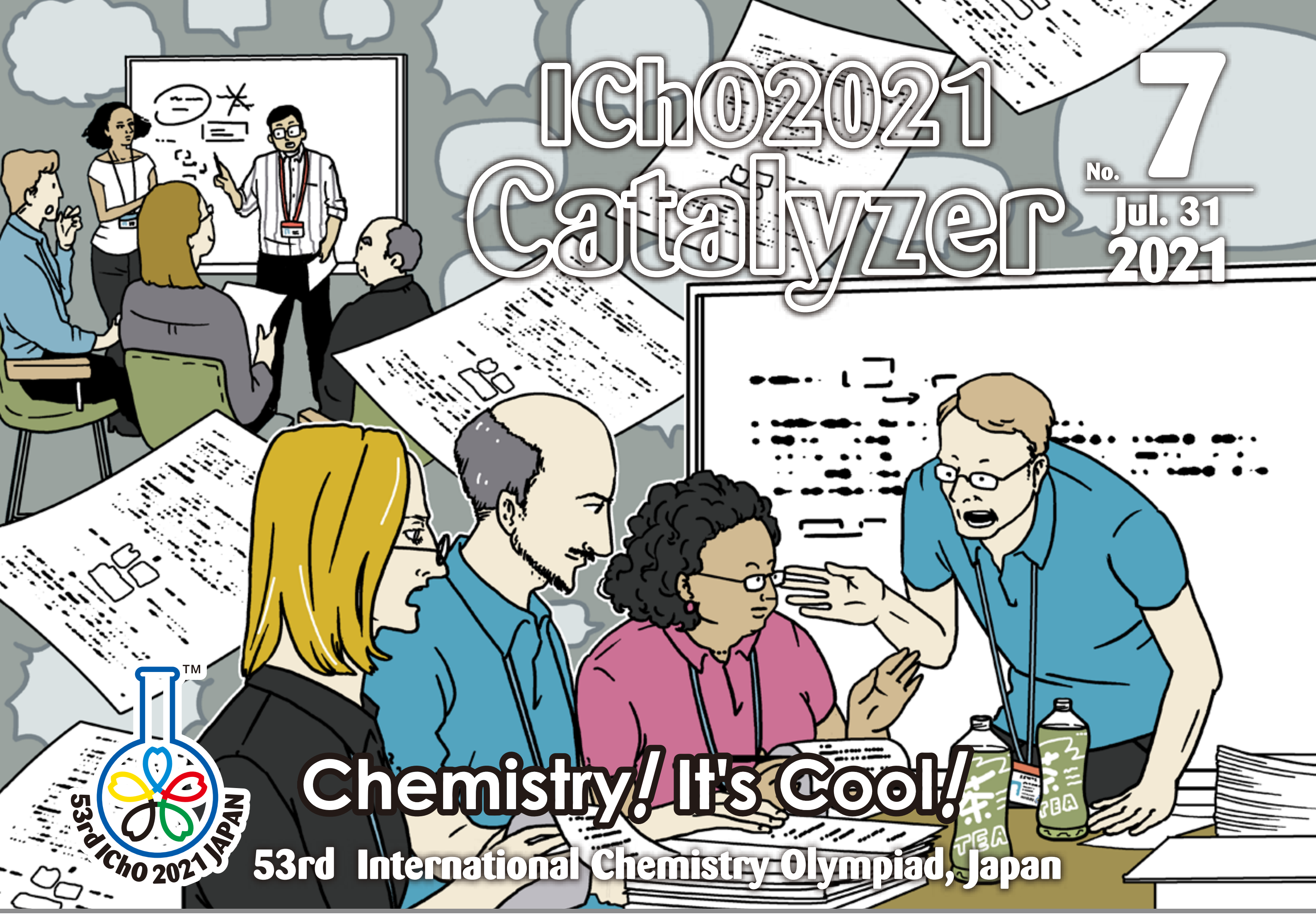
# IChO2021 Catalyzer

No. 7
Jul. 31 2021




Cover illustration : Grading & Arbitration

Nobel Prize Research from Japan 07

# Green Fluorescent Protein

## Osamu Shimomura

Osamu Shimomura became interested in how the bioluminescent jellyfish *Aequorea victoria* glows in the dark, and went to Friday Harbor in the U.S. state of Washington with his family every summer to solve the mystery. They collected as many as 850,000 jellyfish and investigated the nature of the substance that made them glow. He isolated the substance in question, a kind of protein called green fluorescent protein (GFP). This protein undergoes a structural transformation to become a chromophore and emits fluorescence; specifically, via cyclization and oxidation of three amino acid residues, Ser65-Tyr66-Gly67. In the jellyfish body, the calcium-responsive protein aequorin absorbs light, and then emits blue fluorescence; in turn, GFP absorbs this blue light and glows green. However, GFP can also glow on its own, so Martin Chalfie and Roger Y. Tsien used genetic engineering to develop a method of attaching GFP to other proteins and making them glow. This tool enabled the analysis of various biological phenomena in cells to reveal the subcellular localization of proteins (GFP tags), and advanced research in a wide range of fields including cell and molecular biology, developmental biology, and medicine. The 2008 Nobel Prize in Chemistry was awarded to Osamu Shimomura, Martin Chalfie, and Roger Y. Tsien for "the discovery and development of the green fluorescent protein, GFP." Today, artificial fluorescent proteins that glow in a variety of colors are being produced.

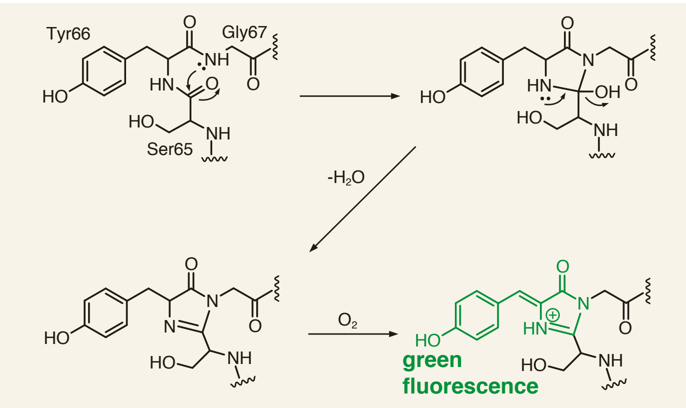



Photo by Nagasaki University

**Dr. Osamu Shimomura (1928–2018)**

ICHO2021 Problem Q6

