large sized, single crystals of PS II, an extremely large membrane-protein complex, was critical for determining the crystalline structure of this protein complex to a resolution of 1.9 Angstroms. These results are the culmination of 20 years of my life spent on the development and improvement of the process to produce such large crystals."



PS II crystals

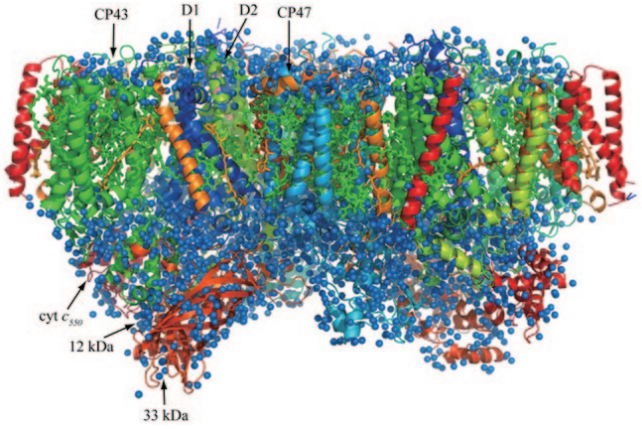
Professor Shen's initial research on photosynthesis was focused on clarifying the effects of air pollution on plants. The objectives of this research necessitated clarification of the fundamental mechanism underlying photosynthesis, which in turn required the production of a high quality crystal of PS II. "After many years of exhaustive experiments and uncountable failures, we eventually succeeded in producing large, 'tofu-like' single crystals of PS II with dimensions of 0.7 x 0.4 x 0.1 mm," explains Shen. "This was a major breakthrough that led to the ultra-high resolution analysis of PS II."

Recent reports on the crystallographic analysis of PS II can be traced back to the early 2000s but the results yielded only 'fuzzy' images because of imperfections in the samples. In contrast the 2011 findings by Shen and colleagues yielded unprecedented images of the core of the PS II protein, showing the existence of cubic-core of four manganese atoms, five oxygen atoms, and a calcium atom, which constitutes the heart of plant life (Science 2011, 334, 1630).

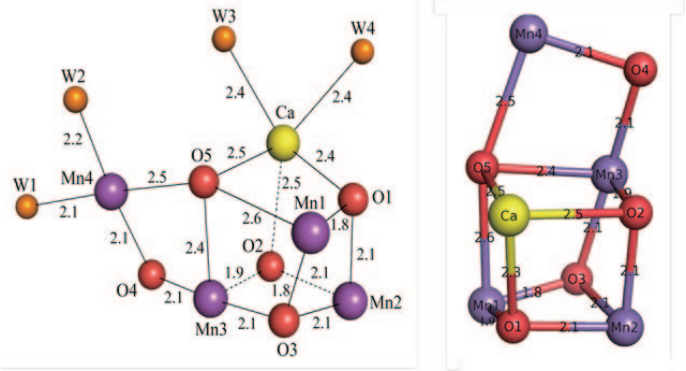
"This cubic structure of Mn_4CaO_5 acts as a catalyst for the water splitting reaction induced by sunlight," explains Shen. "These results have many important practical applications including the possibility of synthesizing artificial catalyst to dissociate water into oxygen and hydrogen to produce electricity in fuel cells, for example."

Indeed there is increasing interests in 'artificial photosynthesis' for the production of energy. But Professor Shen says that his group will focus on basic research on the reaction mechanism of PS II. "Our next goal is to clarify the so-called 'intermediate structure' of PS II," says Shen. "To do so we require even higher resolution x-ray diffraction experiments at both space and time levels. We are planning to use the SACLA X-ray Free Electron Laser (XFEL) facility in SPring-8 to achieve this. This will enable us to look at the movement of atoms during photosynthesis."

Professor Shen's contributions to clarifying the mechanisms underlying photosynthesis have received many accolades including the 'Breakthrough of the Year' for 2011 by AAAS Science; the 2012 Asahi Prize; and the launch of the Okayama University Photosynthesis Research Center on 1 April 2013.



Structure of PS II dimer



The catalytic core for photosynthetic water-splitting

Reference:

- 1. Yasufumi Umena[1], Keisuke Kawakami[2], Jian-Ren Shen[2] and Nobuo Kamiya[1], Crystal structure of oxygen-evolving photosystem II at a resolution of 1.9 Å; Nature **473**, 55–61, (2011).
  DOI: 10.1038/nature09913
- Affiliations

1 : Department of Chemistry, Graduate School of Science, Osaka City University, 3-3-138 Sugimoto, Sumiyoshi, Osaka 558-8585, Japan.

