The CATALYST

Helping you react with chemical reactions

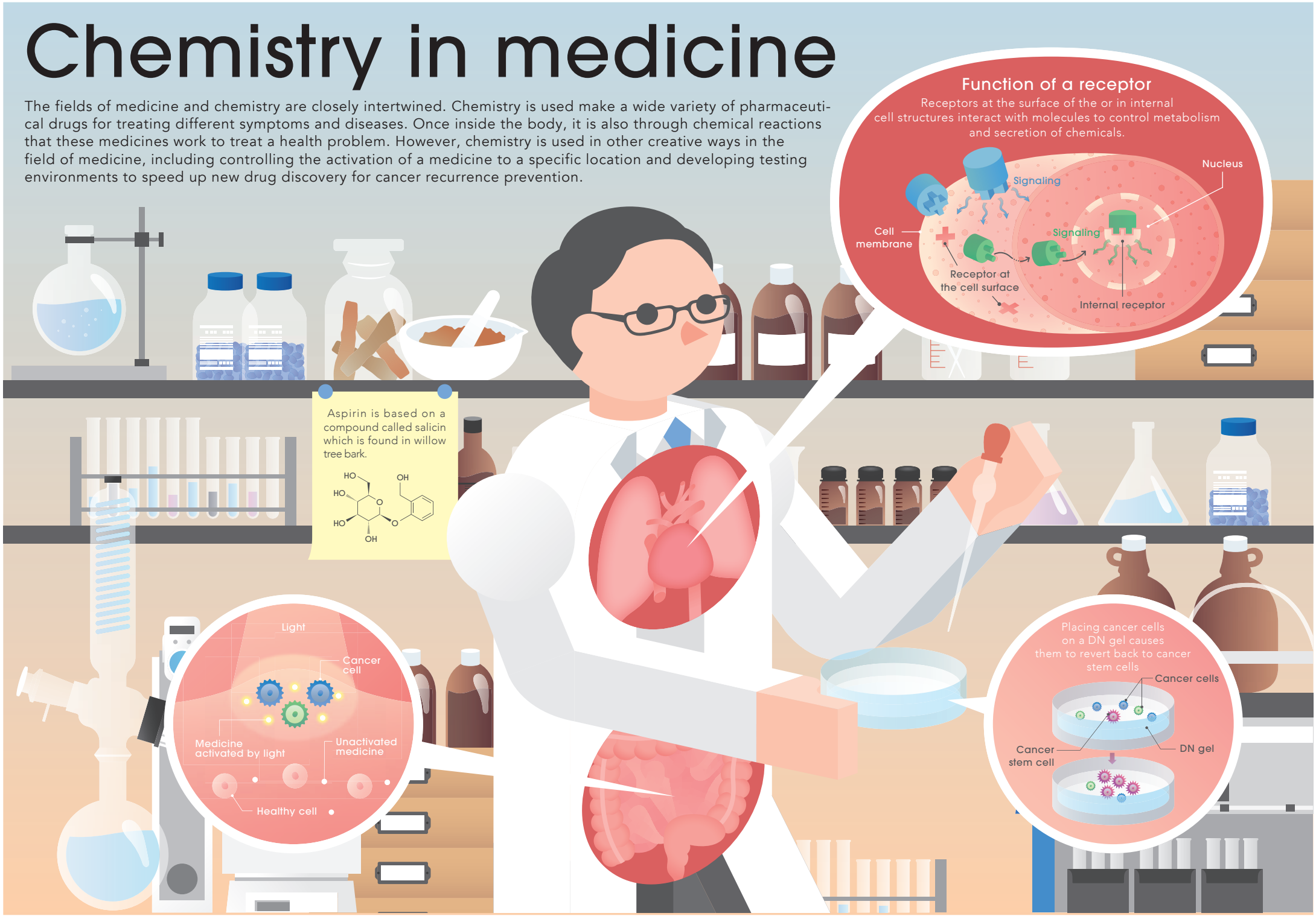
Issue 10
December 2022

Chemistry in medicine

ICReDD
Institute for Chemical Reaction Design and Discovery
HOKKAIDO UNIVERSITY

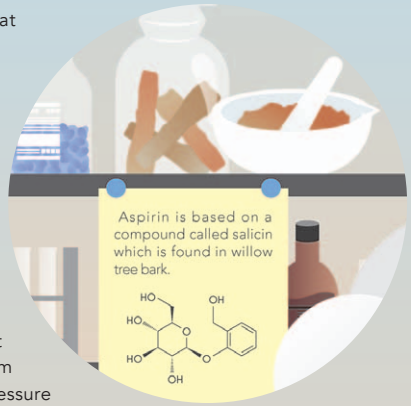
Chemistry in medicine

The fields of medicine and chemistry are closely intertwined. Chemistry is used make a wide variety of pharmaceutical drugs for treating different symptoms and diseases. Once inside the body, it is also through chemical reactions that these medicines work to treat a health problem. However, chemistry is used in other creative ways in the field of medicine, including controlling the activation of a medicine to a specific location and developing testing environments to speed up new drug discovery for cancer recurrence prevention.



