aim HIGH

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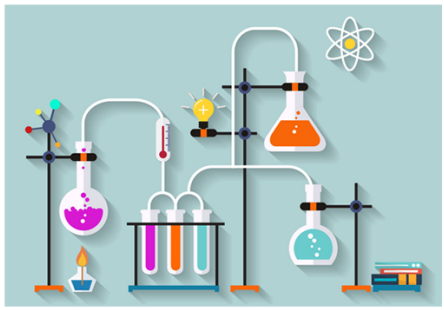
WIĘCEJ NIŻ SZKOŁA

Dawid Mazur

SCIENTIFIC LOOK AT LIFE HACKS

[DawidMazur 3a] Everyone knows some life hacks for example: opening a bottle of wine without corkscrew, fitting in more clothes in wardrobe or maybe organizing your cables on the desk. There are many of them but have you ever thought: "How do they work ?" Probably not, but now you have a chance to do so.

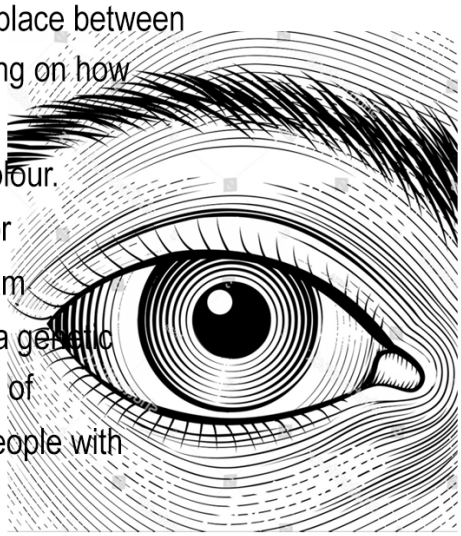
First life hack is good for shocking your friends at the party. You just need to put some drink to a freezer and cool it down to temperature a little bit below 0 degrees Celsius and after you hit the bottle, liquid inside it will instantly freeze. How does it work? When you hit the bottle you disturb the molecules creating nucleation sites that allow ice crystals to form and those crystals are spreading all over the liquid, making it solid. Enjoy your frozen drink!



The next one is making ice with a deodorant. It's very simple. You need to put some water in a plastic bag and spray it with deodorant. After a short time it will freeze because of the injection. In process of injection liquid transforms into gas because of the lowering pressure. That process requires some amount of energy. Transformation proceeds really violently and system has no time to take energy from surrounding and it must use its own internal energy which is connected with lowering temperature of the substance. That's why the gas coming from a can is cold. As you can see, science makes our life easier and it is not a just a bunch of patterns and theories but it surrounds us. It's everywhere!

Why aren't the blue eyes blue?

[GabrysiaTomaszewska 3a] The fact that our eyes are blue or green is only an optical illusion. There is no dye of such colours in the eyeball. The visual system in every person colours exactly the same pigment - dark brown pigment classified as a melanin. How, then, is there a division into supposed colours? This process takes place between two layers of the iris: anterior stroma and pigmented epithelium. Depending on how much melatonin our eyes contain and how it is distributed on the eyeball, the iris reflects light differently, which gives the impression of a specific colour. What is intresting, originally every person had brown eyes, says Professor Hans Eiberg from the University of Copenhagen. He and his research team discovered that several thousand years ago this state of affairs changed a genetic mutation affecting the OCA2 gene, which codes the protein P. In the case of blue-eyed melatonin has changed to the same extent. It follows that all people with blue eyes have the same ancestor.



Currently, the most common eye colour among the representatives of the white race is blue - as many as 52% of people have it. Brown-eyed are 27%, and green-eyed are 21%

THE GAME MUSIC FESTIVAL

On 19h October I had an opportunity to participate in one of a few concerts which were a part of The Game Music Festival. The event was full of excellent music, professional performance, talented musicians and celebrities. It's a pity it lasted only a few days and ended a week ago, so you'll have to wait whole year for the next one.