2 : Division of Bioscience, Graduate School of Natural Science and Technology/Faculty of Science; Okayama University, Okayama 700-8530, Japan.http://en.wikipedia.org/wiki/Kofun

Further information

1. Asahi Prize 2012

http://www.okayama-u.ac.jp/user/kouhou/ebulletin/news/vol3/news_001.htmll

2. Okayama University Photosynthesis Research Center:

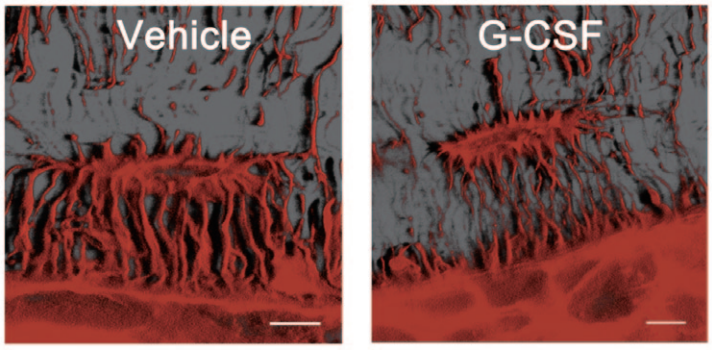
http://www.okayama-u.ac.jp/en/tp/news/news_id2402.html

Research Highlights

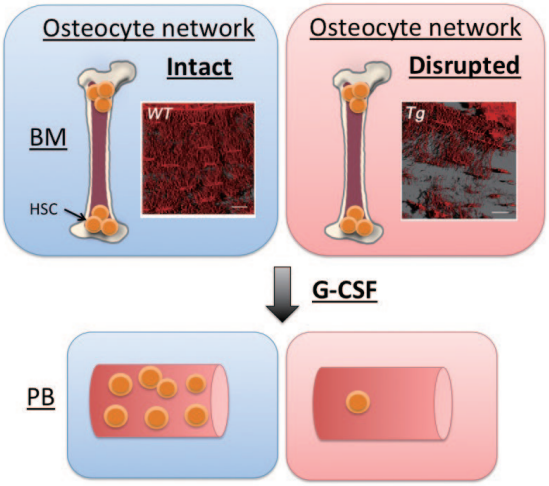
Osteocyte: Shadow commander of HSC niche

Hematopoietic stem/progenitor cells (HSPCs) reside in their niche in the bone marrow, which is the local environment that regulates stem cell fate including their trafficking. Clinically, cytokine granulocyte-colony stimulating factor (G-CSF) is used to mobilize HSPCs from the bone marrow into peripheral circulation, and they are harvested as a source of stem cells for transplantation. The mechanism of this HSPCs egress by G-CSF has been vigorously investigated, but is still not fully understood.

Now, the research group of Dr. Noboru Asada, Professor Mitsune Tanimoto (both at Okayama University) and Dr. Yoshio Katayama (Kobe University) has found a new player of HSPC niche controlling cell—osteocyte—which is buried in the mineralized bone tissue. Osteocytes are the most abundant cells that exists in bone tissue, and recent research has revealed that osteocytes act as sensors of mechanical stress to the bone and actively control the balance of bone remodeling.



(Asada N. et al., Cell Stem Cell 12, 2013 Figure 2C)
The projections of osteocytes are apparently suppressed by G-CSF administration.



While HSCs were mobilized from bone marrow (BM) to the peripheral blood (PB) by G-CSF administration in mice whose osteocyte network was intact (Blue panels), mobilization of HSC was severely impaired in osteocyte network disrupted mice (Red panels).

At first, the researchers found that osteocytes were suppressed by G-CSF treatment both morphologically and functionally. This suppression of osteocytes by G-CSF was mediated by the sympathetic nervous system, since osteocytes express the beta-2 adrenergic receptor and surgical sympathectomy diminished the suppression effect of G-CSF on osteocytes. Mice with targeted ablation of osteocytes or a disrupted osteocyte network have comparable numbers of HSPCs in the bone marrow but fail to mobilize HSPCs in response to G-CSF. In addition, osteocyte deletion had an effect not only on the osteoblastic niche but also other niche controlling cells such as bone marrow macrophage.

Taken together, these results indicate that the bone marrow/bone niche interface is critically controlled from the inside of the bone matrix and establishs an important physiological role for skeletal tissue in hematopoietic function.