## Coordination polymers: found in minerals - promising storage materials for small molecules

An enormous variety of minerals exist in nature. Most of these are inorganic compounds, while some are known as organic minerals. For example, there are currently 23 known organic minerals that contain carboxylic acids such as formic acid, oxalic acid, or acetic acid. In oxalate minerals, the two carboxylate groups ($-COO^-$) of oxalic acid are linked to various metal ions by coordination bonds to form network crystal structures (Fig. 1). Although not an organic mineral, Prussian blue, which was accidentally discovered in Germany in the early 17th century and has ever since been valued as a blue dye, adopts a crystal structure in which iron cations and cyanide anions ($CN^-$) are linked by coordination bonds (Fig. 2). Prussian blue was also used in Katsushika Hokusai's famous woodblock print "*Under the Wave off Kanagawa*" (ca. 1831; Fig. 2). Such crystalline network structures, which arise from coordination bonds between metal ions and bridging ligands, are called 'coordination polymers'.

In the middle of the 19th century, in parallel to the development of X-ray crystallography, chemists began to synthesize new coordination polymers using organic ligands that do not necessarily exist in nature. The crystal structure of an organic ligand-bridged coordination polymer that consists of adiponitrile and copper ions was firstly reported by Yoshihiko Saito et al. in 1959 (Fig. 3; left). We can only wonder how amazed these scientists must have been at the time by the complexity of the "reticular" networks of these crystal structures. After that, various other crystal structures were reported and chemists started to think about useful applications for these characteristic crystal structures.