First time the event took place in 2016 in Łódź. Then the following year it was held in Wrocław and you could listen to concerts in The National Forum of Music. The next editions grew up to be even festivals – not just minor events – and were organised in the same place, which was… Wrocław. Last year, in 2018, you could hear amazing concerts inspired by computer games like "Heroes of Magic and Might" or well known classics like "World of Warcraft" or "Diablo". Moreover, you were able to see or even personally meet some of game music composers or other people connected with this branch.

This year there were three concerts: "The Symphony of the Desert", "The Symphony of the Colossus" and "The Symphony of the Shadows". Each of the titles was connected with games them, for example "The Symphony of Desert" was connected with game titles, such as "ICO", "Shadow of the Colossus" and "The Last Guardian".

In this article I will focus on "The Symphony of Shadows" – a concert which I personally heard. It contained music from well-known games: "Assassins Creed II" and "Hitman" – in which one impersonates stealthy assassins. Music in both titles was composed by Jasper Kyd – a worldwide known game music composer. Not only you could listen to his own compositions, but you were able to see him during the concert, entering the stage. Another famous person which appeared during the event was David Bateson – a voice actor known better as Agent 47. It was the finale of Game Music Festival and a great way of celebrating the 10th anniversary of "Assassins Creed II" release and 20th anniversary of the firs "Hitman" title. I must say that this concert was an unforgettable experience for me. Listening to game music performed live on stage by 120 musicians is much different than listening to it on your headphones at home.

In general, I really recommend you to participate in this festival next year. If you happen to listen to one of the concerts, you won't be disappointed. There is one important thing to say: it's amazing how many great events happen near us and it would be great to experience the atmosphere of some of them by yourself. So don't hesitate to do it next year when Game Music Festival is on. Even if you aren't a passionate of computer games, you'll enjoy it, trust me. (Dawid Mazur)

The Barycz Valley Landscape Park is placed in the north part of Lower Silesia and the south part of Greater Poland.

Created in 1996 its about 870 square kilometers big and has close to 300 ponds near Żmigród and Milicz. The Landscape Park in itself is a fantastic place to visit if you love outdoor activities and being close to history and nature.

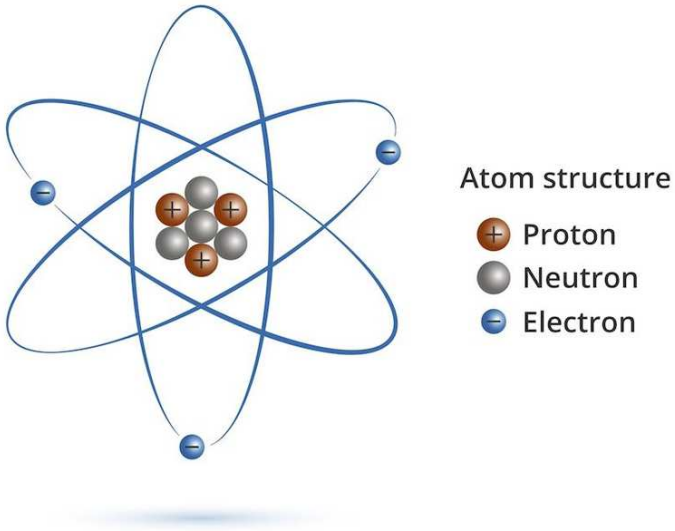
There are multiple historical monuments like the Church of Saint Andrzej Bobola in Milicz , Palace in Żmigród or Palace in Antonin, which are only a few of many.

It is also known for its big amount of cycling paths on which you can ride through the forests, fields and causeways while enjoying the sight of rare birds, animals and plants.

It is a popular activity to sail in kayaks during summer on special kayak routes, or ride on a horse on the horses routes. In Potaszania during summer takes place a horse festival where you can see multiple horse riding competitions.