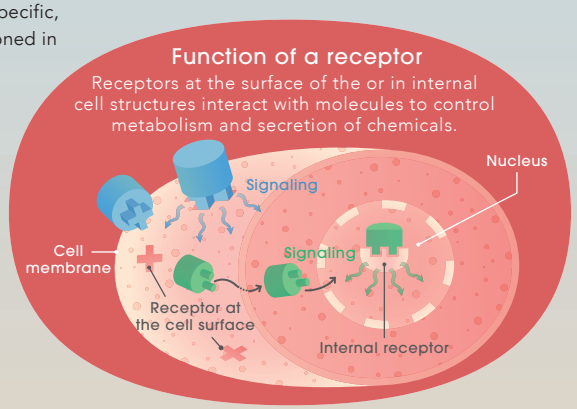
1. A multitude of medicines

Nearly all the medicines on the shelf at your local drugstore or pharmacy are created through chemical reactions. In some cases, humans take inspiration from compounds found in nature. For example, the active ingredient in the commonly used fever-reducing drug Aspirin is based on a similar compound originally discovered in willow tree bark. For most medicines, though, chemistry has been used to design new compounds from scratch to treat specific health problems, ranging from chronic conditions like high blood pressure or high cholesterol to deadly diseases like malaria or cancer.



2. Being receptive

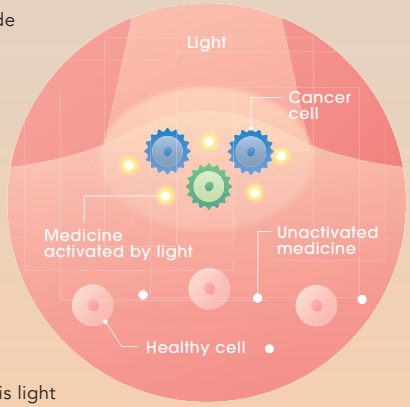
Drugs often work by interacting with molecular receptors in our body. These receptor molecules can be on the surface of cells, helping control which external molecules can enter the cell, or the receptors can be inside the cell, controlling internal processes such as metabolism. Much like a lock and key, these receptors have unique structures and will only react with molecules of a specific, matching shape. As mentioned in Issue 6 of The CATALYST, when developing a new drug, chemists must be careful to produce only one mirror image version of a molecule so that the medicine doesn't react with other receptors in the body and cause unintended side effects.



Issue 6 of The CATALYST ▸

3. In the spotlight

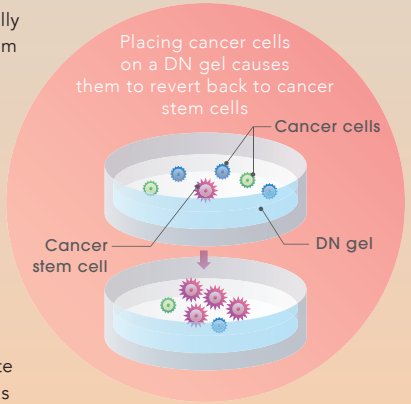
Sometimes it is difficult to prevent side effects just by creating a precisely shaped molecule, as is the case with cancer treatments. Chemotherapy drugs often can't differentiate between healthy and cancerous cells and end up attacking both, causing damaging side effects. Utilizing photochemistry, which was talked about in Issue 8 of the CATALYST, is one method for increasing the accuracy of these medicines. This involves using medicine that is only activated when exposed to a certain type of light. This light can then be focused locally to the tumor area, so that only medicine in the tumor is activated, helping prevent healthy cells from being damaged.



Issue 8 of The CATALYST ▸

4. Preventing cancer recurrence

Even when a cancer tumor has been successfully eradicated, chemotherapy-resistant cancer stem cells can remain in a patient's body and lead to the recurrence of cancer. As mentioned in Issue 9 of The CATALYST, ICReDD is researching a unique material called double network hydrogels (DN gels). Researchers found that these gels can convert cancer cells back into cancer stem cells, and this ability to create stem cells allows researchers to test new drugs on the stem cells in a high-throughput manner. Using this method, researchers at ICReDD identified a molecule that was able to eradicate the stem cells converted by the hydrogels. This rapid testing capability has the potential to speed up the development of stem-cell-targeting drugs that can stop the recurrence of cancer!