In 1997, Susumu Kitagawa of Kyoto University discovered that the nanometer-sized small pores formed inside coordination polymers that consist of cobalt ions and bipyridine could be used as a gas-storage material (Fig. 3; right). Such "porous coordination polymers" can store large amounts of gas inside the crystals and are now being put to practical use. The applications of these materials can be expected to continue to expand in the future and probable applications include storing $H_2$ to power fuel cells, capturing $CO_2$ to ameliorate global warming, and storing $H_2O$ to water the desert.

Fig. 1. (left) Photo of a macroscopic crystal of calcium oxalate and (right) its microscopic crystal structure determined by single-crystal X-ray diffraction analysis.

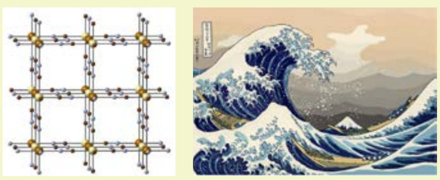


Fig. 2. (left) Microscopic crystal structure of Prussian blue. (right) Katsushika Hokusai's "*Under the Wave off Kanagawa*".

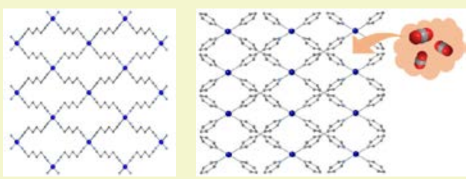


Fig. 3. (left) Crystal structure of a coordination polymer that consists of copper ions and adiponitrile ligands. (right) A representative porous coordination polymer that is able to store gas molecules inside its small pores.

# VR TOUR SPring-8






# Kumano Kodo

Kansai Scenes 7

*Kumano Kodo* (literally means the old ways of Kumano) is a general term for the network of pilgrimage routes that lead to the three main Kumano Shrines: *Kumano Hayatama Taisha*, *Kumano Hongu Taisha*, and *Kumano Nachi Taisha*. Located in the southwestern part of the Kii Peninsula and starting eastwards from the city of Tanabe, the network spans Mie, Nara, Wakayama, and Osaka Prefectures. It was registered as a UNESCO World Cultural Heritage Site in 2004. Kumano is regarded by the Japanese people as a sacred place for mountain worship, a practice that originates from the worship of nature in which the gods dwell in rivers, waterfalls, and huge rocks. The *Kumano Kodo* is also mentioned in the ancient history book *Nihon Shoki*, written during the Nara period (710 to 794). People walking the routes today can see the same scenery as the pilgrims who visited Kumano to gain enlightenment in the old days, including such joys of nature as the large cypress trees that are more than 800 years old, and the smooth cobblestones on the paths.

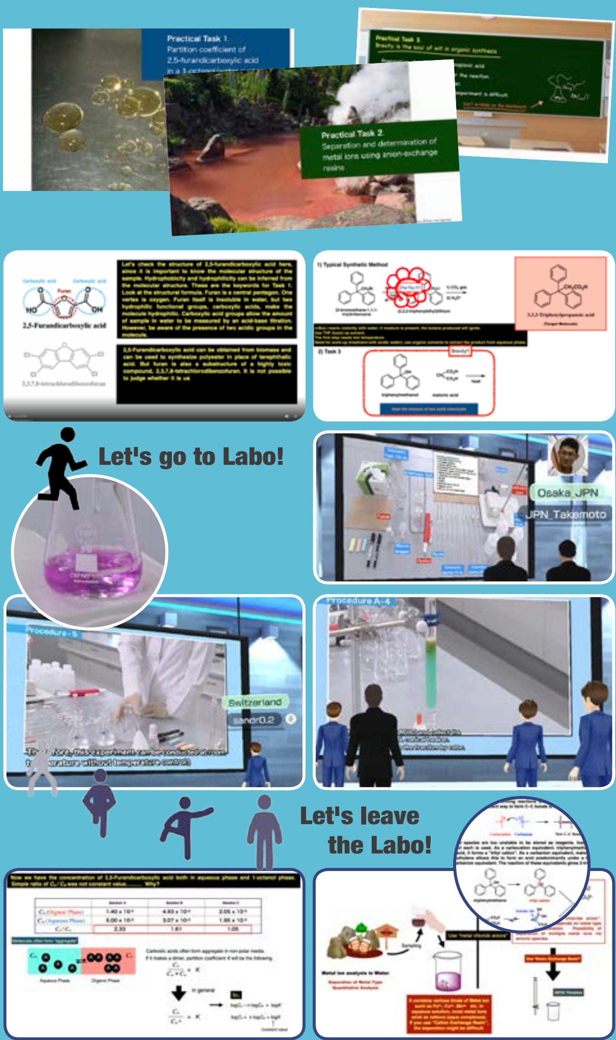
# Other Local Dialects in the Kansai Region

