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News

International collaboration at the Okayama University Institute of Plant Science and Resources (IPSR)

Reflecting the continued internationalization of research at IPSR, the Institute's director Professor Masahiko Maekawa and Professor Eric Richards from Boyce Thompson Institute for Plant Research (BTI) (Ithaca, NY, USA) have signed a memorandum of understanding (MOU) on 26 August 2015.

Dr. Richards (BTI) and IPSR Director Dr. Maekawa at the MOU signing ceremony.

"It is a highly meaningful fact that the two institutes with approximately century long history agreed on making international collaborative efforts to improve food security by scientific approaches," said Professor Maekawa at the signing ceremony. Later, to mark the special occasion, Professor Richards gave a lecture on plant epigenetics and stress responses.

In related activities underscoring the aim of acting as an international research hub in plant research, the Institute organized the 2nd IPSR International Training Course (24-28 August 2015) on the theme of "Methods in Plant Stress Research". This course was initiated in 2014 with the goal of providing unique opportunities to young Japanese researchers for concurrent training and interaction with scientists from overseas.


Participants during the hands on training at IPSR.

This year three young Japanese researchers have been joined by their counterparts from UK, USA, and Taiwan to study modern mass spectrometry (MS) analytical methods using cutting-edge instruments such as MALDI-TOF-MS, LC-MS/MS, and GC-MS at the IPSR. This year, for the first time, all training sessions were held in the new Advanced Plant Science Research Building opened in April 2015.

The instruments were used for fingerprinting-based identification of bacterial species isolated from leaf samples; plant hormone determination (jasmonic acid, salicylic acid, abscisic acid); and analysis of plant volatiles released from herbivore attacked plants.

The course included lectures covering theoretical aspects of each method as well as hands on training to use the equipment and master analytical protocols.

Notably, this year's course included a plenary lecture by Professor Eric Richards entitled "The interface between epigenetics and plant stress responses", followed by a round table discussion about major issues in epigenetics, regulation of environmental responses and evolution.

Finally, the participants each gave short presentations about their own current research projects.

Additional details about the course can be found at IPSR website:
http://www.rib.okayama-u.ac.jp/information/20150902.html

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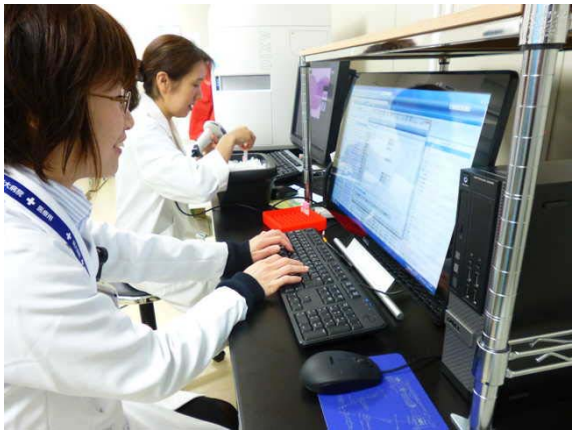
News

The launch of Okayama University Hospital's Biobank (Okadai Biobank)

Okayama University Hospital launched its 'biobank', the Okadai Biobank, in April 2015. The biobank provides a space in which to store biological specimens from patients who visit or stay in various departments in the hospital, and provides specimens to researchers and scientists both working inside and outside of the hospital. The Okadai Biobank is the latest in a number of biobanks to open in Japan.

A briefing session in the cardiovascular medicine department in the hospital. The Okadai Biobank is supported by departments and laboratories in the Okayama University Hospital.

The Okadai Biobank supports not only basic sciences but also clinical practice in a broader sense. More specifically, the Okadai Biobank willingly provides its stored biological specimens to private companies for promoting drug discovery and development. This will enable scientists to increase the diversity of accessible drugs in daily clinical practice, as well as providing support to public research institutes for driving medical and pharmacological studies forwards.



Information system in the Okadai Biobank is directly connected with the electronic medical records in the hospital via a de-identification component.

The key features of a hospital biobank are 1) the availability of abundant clinical information associated with each biological specimen, 2) the high quality of specimens because of close physical distance from the surgeries, and 3) a rapid and flexible response to request from applicants. In addition, a hospital biobank has the potential to be the central facility for advancing genomic medicine by providing storage for specimens and analytical instruments.

The Okadai Biobank and several other hospital biobanks in Japan jointly established the "Clinical Biobank Study Group" in March 2015 for networking and sharing information. The group had its first symposium in October 2015 in Okayama. Many participants attended

from industry, government, and academia to make various presentations and facilitate discussions, all of which indicated high expectations for hospital biobanks and genomic medicine.

The Okadai Biobank and the Clinical Biobank Study Group intend to play an important role in this field in Japan.

The first symposium of the Clinical Biobank Study Group on October 2015, gathering many participants from industry, academia, and government.

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News

Misasa International Student Intern Program 2015: Japanese and Overseas Students Participate in Cutting-Edge Research

The program has been led annually since being launch in 2005. The aim of the program is to promote international research and education for Japanese and overseas third or fourth year undergraduates and masters' program students. This year 12 interns from USA, Canada, Britain, Germany, France, Taiwan and Japan were selected from 86 applicants from 27 countries.

The student interns discuss their research projects with faculty members.

Each intern participated in a cutting-edge research project for six weeks under the guidance of faculty members and research groups at the Institute for the Study of the Earth's Interior. Notably, the interns actually carried out experimental research such as the comprehensive analysis of meteorites and determination of the physical properties of materials.

On the final day of the program the interns gave presentations about the outcomes of their research. At the farewell party following the talks, Professor Eizo Nakamura, Director of the Institute, presented each of the student interns with completion certificates.

Student interns with the staff of the Institute for the Study of the Earth's Interior.

The organizers hope that this program will not only give the participants experience in using advanced experimental and analytical technology, but also help students develop a passion for cutting-edge research.