An important part in the regional culture plays famous carp which is bred in multiple ponds. From September to November there's even an event "Carp Days" which includes concerts like of Beata and Bajm who were this year guests in Milicz. During this time you can also enjoy special fish dinners in multiple restaurants. (Marysia Mikołajczak)

WE ARE MADE OF NOTHING



Everyone knows that all items surrounding us are made of atoms. Even ancient thinker and traveler Democritus from Abdera knew that there is an end to materiality division and it ends on the smallest, indivisible particles. Later scientists discovered that those particles are atoms and they have atomic nucleus made of protons and neutrons - around it circulate electrons. But what's the rest of the atom made of? The answer is simple - nothing. Actually we can say that our body and other things are mostly made of nothing. You may be astonished right now but just imagine something. If protons and neutrons had diameter of 1cm, electrons would have a thickness of a hair or even smaller. The best part is that this size of the atom would be bigger than the length of 30 football pitches, and more than 99,99 % of it would be just filled with... nothing. But don't worry! In a single drop of water there are 10 thousand billion billions of hydrogen and oxygen atoms, so at least there are a few electrons and atomic nucleuses which will recompense this nothingness.

The next question may be "How can we get energy in nuclear reactors if almost the whole atom is built of nothing?" It's simple to imagine if we some numbers. In the reaction of the atomic nucleus splitting, the energy we get from one nucleus splitting is about 200 MeV, which equals to something around 3,2· 10-11J. To imagine how much energy it is, you need to multiply it by the number of atoms in a sample. As I said earlier, one drop of water has a lot of them, so just think how many of them are in one kilogram of uranium. Surely a lot!

As you can see, even if we are made mostly of nothing (cause the sum of masses of electrons in all of our body cells equals to 20 grams), this "nothing" has a lot of energy and without it there wouldn't be anything.

(Dawid Mazur)

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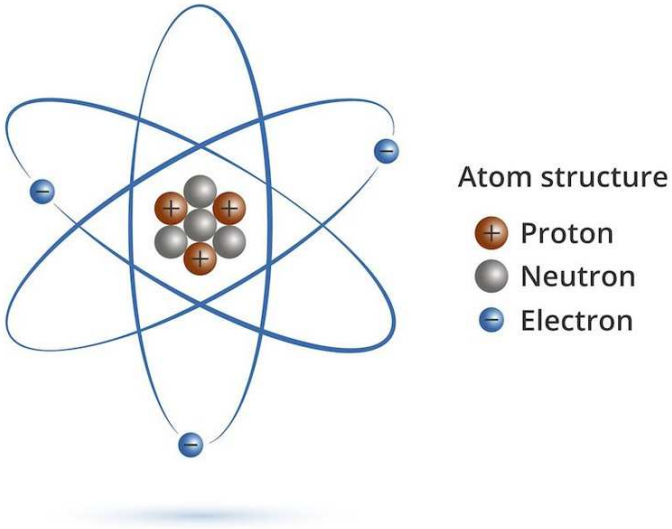

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(Dawid Mazur)

BETELGEUSE - A STAR WHICH WILL DISAPPEAR

Betelgeuse is a red supergiant star located in Orion constellation. It's much bigger than the Sun and if it replaced our star, it would reach Jupiter's orbit (its diameter is approximately 10 astronomical units, which corresponds to about 1,5 billion kilometers). Thanks to Hershels telescope observations we know that Betelgeuse is dying and its life will end with a massive explosion - supernova. Many people ask: When will it happen ? The answer is ... we don't know.

During its life star uses hydrogen (fuel) to carry out nuclear fusion, creating helium and heavier elements. When it runs out of fuel, changes occur in its core. Thanks to its own mass, it starts to collapse and its external coats hit its surface with unimaginable force. Then they rebound and fly out into outer space. From the remnants of the star new stars, planets and nebulas are born. Objects sized like Betelgeuse become neutron stars or black holes afterwards.

What will be the results of such an explosion in case of Betelgeuse? Many people overestimate it and say we'll see another object as bright as the Sun in our sky. Actually, it's going to be much less brighter but still it'll be an interesting phenomenon which many people would like to see in their lifetime. It's going to look like a big and very bright star, seen during the day, almost like another moon.

Is this huge explosion going to have a big impact on our planet and people? No, we don't need to worry about our civilization. Betelgeuse is about 640 light years apart from us, so the supernova won't reach our planet. The heavier elements that Betelgeuse has created during its existence will be spread all over in the nearby space and this might be a start of a new formation. The same process might repeat itself as on Earth the primordial soup will form and in many years more complicated organisms will develop.