Issue 9 of The CATALYST ▸

Activation!

Quiz

Chemistry is used in the field of medicine to _____.

Send us your answer!

A make new drugs

B localize drug activation

C accelerate new drug development

D all of the above

Check our Instagram highlights for the answer to the quiz!
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ICReDD News

December 2022

New Researchers

Zhijian Wang
Polymer Science and Engineering

Alexander Mikherdov
Crystal Engineering for Luminescent Properties

Vishal Kumar Rawat
Coordination Catalysis and Electrochemistry

Selected Publications (from September 2022 to November 2022)

Molecule that breaks the nearly 100-year-old Hund's Rule opens path for more efficient organic LEDs.
(Y. Harabuchi, S. Maeda)
https://www.icredd.hokudai.ac.jp/research/8211

BA.4 and BA.5 subvariants of COVID show higher pathogenicity and higher resistance to natural and vaccine-induced immunity
(L. Wang, M. Tsuda, S. Tanaka)
https://www.icredd.hokudai.ac.jp/research/8217

UV-to-red light converting films accelerate plant growth
(S. Shoji, Y. Kitagawa, Y. Hasegawa)
https://www.icredd.hokudai.ac.jp/research/8301

Simplified process shines light on new catalyst opportunities
(H. Takano, H. Katsuyama, H. Hayashi, W. Kanna, Y. Harabuchi, S. Maeda, T. Mita)
https://www.icredd.hokudai.ac.jp/research/8433

Method for automated reaction path search of photoredox reactions enables determination of the Knowles hydroamination mechanism
(Y. Harabuchi, H. Hayashi, H. Takano, T. Mita, S. Maeda)
https://www.icredd.hokudai.ac.jp/research/8463

Outreach

- Monthly News Postcard
- The CATALYST 9th Issue
- "A Message to the Next Generation" Special Lecture by Professor Benjamin List (2021 Nobel Laureate in Chemistry)
- Joint Symposium with Hokkaido University Department of Pharmaceutical Science
- Visit by delegation from the National Institute of Science and Technology Policy
- Visit by delegation from the Embassy of France in Japan

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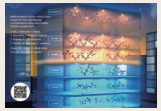


Monthly News Postcard

The CATALYST 9th issue

Awards

- Conferment of title of University Professor
  (Benjamin List)
- Hokkaido Medical Association Award and Hokkaido Governor's Award 2022
  (Shinya Tanaka)