Further information

Institute for Study of the Earth's Interior Okayama University
http://www.misasa.okayama-u.ac.jp/eng/

827 Yamada, Misasa, Tottori 682-0193, Japan.

News

Okayama University at the Licensing Executives Society 2015 Annual Meeting in New York City

Licensing Executives Society (U.S.A. and Canada), Inc. (LES) Annual Meeting and 50th Anniversary Celebration held in New York City, 25-28 October 2015. More than a thousand of technology licensing professionals globally attended the LES annual meeting. There were 38 exhibition booths from various entities at the Tech Fair (technology showcase). Okayama University had our own exhibition booth to promote the research outcomes as well as university itself.

Representatives from Okayama University were Prof. Shin-ichi Yamamoto (Director, the Organization for Research Promotion & Collaboration), Prof. Mototaka Senda (Director, Okayama University Silicon Valley Office), Prof. Takashi Sera (Graduate School of Natural Science and Technology) and the associates. Prof. Sera presented his research findings to the attendees. Our presence at this meeting gave a significant impression, and we enjoyed positive feedback from many of participants.

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For inquiries, please contact us by replacing (a) with the @ mark.

Prof. Mototaka Senda, Prof. Shin-ichi Yamamoto, Prof. Takashi Sera

Prof. Takashi Sera introducing his research findings to a participant

The Tech Fair

The LES 50th Anniversary Ceremony

News

The 'Japan Initiative for Global Research Network on Infectious Diseases': a kickoff symposium

Okayama University has been selected to participate in the Japan Agency for Medical Research and Development (AMED)'s 'Japan Initiative for Global Research Network on Infectious Diseases' for the academic year 2015. A kickoff symposium for the initiative, hosted by the Okayama University Research Core for Control of Infectious Diseases, was held in the Junko Fukutake Hall on the Shikata Campus of Okayama University on July 16. The aim of the symposium was to introduce the activities of the initiative, and hold an exchange of views on the project's future development.

AMED's program supervisor Kanda giving an overview of the initiative.

Director and Specially Appointed Professor Sumio Shinoda introducing the activities of the Collaborative Research Center of Okayama University for Infectious Diseases.

In his greeting to the symposium, president Kiyoshi Morita stated: "We will further strengthen the Collaborative Research Center of Okayama University for Infectious Diseases, which has been active as a research base for many years in the Indian city of Kolkata (Calcutta). We wish to contribute to the suppression of infectious diseases through a fusion of Okayama University's basic research prowess and Okayama University Hospital's fine clinical capabilities." In the greetings from the guests of honor, AMED program supervisor Tadahito Kanda and the Ministry of Education, Culture, Sports, Science and Technology (MEXT)'s director for Advanced Medical Science, Hideyuki Kobayashi, expressed their expectations for Okayama University while introducing the objectives and achievements of the initiative.

The director of the Collaborative Research Center of Okayama University for Infectious Diseases, Specially Appointed Professor Sumio Shinoda, introduced a project to control diarrhea infections, which has been carried out jointly with the Japan International Cooperation

Agency (JICA). Professor Shinichi Miyoshi of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences gave a talk on international collaborative research into the prevention, diagnosis and pharmaceutical development for diarrhea infections at their research base in India.

Dean Kouichi Morita of the Nagasaki University Institute of Tropical Medicine, gave an explanation of infectious disease control, including infectious diseases mediated by mosquitoes, being carried out at the Institute's research station in Vietnam. In addition, Yoichi Kurebayashi, executive officer and director of AMED's Department of Innovative Drug Discovery and Development, introduced AMED's ongoing drug development program and the collaborative arrangements for the Initiative.

This year marks the 30th anniversary of the conclusion of the Japan-India Agreement on Cooperation in the Field of Science and Technology, and Okayama University will also be deepening coordination for the strengthening and promotion of international research capabilities in these key research areas. Further information including the Okayama University- NICED 2007 MEXT program Founding Research Centers for Emerging and Reemerging Infectious Diseases can be found below.

Dean Kouichi Morita of the Nagasaki University Institute of Tropical Medicine giving his talk on efforts being made in Vietnam.

Yoichi Kurebayashi Executive Officer and Director of the Department of Innovative Drug Discovery and Development explaining AMED's support for innovative drug discovery.

For reference:

Collaborative Research Center of Okayama University for Infectious Diseases(CRCOUI) :
http://wwwcid.ccsv.okayama-u.ac.jp/
National Institute of Cholera and Enteric Diseases (NICED) :
http://www.niced.org.in/
Japan Agency for Medical Research and Development (AMED) :
http://www.amed.go.jp/en/

Combatting Infectious Diseases with Research Networks (OKAYAMA UNIV. e-Bulletin Vol.12):
http://www.okayama-u.ac.jp/user/kouhou/ebulletin/news/vol12/news_003.html
International research: Collaborative Research Center of Okayama University for Infectious Diseases in India (OKAYAMA UNIV. e-Bulletin Vol.7) :
http://www.okayama-u.ac.jp/user/kouhou/ebulletin/topics/vol7/travelogue.html
Vice President Shin-ichi Yamamato leads delegation to India to visit national research institutes and Okayama University-India collaborative research center (OKAYAMA UNIV. e-Bulletin Vol.3) :
http://www.okayama-u.ac.jp/user/kouhou/ebulletin/news/vol3/news_002.html

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Feature

Terahertz chemical microscope: Innovative terahertz technology for high resolution mapping of chemical reactions, label free immunoassays, cosmetics research, and more.

Toshihiko Kiwa, Associate Professor, Graduate School of Natural Science and Technology, Okayama University.

"My first encounter with terahertz physics and technology was during my master's degree," says Toshihiko Kiwa, an associate professor at the Graduate School of Natural Science and Technology, Okayama University. "Then, my research moved to superconductor photonics and 800 GHz high frequency Josephson junction devices. My desire to find innovative applications for terahertz technology led to the invention of the Terahertz Chemical Microscope (TCM)."