Reference:

- Authors: Noboru Asada[1,2], Yoshio Katayama[2,3], Mari Sato[2], Kentaro Minagawa[2], Kanako Wakahashi[2], Hiroki Kawano[2], Yuko Kawano[2], Akiko Sada[2], Kyoji Ikeda[4], Toshimitsu Matsui[2], and Mitsune Tanimoto[1].
- Title of original paper: Matrix-Embedded Osteocytes Regulate Mobilization of Hematopoietic Stem/Progenitor Cells
- Journal, volume, pages and year: Cell Stem Cell 12, 737-747, 2013
- Digital Object Identifier (DOI): 10.1016/j.stem.2013.05.001.
- Journal website: http://dx.doi.org/10.1016/j.stem.2013.05.001
- Affiliations

  1 Hematology, Oncology and Respiratory Medicine, Okayama

  2 Hematology, Department of Medicine, Kobe University Graduate School of Medicine

  3 PRESTO, Japan Science and Technology Agency

  4 Department of Bone and Joint Disease, National Center for Geriatrics and Gerontology (NCGG)

Author website(Japanese): http://ninai.med.okayama-u.ac.jp/

Research Highlights

Why physiologic mechanical stress is important in enhancing chondroprotective gene expression: Stretch-mediated activation of TGF-β-Smad2/3 pathway

Articular cartilage is subjected to a wide range of biomechanical stresses such as static/dynamic loads, compressive force, shear strain, tensile strain, hydrostatic pressure, fluid flow, and osmotic stress. Such physiologic mechanical stress stimulates the expression of chondrogenic genes, such as multifunctional growth factor CYR61/CTGF/NOV (CCN) 2 and α1(II) collagen (COL2A1), and maintains cartilage homeostasis. On the other hand, repetitive excess mechanical stress can alter cartilaginous composition and metabolism, and lead to osteoarthritis.

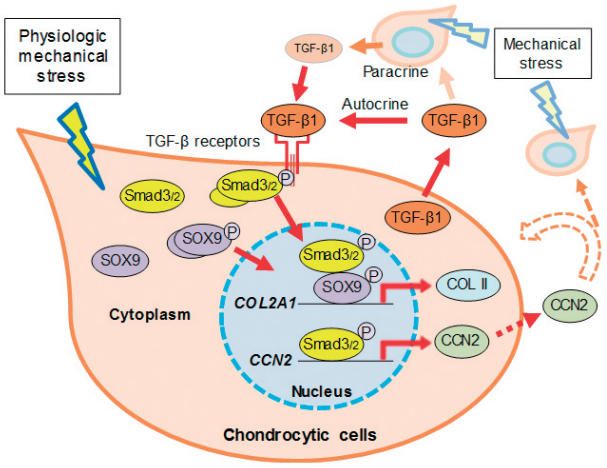


Figure. Schematic illustration of mechanical stress-mediated cellular responses.

Takayuki Furumatsu and colleagues have previously demonstrated that cyclic tensile strain (CTS) induces nuclear translocation of transforming growth factor (TGF)-β receptor-regulated Smad2/3, and the master chondrogenic transcription factor Sry-type HMG box (SOX) 9[1, 2]. However, the precise mechanism of stretch-mediated Smad activation remains unclear in transcriptional regulation of chondrogenic genes. Here, to elucidate this stretch-dependent transcriptional mechanism, the researchers hypothesized that physiologic tensile strain may induce TGF-β1 release from chondrocytic cells and stimulate Smad-dependent chondroprotective gene expression in chondrocytic cells.

In the Journal of Biomechanics[3], the Okayama University group demonstrated that uni-axial CTS (frequency, 0.5 Hz; strain, 5% elongation) increased TGF-β1 secretion and stimulated expression of chondroprotective genes (CCN2 and COL2A1) in chondrocytic cells. Nuclear translocalization of Smad2/3 and SOX9 were also stimulated by CTS. In addition, CTS increased the complex formation between phosphorylated Smad2/3 and SOX9 in chondrocytic cells. The CCN2 promoter activity was cooperatively enhanced by CTS and Smad3 in luciferase reporter assay. Chromatin immunoprecipitation assay revealed that CTS increased Smad2/3 interaction with the CCN2 promoter and/or the COL2A1 enhancer (Figure).

These results suggest that physiologic mechanical stress epigenetically stimulates CCN2 transcription via TGF-β1 release associated with Smad2/3 activation and enhances COL2A1 expression through the complex formation between SOX9 and Smad2/3.

