IChO2021 Catalyzzer

No. 3
Jul. 27 2021

Chemistry! It's Cool!

53rd International Chemistry Olympiad, Japan

Cover illustration : Practical Exam

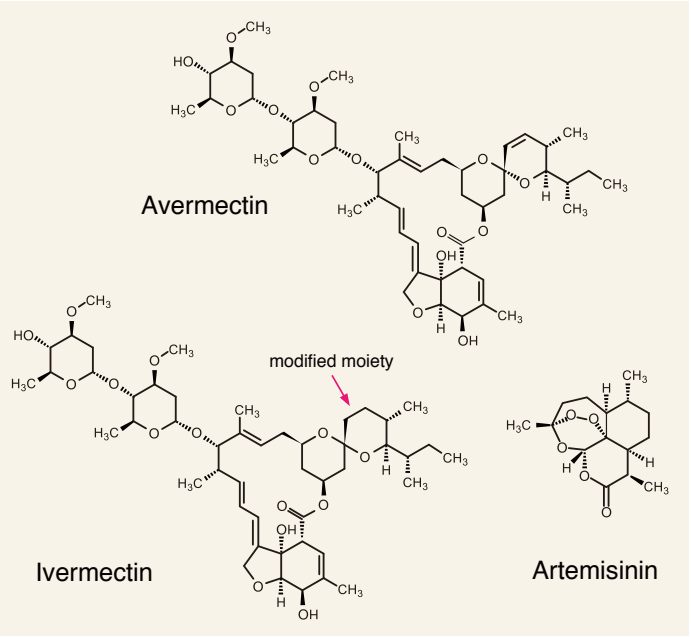
Nobel Prize Research from Japan 03

Natural Product Chemistry that Leads to Medicines ..... Satoshi Ōmura

Nature is host to countless compounds that can be used as medicines and yet remain undiscovered by humans. Satoshi Ōmura has isolated and determined the structures of many useful natural organic compounds produced by microorganisms in soil, many of which have been put to practical use. One such compound is avermectin, a substance produced by the bacterium Actinomycetes that was isolated from the soil of a golf course in Shizuoka Prefecture. Ōmura's research in collaboration with William C. Campbell showed it has strong activity as an anthelmintic, a treatment for parasitic diseases. Subsequently, a structurally modified version of this compound, ivermectin, was developed as an anthelmintic for livestock. Furthermore, ivermectin has been shown to be effective against onchocerciasis, a disease which may lead to loss of sight, caused by filarial nematodes transmitted by mosquitoes in Africa and other tropical regions, and is now widely used as an anthelmintic. The 2015 Nobel Prize in Physiology or Medicine was awarded to Satoshi Ōmura, William C. Campbell, and Youyou Tu for "their discoveries concerning a novel therapy against infections caused by roundworm parasites." Youyou Tu also discovered artemisinin, which is the basis of a group of drugs used to treat malaria.

Photo by Satoshi Ōmura

Dr. Satoshi Ōmura
(1935–)



Chemistry! It's Japan!

Studies on Urushiol

Rikō Majima

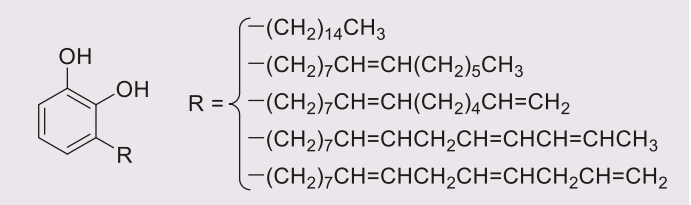
Urushi lacquerware is one of Japan's well-known traditional crafts. Urushi, which has a beautiful black luster, is a natural resin obtained from the sap of the lacquer tree and consists mainly of a catechol derivative called urushiol. The structure of urushiol was determined by Rikō Majima, and the research process became the starting point for the development of organic chemistry in Japan. When Majima started his research around 1900, chemistry in Japan was still in its infancy, and there was a serious shortage of skilled chemists to guide experimental research. Majima studied organic chemistry almost entirely on his own and became acutely aware of the gap in ability between Japan and the Western countries; at the same time he came to the conclusion that if he could conduct research on lacquer, which is native to the Orient, he would be able to develop his own original research without being outdone by researchers from other countries.

Urushiol: originally a light-yellow resin, it turned blackish after 100 years

After studying in Germany, Majima began to determine the structure of urushiol in earnest at Tohoku Imperial University. With the latest European methods such as advanced vacuum distillation, ozonolysis, and catalytic reduction, he tried to determine the structure of urushiol. After several steps, he finally determined that urushiol exists as a mixture of the compounds shown in the figure. Majima began to determine the structures of many other natural products found only in the Orient such as indole and aconite alkaloids, in addition to urushiol, and trained many of his students as organic chemists. His students eventually established organic chemistry laboratories at universities around the country and laid the foundation for modern organic chemistry in Japan.