Lately Betelgeuses brightness has decreased and become the lowest in whole period of the observation. There're some sources that suggest it's a sign that Betelgeuse is going to explode soon. On the other hand many people are skeptical and say that its normal. For sure, Betelgeuse is changing its brightness every 420 day (+/- 15 days). One reason for this are solar winds which are just particles thrown out into space. Dust thrown during this process obscure the star and effect its brightness. Another reason is shaking of balance between gravity forces pulling in and the light pressure pushing out - a common process in stars. When the interior of the star releases less radiation, the star shrinks, increasing its density and temperature which creates more radiation, so the star expands out again.

Will we know that Betelgeuse is going to explode a moment before it happens? It might be possible thanks to neutrinos. During the supernova phase the star releases 99% of its energy in the form of neutrinos. They pass through almost everything but we can detect a small fraction of them in things such as 1 km-long ice cube instrument in Antarctica. Neutrinos travel faster than the light and can inform us about the supernova even a few hours before we can see it but only if the exploding object is less than 100 000 light years apart. Still we are waiting to see Betelgeuse explode but we only know that it must happen sooner or later. (Dawid Mazur)

MEDIEVAL AGES: UNUSUAL TRIALS

When we think about The Middle Ages, certain words come to our mind. Those are: fortified casteles, noble knights, deadly tournaments and (probably most often) regression times, especially in terms of science. However, we ten to skip some of the most interesting and funny aspects of those times. Every time has some odd traditions and behaviours connected with it. The Middle Ages aren't an exception, so I would like to focus on one specific custom: animal trials.

Let's travel back in time to Falaise in Normandy. This place might be known from modern history (World War II), but there's another interesting story concerning it. In the beginning of January 1386 a sow was accused of murdering a three-month-old child. After a nine-day long trial it was found guilty and executed by mutilation, hanging, dragging on the ground and finally burning down. What makes this event even "funnier" is that during the interrogation the pig had a defence lawyer, moreover, it was locked in a cell during the whole lawsuit and the death sentence was read before the execution. The local vice-count ordered to bring all of the pigs nearby to watch as the convicted die. When it comes to the owner of the pig: he wasn't held liable for his sow's actions and didn't have to repay the trial costs. The only punishment he received was watching the execution. Another interesting thing is that this event was depicted in the local church. It's said that it showed the eaten child in a cradle, the scaffold, the sow dressed in human clothes and the previously mentioned vice-count on a horse.

It's worth mentioning that it wasn't the only case of such a trial. Michel Pastoureau counted 60 cases in years 1266 – 1586 only in France. Among the suspects we can find: cattle, horses, donkeys, dogs, wild animals (such as boars and wolves), rodents and even insects. Tamed animals were often accused of hurting people and the wild ones of devastation of fields. When it came to insects and other smaller creatures, religious authorities were asked for help. For example, in 1120 the bishop of Bathelem excommunicated mice and caterpillars. In 1516 in Villenauxe bishop threatened that he would excommunicate locusts if they don't leave certain area.

After investigating this topic you might ask yourself the question: "Why would they do that?". By analysing some clues we can solve this riddle. The first thing is a fragment of the Bible, more precisely, the book of Exodus. It says: "If a bull gores a man or woman to death, the bull is to be stoned to death, and it meat must not be eaten. But the owner of the bull will not be held responsible" (Exodus 21,28). If we look at the described trial, we can see that the owner of the pig wasn't punished, just as intended in the Bible. However, the Bible doesn't describe any kind of trial leading to a public execution.

We have to go a little bit further. What was the medieval attitude to animals? Saint Thomas Aquinas said that they have a specific type of soul which makes them unable to think abstractly and know what's bad or good. So, it collidea with the concept of the animal trial (treating animals like normally thinking creatures). At last, we come to the conclusion that the purpose of it was to be an example. An example of how justice is always served, that no one can escape the punishment.

This interesting story, hopefully, proves that the Middle Ages aren't as boring as they are thought to be. Who knows what will be the future generation's opinion of our trends and culture? Maybe they will find them as strange and hilarious as we find those medieval ones. One thing is certain: history was, is and will be a field of science with some unknown stories that can really shock and give everyone a good laugh. (Dawid Mazur)

TOXINS
DANGER OR GOLD IN DISGUISE

Whenever we hear that something is toxic, immediately some connotations come to our minds. Obviously those aren't good. Mentioning potassium cyanide or arsenic gives all thrills or at least bring memories of latest crime book they have read. However, it's not as simple as that and many chemical substances are commonly used by scientists or even the whole society, despite some being quite toxic. I would like to present some of famously known death factors, but shown from a different perspective.