Reference:

1
Authors: Tomoko Kanazawa, Takayuki Furumatsu, Motomi Hachioji, Toshitaka Oohashi, Yoshifumi Ninomiya, and Toshifumi Ozaki.
Title of original paper: Mechanical stretch enhances COL2A1 expression on chromatin by inducing SOX9 nuclear translocalization in inner meniscus cells.
Journal, volume, pages, and year: *J Orthop Res* **30**, 468-474 (2012).
Digital Object Identifier (DOI): 10.1002/jor.21528

2
Authors: Takayuki Furumatsu, Tomoko Kanazawa, Yoshiaki Miyake, Satoshi Kubota, Masaharu Takigawa, and Toshifumi Ozaki.
Title of original paper: Mechanical stretch increases Smad3-dependent CCN2 expression in inner meniscus cells.
Journal, volume, pages, and year: *J Orthop Res* **30**, 1738-1745 (2012).
Digital Object Identifier (DOI): 10.1002/jor.22142

3
Authors: Takayuki Furumatsu, Emi Matsumoto, Tomoko Kanazawa, Masataka Fujii, Zhichao Lu, Ryotaro Kajiki, and Toshifumi Ozaki.
Title of original paper: Tensile strain increases expression of CCN2 and COL2A1 by activating TGF-Ð-Smad2/3 pathway in chondrocytic cells.
Journal, volume, pages, and year: *J Biomech* **46**, 1508-1515 (2013).
Digital Object Identifier (DOI): 10.1016/j.jbiomech.2013.03.028
http://ousar.lib.okayama-u.ac.jp/metadata/51099

Author website(Japanese): http://www.okayama-u.ac.jp/user/med/orthop/japanese/index.htm

Takayuki Furumatsu, M.D., Ph.D.
Department of Orthopaedic Surgery, Science of Functional Recovery and Reconstruction, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences, 2-5-1 Shikata-cho, Kita-ku, Okayama 700-8558, Japan
Tel.: 81-86-235-7273; Fax: 81-86-223-9727; E-mail: matino@md.okayama-u.ac.jp

Research Highlights

Regenerative medicine: Amphibian limb models to resolve why humans lost their ability to regenerate organs

Evolution is thought to have led to the loss of organ-regeneration potency in humans. However some lower vertebrates, such as newts and axolotls, have still retained their organ regeneration potency. Thus understanding of why lower vertebrates are able to regenerate organs would be useful to improve our poor ability of organ regeneration.

Limb regeneration has been studied as a model representing organ regeneration for more than a 100 years. Recently, a new experimental system referred to as the accessory limb model, has led to a major breakthrough in research on limb regeneration. The model clearly shows that nerves trigger the regeneration of limbs, where the presence of nerves governs early regulation of limb regeneration. Thus, research is focused on nerve regulation.

Here, in experiments to identify nerve regulation, Akira Satoh and colleagues at the Okayama University, Research Core for Interdisciplinary Sciences (RCIS), performed a deep sequencing analysis and compared regenerative (nerve supplied) and non-regenerative (non-nerve supplied) conditions. In the analysis, three factors (Gdf5, Fgf2, and Fgf8) were selected. Only Gdf5 application, which can promote Smad1/5/8 phosphorylation, induced 'bump' formation but did not result in limb formation. Similarly, the application of Fgf2 and Fgf8, which leads to ERK phosphorylation, induced 'bump' formation but did not result in limb formation. In contrast, the application of all three factors resulted in limb formation (Fig. 1). The induced limb showed the same histology as observed a normal limb.

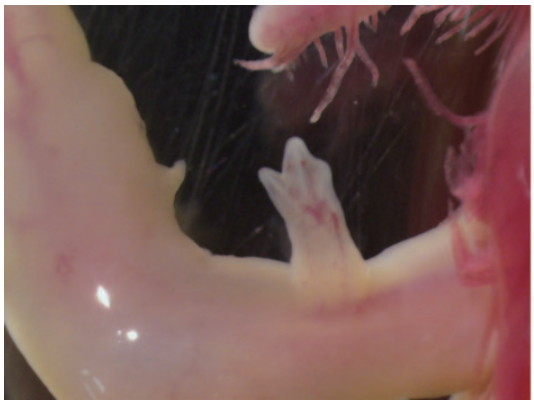


Fig1: An induced limb by the regenerative medicine. Gdf5, Fgf2, and Fgf8 application into the skin wound resulted in induction of the accessory limb.