Terahertz (THz) radiation refers to electromagnetic spectrum in the range 0.3 to 30 terahertz, where 1 THz = 1 x 10^{12} Hz, and corresponds to wavelengths of approximately 1 mm to 0.01 mm. So the terahertz range fits into the gap between microwave and infrared radiation. Terahertz radiation penetrates plastics, concrete, and clothing thereby finding applications that include non-destructive quality control of electronic components and manufacturing processes, security surveillance, and imaging of human tissue. Terahertz radiation also has fundamental scientific applications such as spectral analysis of galaxies and materials research.

"Although so called terahertz time-domain spectroscopy (TDS) is used for nondestructive testing, terahertz radiation does not penetrate water, explains Kiwa. "So it is very challenging to use terahertz radiation to determine the physical properties of

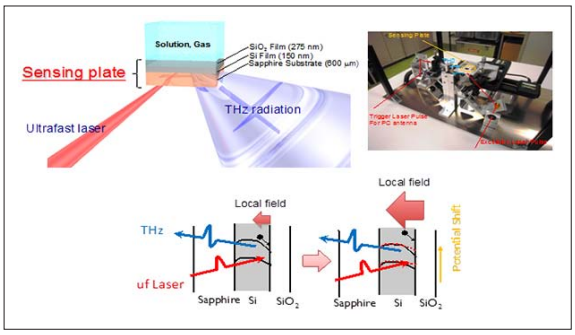
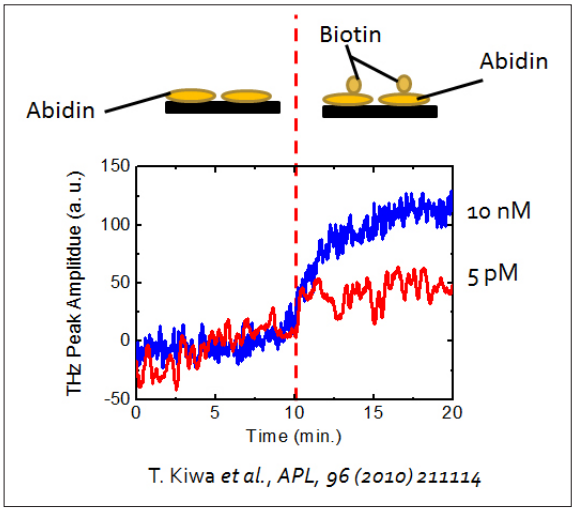
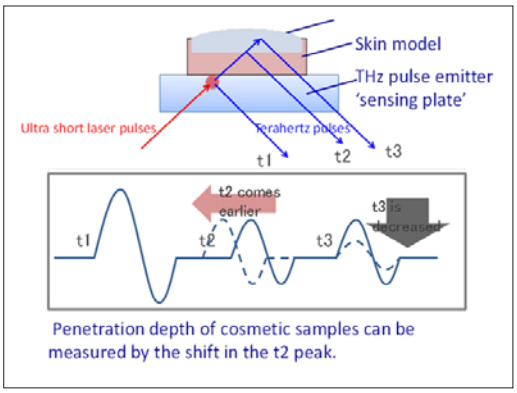


Figure showing the main components of the TCM system.



Recent results
Label free immunoassay
Novel label-free, none-destructive THz-time-of-flight evaluation of cosmetic penetration into artificial human skins

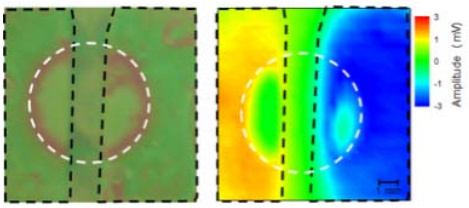
chemical and aqueous solutions." Kiwa and colleagues overcame the limitation of conventional terahertz spectroscopy by inventing the TCM for mapping electric potentials of chemical reactions in aqueous solutions. The fundamental distinguishing feature of the TCM is that the imaging process entails irradiating pulsed light from a femtosecond laser onto a specially designed sensing plate and detecting the resulting emission of terahertz from the sample. So the spatial resolution of the images is only limited by the incident light (typically ~800 nm) and not by the wavelength of the actual terahertz radiation that is generated in the sample, which is typically 300 micrometers.



T. Arisawa, JSAP-OSA joint symposia 13-16, Sep. 2015, Nagoya, Japan.

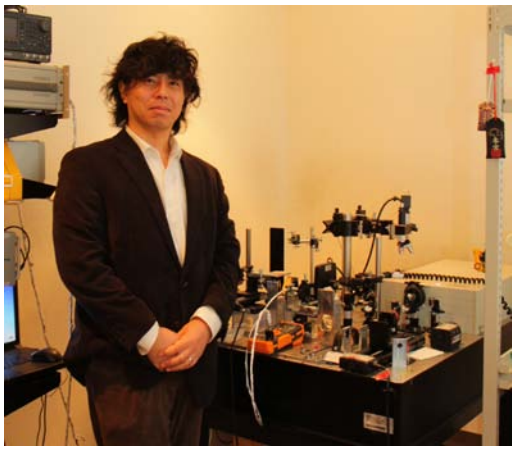
Operating principle of the terahertz chemical microscope

The sensing plate is one of the key components of the TCM. In its simplest form, it consists of thin films of silicon oxide and silicon deposited on a sapphire substrate. Now, pulsed light from a femtosecond laser incident on the sensing results in the generation of terahertz radiation that is captured by a photoconducting detector. Importantly, chemical reactions at the surface of the sensor induce fluctuations in the magnitude of the local electric potential that in turn result in corresponding changes in the intensity of the terahertz radiation emanating from the sensor. The changes in the magnitude of the terahertz radiation are a signature of the chemical composition of the aqueous solution on the sensor.



Imaging catalytic reactions at the electrodes of fuel cells
T. Kiwa, et al. Optics Express 20, 11637-11642 (2012).

"We the terahertz radiation is generated at exactly the same location as the incident light," says Kiwa. "So by scanning the femtosecond laser we can produce image of



Toshihiko Kiwa, Associate Professor, Graduate School of Natural Science and Technology, Okayama University.

the chemical nature of the surface of the sensor." Kiwa and colleagues are extending the applications of the TCM to areas including label free immunoassays, monitoring catalytic reactions in fuel cells, and determining the depth of penetration of cosmetics into the human skin.