Researcher Profile

vol.10

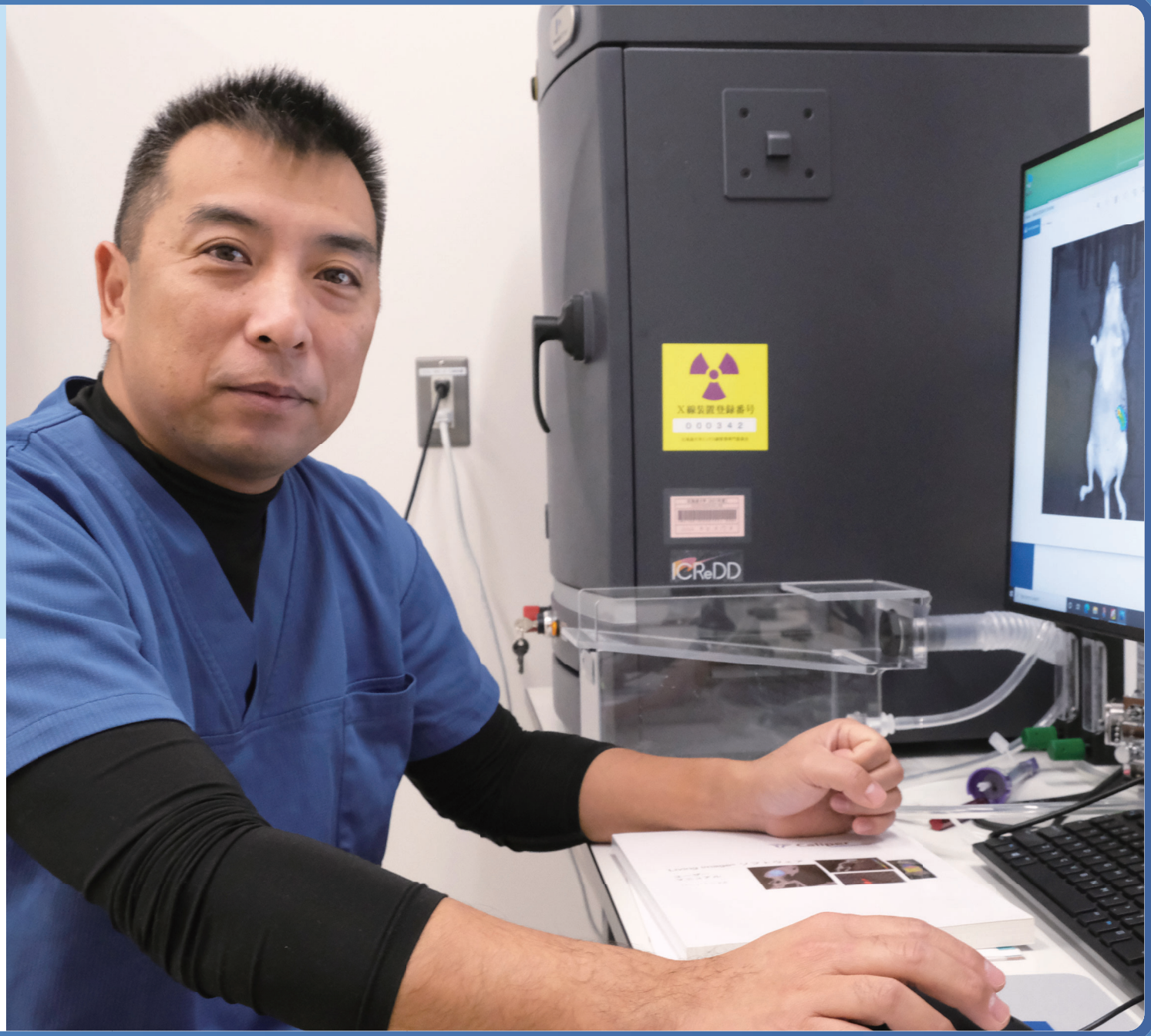
Lei Wang

Assistant Professor Lei Wang utilizes a variety of hydrogel materials to mimic cancer microenvironments and induces cancer stem cells of various types of cancer for study. He uses these stems cells to work on the development of treatments and medicines that specifically target cancer stem cells.

Representative Papers:
Nature, 2022, 603, 700-705
J Biomed Mater Res A, 2022, 110, 747-760
Nat Biomed Eng. 2021, 5, 914-925

Short Biography

Specially Appointed Assistant Professor at ICReDD and Hokkaido University (HU) Faculty of Medicine. After receiving his PhD in 2010 from the HU Faculty of Medicine, he performed research there as a JSPS Research Fellow. In April 2012, he began work as a Specially Appointed Assistant Professor of the Exploratory Pathology Course at the HU Faculty of Medicine and in April 2018 became an Assistant Professor in the Department of Cancer Pathology within the HU Faculty of Medicine. From March 2021, he began his current position.



About ICReDD

The development of new chemical reactions is intrinsically entangled with the prosperity of humanity and the preservation of the environment. A recent example of such transformative chemical reactions with profound impact is cross-coupling reactions, the discovery of which was awarded with the 2010 Nobel Prize in Chemistry. These reactions are used to produce approximately 20% of all medicinal reagents, and almost all liquid crystalline and organic electroluminescent materials. The industrial use of these chemical reactions contributes ~60 trillion yen per annum to the global economy. The development of new chemical reactions thus significantly affects the evolution of society.

ICReDD is the Institute for Chemical Reaction Design and Discovery, a WPI center at Hokkaido University where researchers from different disciplines combine their strengths to take full control over chemical reactions. The institute was born out of the realization that the purposeful design of chemical reactions requires cross-sectional collaborations at every step. Working on such a fundamental natural process, quantum-chemical computations, information technology, modern experimental techniques, and the development of advanced materials can no longer be separate fields if we want to achieve significant breakthroughs. Rather, they have to become part of a diverse toolbox for truly integrated research.

The Catalyst is inspired by catalysts used in chemistry to bring molecules together, to reduce reaction barriers, and to activate molecules—to make reactions happen faster. In this spirit, this poster series should enable its readers to make the connection between chemical reactions and the wellbeing of our society, and to look at the world in a new way, seeing how chemical reactions and chemistry shape the world around them. And if we can take this opportunity to introduce ourselves, too, this may also catalyze new friendships and opportunities. #ReactWithUs

React With Us!

To stay up to date
with what's happening at ICReDD,
follow us on our social media channels:

@ICReDDconnect

Congratulations to ICReDD Principal Investigator and Hokkaido University Faculty of Medicine Professor Shinya Tanaka for being awarded the Hokkaido Medical Association Award and Hokkaido Governor's Award 2022! Prof. Tanaka (right) is pictured with Governor of Hokkaido Naomichi Suzuki.

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