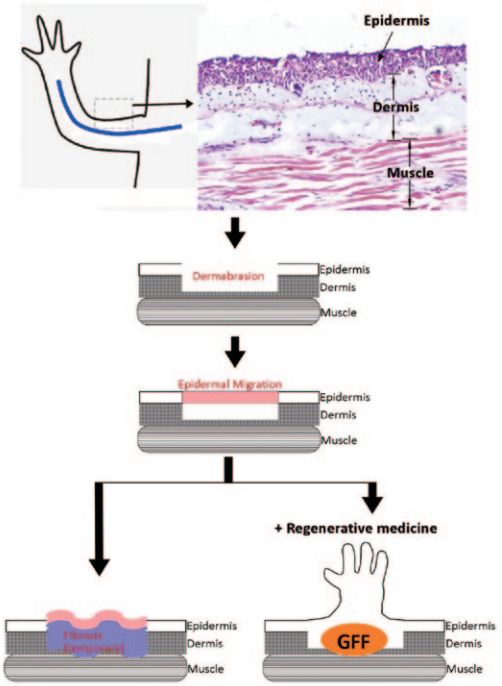


Fig2: Research summary. Axolotl skin histology is basically similar to other vertebrates. It consists of epidermis and dermis. Skin wounding damages the epidermis and dermis. Simple skin wounding resulted in a skin wound healing, which is similar as in higher vertebrates. In contrast, nerve deviation or Gdf5, Fgf2, and Fgf8 (GFF) application to wounded skin result in limb formation instead of skin healing.

In summary, three factors (Gdf5, Fgf2, and Fgf8) can act as substitutes for nerve functions in early limb regeneration. Revealing such factors will help to understand loss of regeneration potency in higher vertebrates. Research summary is shown in Fig. 2.

Reference:

- Authors: Aki Makanae, Kazumasa Mitogawa, Ayako Hirata, Yasuko Honjo, and Akira Satoh.
- Title of original paper: Nerve independent limb regeneration in axolotls.
- Journal, volume, pages and year: *Developmental Biology* **381**, (1), in press.
- Digital Object Identifier (DOI): 10.1016/j.ydbio.2013.05.010
- Journal website: http://linkinghub.elsevier.com/retrieve/pii/S0012-1606(13)00254-6
- Affiliations: RCIS, Okayama University.
- Department website: http://organregeneration.jimdo.com/

Research Highlights

Theoretical physics: Demystifying the molecular mechanisms of the initial stages of how ice melts

In general, the surface of ice acts to initiate melting and therefore ice melts starting from its surface at 0 degrees Celsius—a process referred to as heterogeneous melting. On the other hand, in the absence of a surface, an ideal melting process would occur from inside ice. In this case, where ice spontaneously loses its structural order due to thermal agitations, the process is termed homogeneous melting.

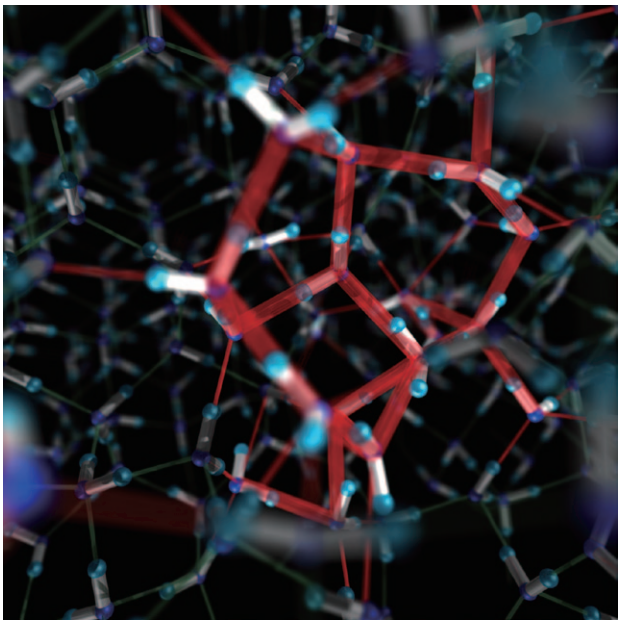


Figure: An initial embryo emerging inside the superheated ice.

Homogeneous melting is one of the most important processes in physics and chemistry and is known as a first order phase transition. Probing the mechanism by which water molecules introduce disorder spontaneously which leads to melting is a major challenge.

Now, the research team of Okayama University simulated the melting process of ice using a computational technique called molecular dynamics. Importantly, they introduced a new measure for the disorder in the structure of ice, and examined the complete mechanisms of melting starting with the emergence of disorder to the growth of a molten droplet and finally the total collapse of ice. They found that the melting process of ice is not a simple process with the emergence and subsequent growth of a disordered embryo but instead an entangled process triggered by the separation of pair defects.