In Catalyzer No. 0, we presented a list of useful Japanese phrases, and in Catalyzer No. 1, a comparison of everyday phrases in Standard Japanese and *Kansai-ben*, a dialect spoken in the Kansai region. There are several sub-regional dialects too, each with distinctive expressions, spoken in various parts of Kansai. When a Kansai person speaks, we can often tell which part in the region they come from. The English phrase "Very Good!", for example, is Totemo Iine! in standard Japanese, *Meccha Eeyan!* in Osaka; *Erai Yoroshiyan!* in Kyoto; *Erai Eegai!* in Hyogo; *Erai Eenaa!* in Shiga; *Gottsu Eena!* in Nara; and *Yanikoo Eewaisho!* in Wakayama. Look at some of the other differences in the table below.


| English | Standard Japanese | Osaka | Hyogo | Kyoto | Shiga | Nara | Wakayama |
|---|---|---|---|---|---|---|---|
| I agree. | Sou-dane. | Seya-na. | Seya-na. | Soya-na. | Hoya-na. | Seya-na. | Soya-ne. |
| No, you can't! | Dame-dayo! | Akan-de! | Akkai-ya! | Akan-shi! | Akasen! | Akan-de! | Akanaa! |
| Lots | Takusan | Gyousan | Jousan | Tanto | Yokke | Youke | Yousan |
| No problem. | Kamaimasen. | Kamahen. | Becchonai. | Dannai. | Dannai. | Kamahin. | Kitsukainai. |
| I can't. | Dekinai. | Dekehen. | Dekihin. | Yousimahen. | Dekihin. | Dekiyan. | Yousen. |
| Bottom | Saikai | Dobe | Getta | Bebetako | Gebeccha | Bebeta | Betta |
| Do not come | Konai | Kēhen | Kōhen | Kīhin | Kiyahen | Kyahen | Kēhen |

* These words are just some examples.

# Practical Examination




## A message from the student narrators of the practical examination video

We are fortunate to be given this opportunity to help the International Chemistry Olympics in this way. We are students who like both English and chemistry. We believed challenging ourselves to try new things would give us new perspectives, and we thought taking this opportunity would give us new discoveries and experiences. Being able to participate in this event with friends was another incentive as well.

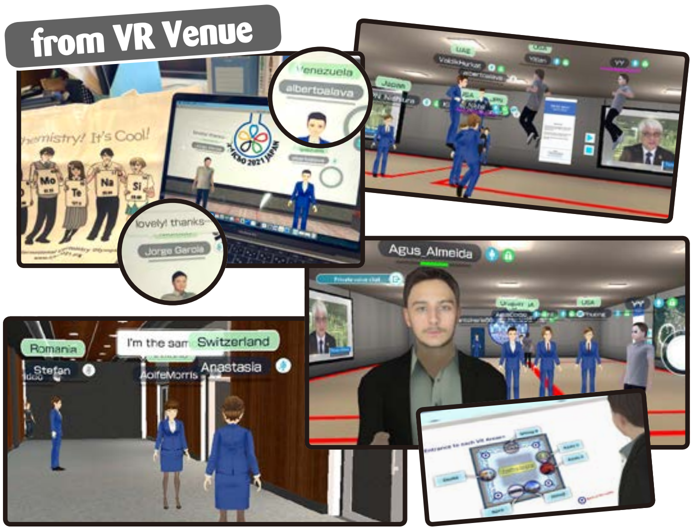
Although it wasn't an easy task to pronounce the long names of chemical substances or highly technical chemistry terms properly, we enjoyed dealing with it.