Further information

▼ Reference(e-Bulletin) :

High-performance Terahertz Project kick-off symposium. Vol.11, June, 2015.
http://www.okayama-u.ac.jp/user/kouhou/ebulletin/news/vol11/news_003.html

Simple, compact, highly sensitive SQUID based magnetic field measurement
sysytem to detection of a very small magnetic signals. Vol.10, February,2015.
http://www.okayama-u.ac.jp/user/kouhou/ebulletin/research_highlights/vol10/highlights_004.html

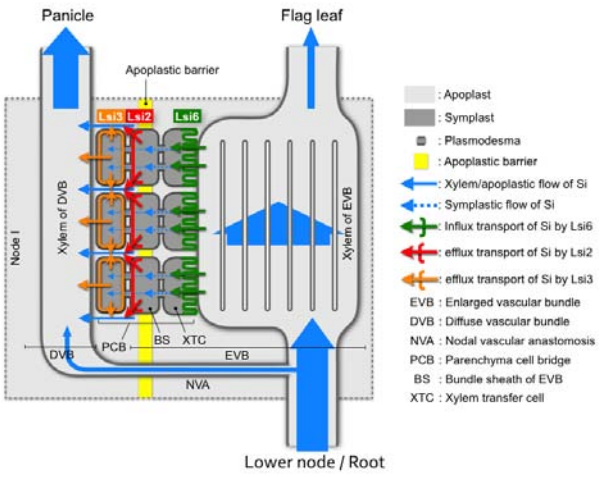
Unique terahertz chemical microscope for mapping chemical reactions.
Vol.4, September, 2013.
http://www.okayama-u.ac.jp/user/kouhou/ebulletin/ipe/vol4/ipe_001.html

▼ Toshihiko Kiwa group website
http://www.sense.ec.okayama-u.ac.jp/member.html

Research Highlights

Preferential distribution of silicon to rice grains

Silicon (Si) is the most abundant element in the Earth's crust. Rice is able to accumulate high Si in the husk, where the element protects the grains from various stresses and enables the rice to maintain its production and high yield. However, the molecular mechanisms involved in the preferential delivery of Si to the husk are unknown.



Schematic presentation of preferential distribution of Si to the rice husk at the node.

Now, Naoki Yamaji, Jian Feng Ma and their colleagues at the Institute of Plant Science and Resources at Okayama University have found that this preferential distribution is mediated by the co-operation of three different Si transporters. These transporters are localized at different cell layers in the nodes of the rice plants.

Further collaboration with Gen Sakurai at the National Institute for Agro-Environmental Sciences uncovered that an apoplastic barrier, alongside the development of enlarged vascular bundles in the node, are also required for preferential Si distribution. Mathematical modelling of the processes allowed the team to pinpoint these specific details.

These findings provide a model case for studying the distribution mechanisms of other mineral elements. The team also hopes their findings will prove useful for the modification of rice crops by enhancing essential nutrients and reducing toxic elements in rice grains, for example.

Reference:

- Authors: Naoki Yamaji, Gen Sakurai, Namiki Mitani-Ueno, and Jian Feng Ma
- Title of original paper: Orchestration of three transporters and distinct vascular structures in node for inter-vascular transfer of silicon in rice
- Journal, volume, pages and year: *Proceedings of the National Academy of Sciences of the United States of America* **112**, 11401-11406 (2015).
- Digital Object Identifier (DOI): 10.1073/pnas.1508987112
- Journal website: http://www.pnas.org/content/112/36/11401

• Affiliations: Institute of Plant Science and Resources, Okayama University Department website:
http://www.rib.okayama-u.ac.jp/plant.stress/index.html

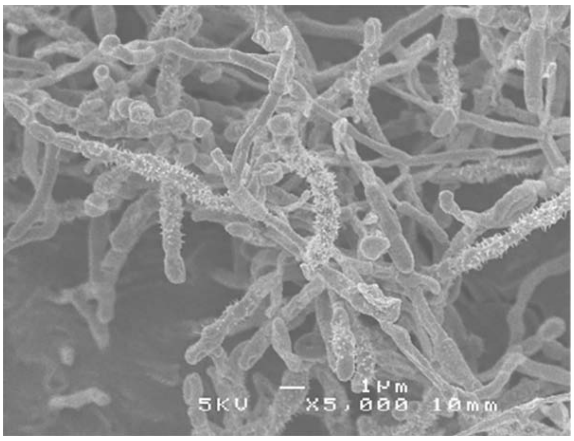
Reference(e-Bulletin) :

OKAYAMA UNIV. e-Bulletin. Plants feel stress! Vol.12, Sep, 2015.
http://www.okayama-u.ac.jp/user/kouhou/ebulletin/feature/vol12/feature_001.html

Research Highlights

Genome sequencing anti-viral antibiotics-producing *Streptomyces incarnatus*, led to the discovery of Se-containing formate dehydrogenase gene for biofuel cell

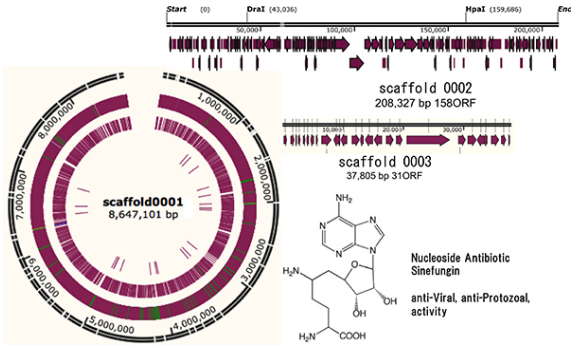
Despite the general understanding that antibiotics cannot be prescribed to cure the common flu, there are lines of antibiotics that are capable of killing viruses, protozoa, fungi, and even cancer cell lines. Notably, these antibiotics-referred to as "nucleoside antibiotics"- are not utilized in our society due to the extremely poor production yield by usual fermentation processes.