Hydrogen bonds strongly bind water molecules in ice. Therefore, even if the ice structure is partially broken by thermal fluctuations, it recovers its order in a short period of time. However, once a pair defect is generated and separated, random motion of the defects prevents it from reuniting by going back to the correct return paths. Pair defects also work as catalysts to accelerate structural changes in ice, thereby leading ice to melt.

These findings are valuable insights into the structural changes in many other materials including biomolecules, and in the future may lead to unraveling the 'mechanism of life'.

Reference:

- Authors: Kenji Mochizuki[1], Masakazu Matsumoto[2], and Iwao Ohmine[3]
- Title of the original paper: *Defect separation as the controlling step in homogeneous ice melting*
- Journal, volume, pages, and year: *Nature*, 498, 350–354 (2013) (Cover Article)
- Digital Object Identifier (DOI): 10.1038/nature12190
- Affiliations:

1: School of Physical Sciences, The Graduate University for Advanced Studies (SOKENDAI), Myodaiji, Okazaki 444-8585, Japan
2: Graduate School of Natural Science and Technology, Okayama University, 3-1-1 Tsushima, Okayama 700-8530, Japan
3: Institute for Molecular Science, Myodaiji, Okazaki 444-8585, Japan

Author website(Japanese): http://ninai.med.okayama-u.ac.jp/

Intellectual Property and Enterprise

Unique terahertz chemical microscope for mapping chemical reactions

Imaging systems utilizing terahertz (THz) time-domain spectroscopy (TDS) are attractive for nondestructive testing. However, due to the large absorption of the water in THz frequency, it is not possible to measure the properties of chemicals and/or chemical reactions.

Here, a THz chemical microscope (TCM) is proposed and developed for mapping chemical potentials of chemical reactions in a gaseous atmosphere and aqueous solutions.

The TCM utilizes a sensing plate, which consists of an insulator thin film and a semiconductor thin film on a sapphire substrate. The existence of defects in the semiconductor thin film, results in the generation of local electric fields by energy band bending in the semiconductor layer near the boundary of the insulator and semiconductor layers. When the femto-second laser pulse hits the sensing plate, the THz pulse—whose amplitude is related to the magnitude of the local fields—is generated.

A chemical reaction is measured by dropping the sample solution onto the sensing plate so as to make contact with the insulator surface. If the chemical reaction proceeds and the chemical potential at the surface of the insulator layer shifts, leading to changes in the magnitude of the local field changes. Thus the chemical reaction at exactly where laser shines can be measured as the amplitude of THz pulse.

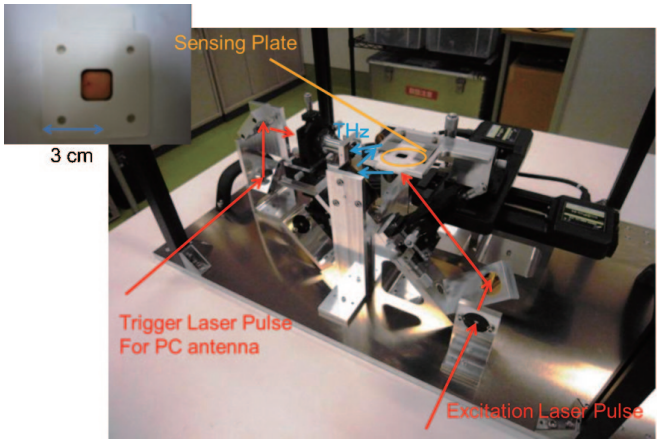


Fig. 1. Prototype TCM system

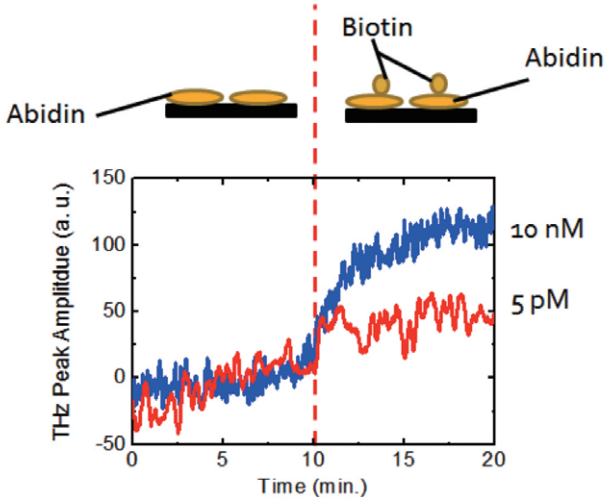


Fig. 2. The detection of abidin – biotin binding using TCM. The red and blue curves represent the detection of the biotin with concentrations of 5 pM and 10 nM,respectively.