Most of us hope to work in a science field such as medicine, biology, or space aeronautics. Some of us would like to deal with environmental problems in the future as well. We are sure we need to use English to work in this field with the global scene. We will make good use of this experience that has given us a chance to get to know what practical English is like. Thank you.

Kyoto Prefectural Sagano Senior High School

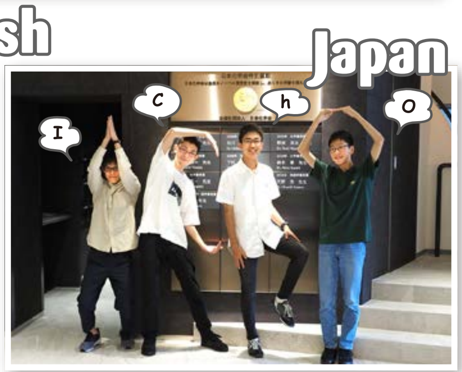
# PHOTO SELECTION

## from VR Venue



## during IChO2021






### Short short from Editors

# The book to take you to the world of Chemistry

Do you remember what made you fell in love with Chemistry? In Japan, there are illustrated books that introduce chemistry to children and fascinates chemists at the same time. Kako is also a scientist himself and has written many Chemistry stories for children. One of them is "Nakayoshi Ijiwaru Genso no Gakkou." It means "School of ELEMENTS with good friends and mean friends." This book introduces the process of creating the periodic table by comparing the properties of elements to the personalities of human classmates.

Little Daruma series

# Today's schedule Jul. 31

**Student**

- **Activity** Video: History and Culture of Nara

**Mentor**

- **Arbitration** (America (west) ››› Asia ››› Europe ››› America (east))
  J 09:00 C 09:00 E 20:00 (Jul. 30)
- **Activity** Video: History and Culture of Nara

J : JST = UTC + 9 C : CET = UTC + 2 (summer time) E : EST = UTC - 4 (summer time)

# Early Bird Communication

## China

## Uruguay


We could not take a group photo since the COVID-19 situation in Uruguay would not allow it. Even when the situation is getting better and the students will perform the test at the same classroom, asking them to travel to the main city, Montevideo, just to take a photo, could not be the best choice.

## Sri Lanka

Sri Lankan team meeting with mentors

# Element #6 Japanese mineral resources Indium

**Basic Information**

Origin of the name: Latin word *indicum* (indigo)
Discovered by: H. T. Richter and F. Reich (Germany) [1863]
Global production: 900 tons
Major producers: China, South Korea, Japan

Indium is an essential material for liquid crystal displays (LCDs), which are widely used for flat-screen TVs and notebook computers. Indium tin oxide (ITO) is used for electrodes in LCD panels because it is both transparent and conductive. Most of the world's indium is now produced in China, but in the past, the Toyoha Mine in Sapporo on the Japanese island of Hokkaido was the world's largest producing mine of indium. However, the mine was closed in 2006 because of its low profitability and the depletion of the resource.

© Crystal Museum

## ELEMENT QUIZ Q7

A shape memory alloys is made by mixing two metals in a 1:1 ratio. Which of the following is the correct combination of two metals?

1 (Zn, Cu) 2 (Al, Cu)
3 (Ni, Ti) 4 (Ni, Fe)

## Answer for Q6

① 2 Palladium
Osmium was used in the oxidation by Dr. Sharpless, and ruthenium and rhodium were used in the hydrogenation by Dr. Noyori and Dr. Knowles. Palladium was not used in either of these reactions.

② 2 Chlorine
Vancomycin is an antibiotic that belongs to the family of glycopeptides, which contain chlorine.

Chemistry! It's Cool!

IChO2021 Catalyzer No. 7

Official Website
https://www.icho2021.org/
icho2021

**Jul. 31**
**1800**
**Birthday**
Friedrich Wöhler, Father of Organic Chemistry

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