Streptomyces incarnatus NRRL8089 is a Gram-positive bacterium with filamentous morphology with characteristic spiked-spore formation. The nucleoside antibiotics produced by this strain has potent activity against propagation of viruses such as New Castle Disease virus, Vaccinia visus and of growth of protozoa like Malaria and Trypansoma. The biosynthetic gene cluster for the antibiotics is the target subject behind the genome sequencing.

Here, in order to exploit the genetic codes of nucleoside antibiotics-producing *Streptomycs incarnatus* NRRL8089, Takashi Tamura and colleagues at Tokyo University have elucidated the 8,897,465-bp genome sequence that were assembled in computer simulations, and putative genes were annotated by homology search, and the sequence opened to public in the international database NCBI.

The Gram-positive bacterium is now being investigated with the aim of dramatically improving production through genome engineering via de-regulation of gene transcription by an RNA polymerase (*rpoB* mutation) and protein quality-control system consisting of *groES/groEL* chaperoning system, which ultimately improves the thermal stability of the biosynthetic enzymes and thereby endures the long-lasting production of these precious antibiotics and metabolites.



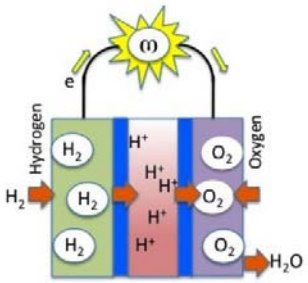
Draft genome sequencing is completed and assembled on one major scaffold0001 which is linear genome containing 8,647,101bp, with telomere sequences at both of the ends. Two additional plasmids scaffold 0002 and 0003 were also elucidated by the assembled contigs.

Intriguingly, a serendipitous discovery from these genome sequencing was an open reading frame for selenocysteine-containing formate dehydrogenase-O (*fdh*-O gene) together with the set of the selenoprotein biosynthetic gene cluster *selABCD* in close vicinity on the bacterial genome.

Importantly, the selenoprtein Fdh-O has potential

applications for the development of bio-fuel cells for generating electricity from hydrogen without burning fossil fuels.

Genome sequencing may offer clues into the efficient and convenient mass production of nucloside antibiotics for large-scale cathode enzymes for the development of biofuel cells.



A biofuel cell is a battery system in which a pair of enzymes works together to generate power by oxidizing hydrogen gas (H_2) on one side and reducing oxygen gas (O_2) on the other side. The anode inevitably requires hydrogenase while the cathode reserves choices of enzymes including formate dehydrogenase.

Reference1:

- Authors: Kenshiro Oshima, Masahira Hattori, Hitomi Shimizu, Koji Fukuda, Michiko Nemoto, Kenji Inagaki, Takashi Tamura
- Title of original paper: Draft genome sequence of *Streptomyces incarnatus* NRRL8089,which produces the nucleoside antibiotic, Sinefungin
- Journal, volume, pages and year: *Genome Announcements* **3**, e715 (2015).
- Digital Object Identifier (DOI): 10.1128/genomeA.00715-15
- Journal website: http://dx.doi.org/10.1128/genomeA.00715-15
- Journal, volume, pages and year: Genome Announcements 3, e715 (2015). http://ousar.lib.okayama-u.ac.jp/metadata/53727
- Affiliations: Graduate School of Life and Environmental Sciences, Okayama University, Okayama, Japan.

Research Highlights

New technique for removal of radiostrontium from wastewater and possible waste management.

Large amounts of radioactive nuclides were released into the environment when the Fukushima Daiichi Nuclear Power Plant was damaged by the earthquake on March 11, 2011 [1, 2]. Among these, the more long-lived radioactive nuclides, such as ^{134}Cs, ^{137}Cs and ^{90}Sr - which have half-lives of 2.06, 30.17 and 28.79 years respectively - are of great concern in terms of environmental contamination. ^{137}Cs, which emits γ rays, has been used to evaluate the environmental monitoring and decontamination, because it is easily detected using various instruments. However, ^{90}Sr emits only β rays, and requires a complicated extraction and purification process for analysis. Therefore, few studies on ^{90}Sr release have been performed so far.

Several methods can be used to remove metal ions from wastewater, such as chemical precipitation, ion exchange, membrane treatment, and adsorption. Adsorption is one of the most commonly used methods due to its simplicity and selectivity. For the separation of strontium ions, various types of organic and inorganic adsorbents have been reported.

Toshiro Ono and colleagues at Okayama University developed an effective system for removing ^{90}Sr from aqueous solution, which is based on the hydroxyapatite (HAP) column procedure. HAP is a major mineral constituent of bone and tooth and has an outstanding biocompatibility. HAP is also a possible sorbent for heavy metals in wastewater due to its high adsorption capacity and low water solubility.

In their tests, the researchers found that more than 90% of ^{90}Sr was adsorbed onto HAP particles. This was far more effective than tests using zeolite, which has been commonly used for ^{137}Cs adsorption (Fig. 1). The adsorption of ^{90}Sr by HAP was not influenced by calcium ion concentrations of up

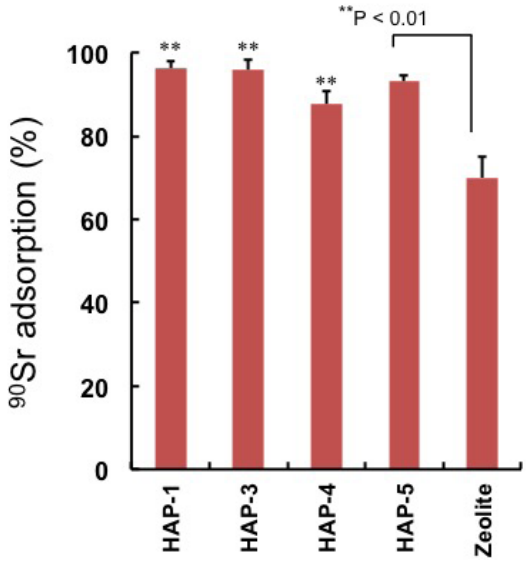


Fig. 1 Adsorption efficiency of ^{90}Sr onto HAP and zeolite examined on competing cation-free solution. *P<0.01 by unpaired Student's *t* test.