Fig. 1 shows is a photograph of the prototype TCM system. The excitation laser pulse is introduced into the unit through the pin hole and focused onto the back-side of the sensing plate. The trigger laser pulse is also introduced into the unit to operate the photo-conductive (PC) antenna which is conventionally used to detect the THz pulses.

Applications demonstrated to date include, a high-sensitivity immune-assay (Fig. 2) , measurement of ionic reactions, and redox reactions of enzymes [1-4].

Reference:

[1] T. Kiwa et al., JJAP, 46 (2007) pp. L1052-L1054.
[2] T. Kiwa et al., APL, 96 (2010) 211114.
[3] T. Kiwa et al., Sens. Act. B, (2012) 10.1016/j.snb.2012.08.051.
[4] T. Kiwa et al., Opt. Exp., 20 (2012), pp. 11637-11642

Topics : Letters from alumni

Tamer Hashem Farag

Assistant Professor Department of Mathematics, Faculty of Science, Cairo University, Egypt.

I received my doctorate from the Graduate School of Natural Science and Technology of Okayama University in October 2009. The theme of my research was wireless networks and my supervisor was Professor Nobuo Funabiki. The doctorate was not only a milestone in my academic career but also in all matters related to my life. In academia, I have learned how to find, define, evaluate, and solve problems. I have developed skills on presenting myself and my work. I have learned how to work as a member of a team.

Funabiki Lab in a trip near Onomichi station (Tamer Hashem Farag is center of front row)

I was lucky that during my stay at Okayama University, I was given the opportunity to stay one more year as a research student after my graduation. And, during my 5 years at Okayama University I was able to absorb a wide spectrum of knowledge and to engage in many activities. With the help and support of Professor Masumi Oka, I had a great culture experience during the Japanese course. I had a 'democratic experience' in establishing Halal food meals in the university restaurants, through my position as the president of the International Student Union. I built good and strong social relationships through the barbeque parties of my lab, by which, I have got the chance to visit Japan in September 2011 as a visiting associate professor organized by Dr. Yukikazu Murakami one of my lab colleagues. My family and the Muslim International Students' Society faced great challenges and nice memories during the establishment of Okayama Students' Mosque beside the university campus.

Egyptian kitchen day activity

My relationship with Okayama University and the city of Okayama has not finished, but is just beginning. Last February, Cairo University invited two professors from Japanese universities specializing in special and rare subjects. Prof. Nobuo Funabiki and Prof. Shinji Sugawara from Chiba institute of Technology. The three students of my research group have benefited greatly from that visit.

Okayama is always in my mind and my heart.

Topics : Okayama Travelogue

Okayama University Institute of Plant Science and Resources in Kurashiki: The oldest agricultural research institute in Japan

The Okayama University Institute of Plant Science and Resources (IPSR) is the oldest agricultural research institute in Japan. Established in 1914, the institute was originally known as the Ohara Institute for Agricultural Research—a privately owned entity named after the founder Magosaburo Ohara, a prominent entrepreneur and philanthropist of Kurashiki City, who established the institute for the welfare of farmers and promotion of agriculture in Japan.

The entrance to the Okayama University Institute of Plant Science and Resources (IPSR)

The institute was transferred to Okayama University in 1952 and in 2010 the Ministry of Education, Sports, Culture and Technology (MEXT) approved the institute as a national 'Joint Usage/Research Center' in the fields of "plant genetic resources and plant stress science".

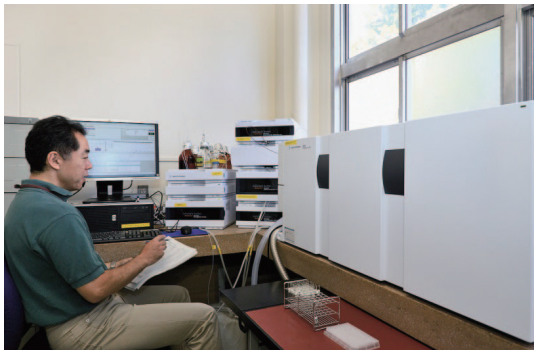
The barley germplasm collection including about 14,000 accessions

Research at the IPSR is conducted by independent groups led by principle investigators affiliated with two core areas of research and a research center:

Research Core for Plant Stress Science
Research Core for Future Crops
Barley and Wild Plant Resource Center

Researchers affiliated with IPSR also play an active role in education at the Okayama University Graduate School of Environmental and Life Science.