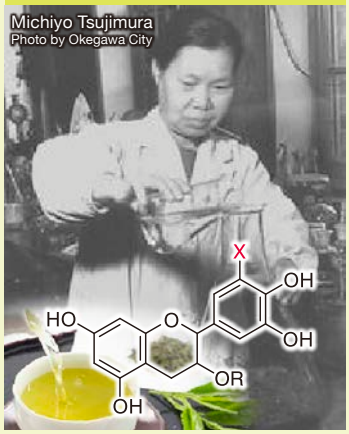
Dr. Rikō Majima
(1874–1962)

Figure: Structure of Urushiol



Tale related to Preparatory Problem

Theoretical Task 23



Green tea, a part of Japanese culture

What would you drink when you are thirsty? Water, juice, soda, or tea? Tea, particularly green tea, is very popular in Japan among other countries. Tea is classified into three major types: green tea (unfermented), black tea (fermented), and the rest such as oolong tea (semi-fermented). As introduced in preparatory problem 23, green-tea culture in Japan started in the early 1200s. The most famous form is the traditional 'tea ceremony', during which *matcha* is prepared and drunk. In addition, green tea is largely consumed as a regular beverage on a daily basis and has been associated with a variety of health benefits. Tea leaves contain several catechins such as epicatechin, epigallocatechin, epicatechin gallate, and epigallocatechin gallate, which are responsible for the characteristic taste (*shibumi*) of green tea. Japan also made significant contributions to green-tea chemistry. For instance, Michiyo Tsujimura, the first Japanese female doctor of agriculture, isolated catechin from green tea for the first time in 1929. Green tea also contains caffeine, which has a bitter taste (nigami), and theanine, which adds a savory (*umami*) flavor. While green tea is produced by suppressing the oxidation of tea leaves, black tea is produced by fermentation of the tea leaves, promoting oxidative dimerization of catechins to give theaflavins, which have a benzotropolone core structure and are characteristic pigments of black tea.

Himeji Castle

Kansai Scenes 3

Himeji Castle (or *Himeji-jo* in Japanese) is an excellent surviving example of a modern Japanese castle. Described as a *Hirayama Jo* in Japanese, meaning a hilltop castle, it is located in the north of present-day Himeji. It is one of the original 12 castle towers (*tenshu*) which were built in the Edo period (1603 to 1868), and is designated as one of the 100 Great Castles in Japan. Himeji Castle was designated as a National Treasure in 1951, and a UNESCO World Heritage Site (Cultural) in 1993; so becoming Japan's first cultural World Heritage Site. The present castle tower was built in 1609 by Ikeda Terumasa, a warlord who married Tokuhime, the second daughter of Tokugawa Ieyasu, the founder of the Edo bakufu (shogunate). The castle is also known fondly as *Shirasagi-jo* (White Egret Castle), as its elegant figure resembles an egret with its wings outstretched. The castle is characterized by brilliant white stucco exterior walls and features a huge *tenshu* (main tower) with five layered roofs and seven stories (one underground and six above ground), which is interconnected with smaller towers (the East, the West, and the Northwest) by *watari-yagura* roofed passages. The *tenshu* was restored to its current beautiful condition after five-and-a-half years of restoration work that stretched from 2009 to 2015.

Early Bird Communication

Saudi Arabia

Mexico

Iceland

Poland

Today's schedule Jul. 27

Student

- VR Closed

Mentor

- Translation ⋙ submission J 09:00 C 09:00 E 20:00 (Jul. 26)

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

CHEER UP! Participants!

Not just IChO, but even the months leading up to it, are like a dream come true. Not only are you stimulated intellectually but you get to meet remarkable people at truly amazing places in the world. The knowledge, the drive, and encouragement you take away are unparalleled and stay with you for life.

from **Maaha Ayub** (Pakistan)

IChO 49th in Nakhon Pathom, Thailand
Bronze Medal

Answer for Q2

4 (Cr, Ni)

Stainless steel was developed to strengthen iron's rust resistance, and a number of researchers contributed to its improvement during the 19th and 20th centuries. The metals added to iron are typically chromium and nickel, which form a passive layer on the surface, preventing rust caused by air or water. Today, stainless steel is widely used, for example, in cooking utensils, vehicles, and machine parts.

Element #2 Japanese mineral resources Iodine

Iodine, with atomic number 53 and an atomic weight of 126.9, is represented by the symbol I. It belongs to Group 17, the halogen group, together with elements such as bromine, chlorine, and fluorine. Although Japan is usually characterized as a country poor in natural resources, it is placed second in the world after Chile in the production of iodine. Eighty percent of iodine is produced from sodium iodide dissolved in ancient seawater in natural gas wells in Chiba Prefecture. Japan even exports iodine to other countries around the world.

Iodine is a dark purple solid at room temperature and ^{127}I is its only stable isotope, with a natural abundance of almost 100%. The isotope ^{131}I is a fission product of uranium and other radioactive elements, and it has a half-life of around 8 days transforming ^{131}Xe with beta and gamma emissions. Therefore, stable ^{127}I can be used to protect people from health hazards caused by a nuclear accident. Iodine as an element has a variety of uses in our lives such as X-ray contrast agents, bactericidal disinfectants, and polarizers used in screens of LCD TVs, PCs, and smartphones.

Since iodine is a component of thyroid hormones, a shortage of iodine in the body may lead to the condition known as hypothyroidism. However, such shortages are rare in Japanese because the country is surrounded by sea and sufficient iodine can be obtained from a diet rich in seaweed and a variety of seafoods. By contrast, many people living in other parts of the world are exposed to the risk of iodine deficiency. Thus, potassium iodide or potassium iodate is added to the table salt to prevent it.

ELEMENT QUIZ Q3

Which element is produced as a result of nuclear fission of uranium-235, apart from krypton?

1 Ba **2** Ra
3 Po **4** Pu

Chemistry! It's Cool!

53rd IChO 2021 JAPAN™

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

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Jul. 27
1921
Succeeded!
Insulin extraction

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