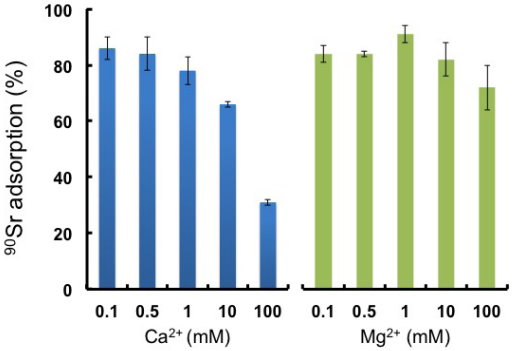


Fig. 2 Effect of competing Ca^{2+} and Mg^{2+} ions on ^{90}Sr adsorption onto HAP.

to 1 mM – more than the average concentration of calcium ions in natural water, which is 15-20 mg/ L (0.375-0.5 mM) in Japan. Furthermore, magnesium ions had little effect on the removal of ^{90}Sr over the entire concentration range that was tested (Fig. 2). Once the ^{90}Sr was adsorbed, the researchers stripped it from the column using a small amount of eluate. They were then able to use the regenerated column for a further round of separation.

The researchers are hopeful that their HAP column technique could be useful for removing ^{90}Sr from wastewater as well as natural water in the environment. The concentrated ^{90}Sr adsorbed onto HAP could then be stored securely as dry solid waste, reducing the required disposal space and lowering costs (Fig. 3).

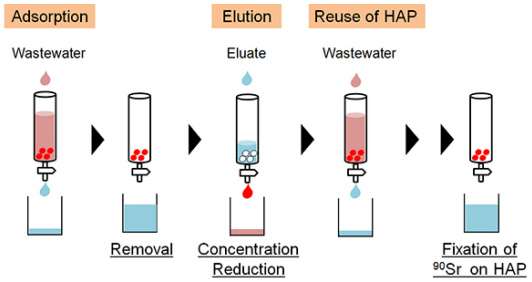


Fig. 3 Concentration and volume reduction of wastewater and fixation of ^{90}Sr on HAP particles for the storage as dry solid waste.

[1] K. Hirose, J. Environ. Radioact., 111, 13-17 (2012)
[2] K. H. Harada, T. Niisoe, M. Imanaka, et al., Proc. Natl. Acad. Sci. USA, 111, E914-E923 (2014)

Reference:

• Authors: Yuichi Nishiyama[1], Tadashi Hanafusa[1], Jun Yamashita[2], Yoko Yamamoto[2], and Toshiro Ono[1]
• Title of original paper: Adsorption and removal of strontium in aqueous solution by synthetic hydroxyapatite
• Journal, volume, pages and year: J. Radioanal. Nucl. Chem. (2015)
• Digital Object Identifier (DOI): 10.1007/s10967-015-4228-9
• Journal website: http://www.springer.com/chemistry/journal/10967
• Journal, volume, pages and year: J. Radioanal. Nucl. Chem. (2015).
http://ousar.lib.okayama-u.ac.jp/metadata/53728
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Research Highlights

Adsorption mechanism of inhibitor and guest molecules on the surface of methane hydrate

Gas hydrates are crystalline solids which consist of water and guest molecules such as methane. Gas hydrate 'plugs' sometimes occur in gas and oil pipelines. This is a serious industrial problem because the pipeline must be shut down until the hydrate plugs are removed. A common way to avoid the plugging is by using a dosage of a type of water-soluble polymers called 'kinetic hydrate inhibitors' (KHIs).

KHIs bind to the hydrate/water interface and inhibit the crystal growth of gas hydrates. Scientists believe KHI adsorbs on the hydrate surface mainly due to hydrogen bonding between the amide groups of the KHI and water molecules on the hydrate surface.

Takuma Yagasaki, Masakazu Matsumoto, and Hideki Tanaka at Okayama University, Japan, performed molecular dynamics simulations on KHI binding, demonstrating that the conventional picture of the adsorption mechanism of KHIs is incorrect.

The team calculated the free energy profiles of various molecules using an umbrella sampling technique with the weighted histogram analysis method. They discovered that the adsorption of nonpolar or weakly polar molecules, including KHIs, on the hydrate surface is largely due to entropic stabilization arising from the presence of cavities on the hydrate surface. The amide-hydrogen bonding makes no contribution to the adsorption affinity.

The researchers believe the mechanism found in this study will help in the development of new KHIs in the future.

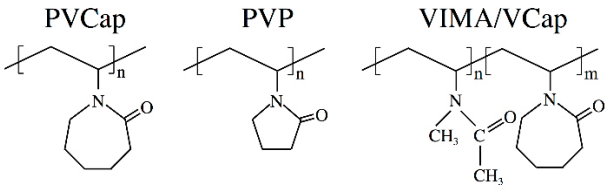


Figure 1: Structures of typical KHIs. Each monomer has an amide group.

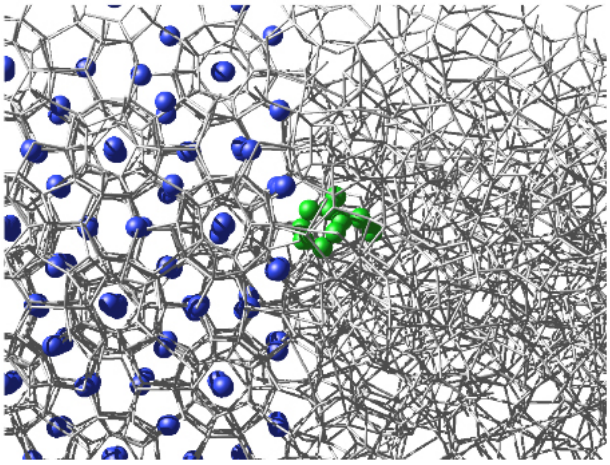


Figure 2: Snapshot of a monomer of a KHI, PVCap, at the interface between structure II methane hydrate and liquid water. The hydrogen bonds between water molecules are represented by gray lines. The green molecule is the monomer of PVCap and blue spheres are methane molecules in the hydrate phase.