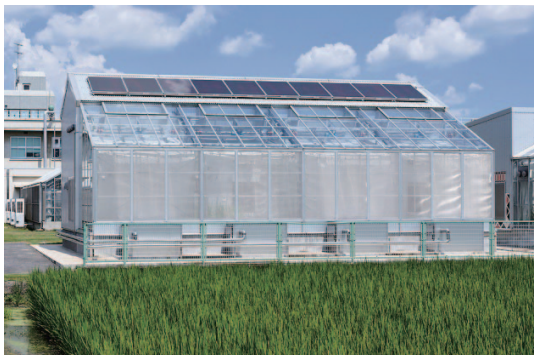
Amongst its wide ranging research activities, the IPSR is an international research center on barley. Reflecting its cutting edge research, in 2012 as a member of an international consortium, it succeeded in sequencing 98% of the barley genome and producing a high resolution assembly of the majority of barley genes in linear order—the results were published in *Nature* [1] with a summary of the findings in *Okayama University e-Bulletin* [2]. Furthermore, the IPSR has developed its own rice mutant lines in which researchers have found genes related to producing increased yields of the number of rice in rice-plant ears. Recently, IPSR researchers have identified the genes that determine



Analytical equipment (LC-MS) for plant hormones

the lengths of 'awns' of barley ears and genes related to cadmium absorption by rice, thereby showing that it is possible to significantly decrease the cadmium content of rice.

The institute is also conducting research on photosynthesis in plants. Researchers are focusing on finding new genes related to the maintenance of chloroplast and regulation of photo-inhibition, and mycorrhizal fungi of plants using mass spectroscopy based methods for highly precise/rapid identification methods. In this way, IPSR researchers are conducting research on various types of environmental stresses in plant bioresources.



Phytotron for genetically modified (GM) plants

Guest house for visitors

Other research areas include research on the effect of salt and radiation on barley and wild plants in farmland affected by the 11 March 2011 earthquake and tsunami in Japan. In the case of barley, research is being conducted on breeding strains of barley resistant to salt and wet injury, which could be cultivated in the affected regions. In research related to wild plants, the emphasis is on wild weeds that grow in areas of Fukushima contaminated with radiocesium from the nuclear power station explosion in 2011. So far, three surveys (spring, summer, and autumn) were conducted in 2012 to measure the concentration of radiocesium in plants and soils. These experiments are expected to yield information for planning strategies for the management of farmland in the areas affected by radiation.

The IPSR welcomes students, researchers from all over the world. Please visit the website for more information about degree programs and international collaboration.

Further information

Institute of Plant Science and Resources, Okayama University: http://www.rib.okayama-u.ac.jp

Publications

[1] The International Barley Sequencing Consortium, "A physical, genetic and functional sequence assembly of the barley genome", *Nature* (2012); DOI: 10.1038/nature11543

[2] Okayama University e-Bulletin Research Highlights: http://www.okayama-u.ac.jp/user/kouhou/ebulletin/research_highlights/vol2/highlights_003.html

Topics : Club Activities

Okayama University Kyudo Club: Enjoyable insights into one of Japan's traditional martial arts

"The Okayama Kyudo Club was founded 63 years ago," says Yuuki Umahara, a senior member of the club. "Some of the founding members still attend our practice sessions." The club has 45 members of whom 30% are female students. "We welcome new members at any time of the year," says Umahara. "We would like to encourage more international students to join. It's really very enjoyable."

Club members meet on Wednesdays for regular practice with competitive sessions on Saturdays. The Club was 2nd place in the local 'chugoku and shikoku' region university competition recently explains Umahara. "We continsuously strive to improve our abilities," stresses Umahara. "Kyudo does not require physical strength, but does need a stable upper body. We say that we 'pull with our bones, not our muscles'."

The Club members meet for an informal dinner each month to relax and share experiences. "The Okayama Kyodo Club offers an enjoyable way of learning more about one of Japan's traditional marital arts," saya Umahara. "Join us!"

Members of the Okayama University Kyudo Club. Yuuki Umahara is the last person on the right hand side in the 2nd row.

'Pulling with the bones, not the muscles'

Further information

http://www.geocities.co.jp/CollegeLife-Cafe/9838/index.html