Reference:

- Authors: Takuma Yagasaki, Masakazu Matsumoto, and Hideki Tanaka.
- Title of original paper: Adsorption mechanism of inhibitor and guest molecules on the surface of gas hydrates.
- Journal, volume, pages and year: *J. Am. Chem. Soc*. **137**, 12079 (2015).
- Digital Object Identifier (DOI): 10.1021/jacs.5b07417
- Journal website: http://pubs.acs.org/doi/abs/10.1021/jacs.5b07417
- Affiliations: Department of Chemistry, Faculty of Science, Okayama University.
- Department website: http://chem.okayama-u.ac.jp/index.html

Reference(e-Bulletin) :

OKAYAMA UNIV. e-Bulletin. Theoretical physics: Demystifying the molecular mechanisms of the initial stages of how ice melts. Vol.4, Sep, 2013. http://www.okayama-u.ac.jp/user/kouhou/ebulletin/research_highlights/vol4/highlights_004.html

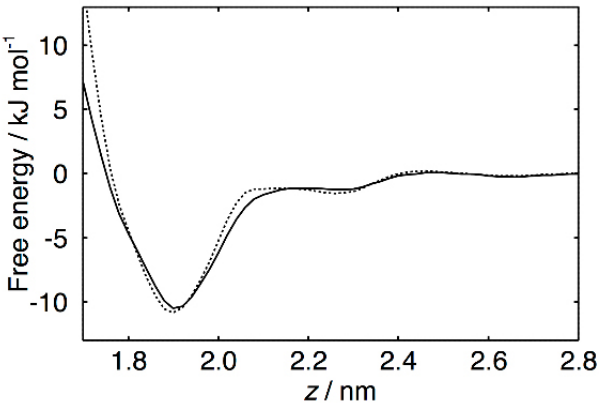
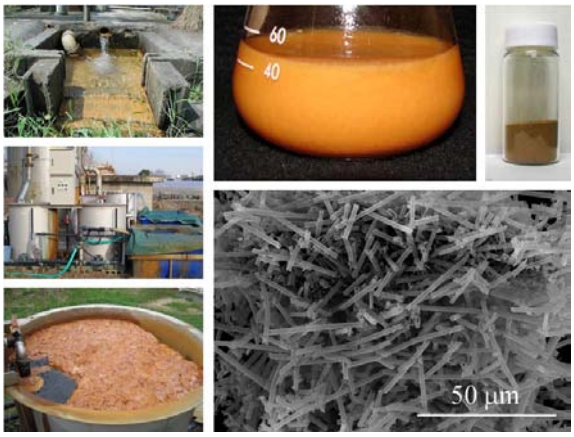


Figure 3. Free energy profile for transferring a PVCap monomer from the bulk liquid phase to the hydrate surface (solid). The figure shows that the monomer is stabilized at the hydrate surface by 10.5 kJ mol^{-1}. The dotted curve is the free energy profile of a fictitious nonpolar PVCap monomer. The adsorption affinity of the fictitious nonpolar PVCap monomer is almost the same as that of the normal PVCap monomer, although the former cannot form hydrogen bonds with water molecules. This result clearly demonstrates that the amide hydrogen bonding does not contribute to the adsorption of KHIs on the hydrate surface.

Intellectual Property and Enterprise

Plant disease control using iron-enriched sheaths naturally produced by bacteria

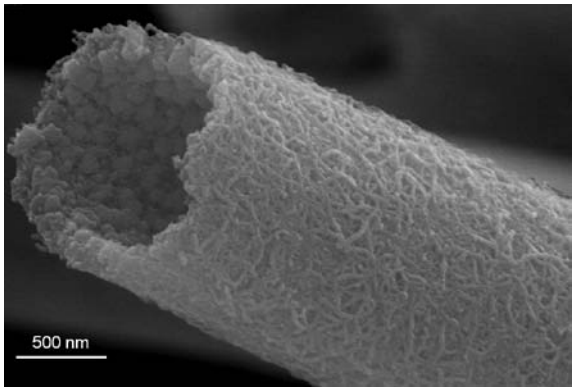
Bacteria have some extraordinary natural ways of protecting themselves against fungi and attacking microbes. For example, the iron-oxidizing bacteria, *Leptothrix* spp., produces microtubular hollow sheaths in aquatic environments where there is an up-welling of groundwater. The sheath is primarily composed of iron oxides (Fe/Si/P = 75/20/5 in the atomic ratio). Interestingly, a colloidal suspension of these Fe-enriched sheaths in powder form has been found to effectively suppress fungal pathogenesis.



L-BIOX; Leptothrix sp.-produced biogenous iron oxide

Kazuhiro Toyoda and Jun Takada at the Okayama University, Japan, and co-workers investigated one such naturally-produced sheath (an Fe-enriched sheath) to determine its antifungal activities in vitro against several phytopathogenic fungi. The fungi tested included *Botrytis cinerea*, *Colletotrichum higginsianum*, and *Mycosphaerella pinodes*.

The fungi were inoculated on ethanol-killed onion epidermis. The researchers found that the germ tube (gt) and apprisorium (app) were particularly effective at causing penetration failure from appressoria when the powdered suspension was mixed with the spore.



SEM image for L-BIOX

These results indicate that the Fe-enriched sheath from *Leptothrix* spp. could provide a new protectant for plant diseases.

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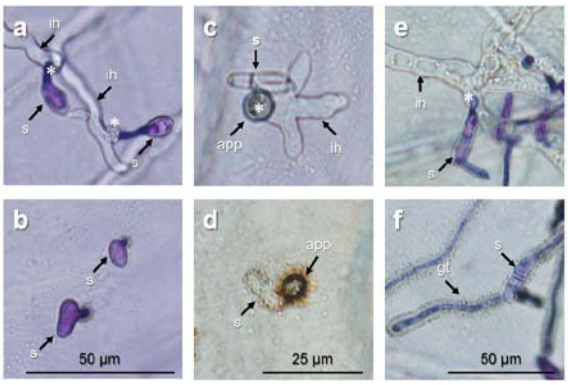

L-BIOX effectively suppresses fungal pathogenesis, especially causing penetration failure from appressoria, when mixed with the spore suspension on ethanol-killed onion epidermis.
Botrytis cinerea (a, b);
Colletotrichum higginsianum (c, d);
Mycosphaerella pinodes (e, f).
app: appresorium;
gt: germ tube;
ih: infection hyphae;
s: spore.
Asterisk indicates a site of attempted penetration

Topics : Letters from alumni

Emilio Satoshi Hara
JSPS Postdoctoral Fellow Department of Biomaterials Graduate School of Medicine, Dentistry and Pharmaceutical Sciences Okayama University

My experience in research at Okayama University started in 2003, where I began as a research student on an initial one-and-a-half year placement. A friendly relationship between two professors - Prof. Tetsuo Saito from the dental school at the University of Sao Paulo, Brazil and Prof. Atsushi Yamashita at Okayama University led to the suggestion that I should come to Okayama. From the very beginning, the experience was totally new and fascinating. I began by learning how to design clinical research involving mainly prosthodontics and temporomandibular joint disorders.

Prof. Kuboki, me and Assist. Prof. Ono - the two major people who supported me during my doctorate.

After some time, I began conducting experiments in biochemistry and the molecular biology of mineralized tissues (bone and cartilage) to obtain a deeper understanding of the biological mechanisms of tissue development, disease and repair. My Ph.D thesis involved the identification of chemicals that can enhance the repair of articular cartilage, under the supervision of Prof. Takuo Kuboki (Department of Oral Rehabilitation and Regenerative Medicine), in collaboration with Prof. Masaharu Takigawa (Department of Biochemistry and Molecular Dentistry).

Prof. Matsumoto, me and Assoc. Prof. Okada. In this picture, we are holding some of the instruments linking different fields (materials/bioengineering, molecular biology and chemistry/engineering) to highlight the many different expertise in our department.

Despite my initial background in clinical research, one of the most important changes in my research career was to start doing basic science, which opened new doors to me in the scientific world. I am extremely grateful to Prof. Kuboki, who encouraged me to pursue this.

Currently, in the latest step of my career as a post-doctoral researcher at the Department of Biomaterials (under the supervision of Prof. Takuya Matsumoto), I am learning from other fields of basic science, including biomaterials, biophysics and bioengineering. This post-doctoral fellowship has been unique and timely, and a very important opportunity to develop other aspects of my career

related to education as well as research. I am enormously grateful to Prof. Matsumoto for this opportunity. With one-to-one meetings we are able to discuss and exchange ideas readily, exploring many different opinions from across these fields of research. To my mind, this is one of the key strengths in our department; that, we can gather researchers with different fields of expertise and discuss research ideas from different perspectives. The research topic for my post-doctorate fellowship is re-analyzing the mechanisms of biomineralization and bone crystal formation from a more extensive view-point based on biology, materials science and crystal formation.

Collaboration among researchers with different backgrounds in a single department is an excellent basis for the development of new and promising research ideas, and can be very fruitful for the development of novel concepts, methods and devices.

Topics : Okayama Travelogue

Bizen Osafune Japanese swords

Okayama Prefecture, blessed with superior quality iron sand, trees for producing charcoal, and fresh water from the Yoshii river, has been famous for the production of Bizen Osafune Japanese swords since ancient times.

Notably, the production of a single Bizen Osafune sword demands the dedicated team work of a plethora of talented craftsmen including swordsmiths, lacquerware artisans, steel smiths, metal carvers, and logistics experts who transport the raw materials.

Swordsmiths making a Bizen Osafune sword

Historical records show that during Japan's Heian period (794-1185) the ready availability of high quality raw materials for making iron and charcoal 'fuel' to fire furnaces played an important role in the manufacture of 'Bizen Osafune' Japanese swords in Okayama.

Okayama is located in central Japan in the area known as Chugoku region. In ancient times, the soil was rich in iron-sand known as "Akome" in Japanese, making it well suited for producing swords. Furthermore, swordsmiths were able to use charcoal made from Akamatsu trees growing locally to generate the potent fire and heat for transforming the raw iron-sand into balls of steel or "Tamahagane".

The Bizen Osafune swords were produced for many centuries from the Heian to Edo Periods (1603-1868), thereby reflecting the high quality and popularly of the swords. Until around 1599 many swordsmiths practiced their craft near Osafune City and lived along the Yoshii river, which was the source of the precious water, another important element required to produce their high quality swords.

Okayama Prefecture has many museums and places where 21st century swordsmiths demonstrate how their predecessors produced the regions famous Bizen Osafune swords.

Further information

Bizen Osafune Sword Museum
http://okayama-japan.jp/en/art/art-bizen/

Setouchi City
http://www.city.setouchi.lg.jp/token/nihontonitsuite/index.html

Topics : Club Activities

Okayama University Kendo Club

"The Okayama University Kendo Club was established in 1954," explains Shinichiro Tanaka, the captain of the club and a 2nd year student at the Department of Mechanical and Systems Engineering. "The essential human traits for success in kendo are civility, respect for opponents, and the will power to continue. Our members have strong personalities."

The Club is composed of 36 students with roughly equal numbers from each academic year and departments including engineering, education, pharmacy, and law. "Very few members started kendo after enrolling at university," says Shinichiro. "Many of our members started kendo during primary school. Some stopped during junior high school and started again at university."

The club participates in many competitions in Japan with the members practicing regularly at the University Dojo. Typically, the members practice 5 times per week and hold training camps in the spring and summer where the students themselves plan the routines for practice sessions.

Recently the Okayama Kendo Club participated in the 61st All Japan Kendo Championships and 62nd Chushikoku Student Kendo League Championships, where the club captain Shinichiro Tanaka finished in the best 16.

"Our club holds other activities each year including BBQs and end of year parties. Come and join us!"

Members of the Okayama University Kendo Club

In action during a competition

Preparing for a BBQ

Website

www.geocities.co.jp/okadai_kendo_club_2nd/