Let's start up with something very toxic. This substance is considered to be the most dangerous when it comes to its toxicity. Lethal dose of it is approximately 1,3-2 ng/kg, which means that consuming 2 nanograms (10-9 or 0,000 000 001 gram) per one kilogram of your body's weight is enough to kill you. It might seem now that this substance, called botulinum toxin, can't have any application at all. Shockingly in reality the variety of uses is just astonishing. The most famous one is injecting the toxin to reduce facial wrinkles. Other medical uses are connected with curing muscle spasticity, for example: caused by a stroke, spinal cord injuries. In addition to that, botulinum toxin can by a cure for chronic migraine or excessive sweating.

Another substance is potassium cyanide (or other cyanide salts). For book writers this is one of the best substance to kill your book's hero with. As for chemists it also is a very toxic substance with LD100 (lethal dose which would kill 100% of those exposed to it) 200-300 mg, but also supremely useful in many reactions (mostly organic synthesis). For example, you can produce nitriles (a group of chemicals with –C≡N group, which are used in medical gloves production) or carboxylic acid, especially using so called "von Richter reaction" (for those who are interested in its mechanism: it's a substitution reaction of aromatic nitro compounds, conducted in liquid ethanol in presence of potassium cyanide; as a product, we get carboxylic acid with carboxylic group next to removed nitro group) - nowadays rarely used due to a low yield (quantity of product you actually get compared to theoretical one) ranging from 1-50%. KCN (potassium cyanide) was also used as photographic fixer (substance stabilising image, making it invulnerable to light). The most fascinating application is probably dissolving gold. As you might know, gold is one of the least reactive metals and only acid that reacts with it is so called "aqua regia". However this metal easily reacts with cyanide salts, forming complex salt (to simplify: salt with more complicated structure) with formula $K[Au(CN)_2]$, which is very soluble in water. It's an efficient way of separating pure gold from impurities.

The last compound I would like to mention is arsenic trioxide (As_2O_3). It's a white solid, said to taste sweet, with minimal lethal dose of 1-3mg/kg. Similar to botulin toxin, it has some medical application, mainly in curing acute promyelocytic leukaemia and in stomatology to destroy tooth's pulp. In the past it was used to produce green glass and green pigment called "Paris green". Due to arsenic toxicity those applications were later abandoned. However, its compound are used in US as wood preservatives. Arsenic trioxide is a precursor to elemental arsenic, which can be alloyed with other metals to be then used in semiconductors production. Another use is producing sodium arsenite ($NaAsO_2$) - a reducing agent used in chemical reactions.

As you can see, many chemicals might look dangerous and, therefore, useless (with the exception of committing crimes), but actually they have much larger number of uses than one might expect. Nowadays we try to replace as many of toxic chemicals with the safer alternatives, e.g. mercury thermometers are displaced by ones filled with alcohol or just electronic ones. Despite this trend some of the substances have found a steady place in industry and our lives, so they most probably won't disappear that rapidly. [Dawid Mazur]

FRACTALS – THE ART OF REPETITIVENESS

Most probably you've come across the term "fractal". Many associate it with abstract images that have some hypnotic powers trapped inside more or less complicated doodles. If you are more interested in such things, you might be able to name a few most popular examples of those extraordinary pieces of graphics. However, from mathematical point of view, it's a little bit more complicated than that… Let me take you for a journey through the world of fractals with more in-depth look at them.

For starters, it's important to precisely define what fractals really are. And just at the beginning we encounter some problems. Mathematicians haven't come up with universal traits that are true for all the fractals. However, there are a few conditions which, when mostly fulfilled, allow us to call something a fractal. Here are the ones worth mentioning:

- it has nontrivial structure in any scale
- it's look is natural (which means it's fimbriate, ragged etc.)
- the structure can't be described with traditional geometry language
- it's (at least roughly) self–similar
- has got quite simple recursive definition

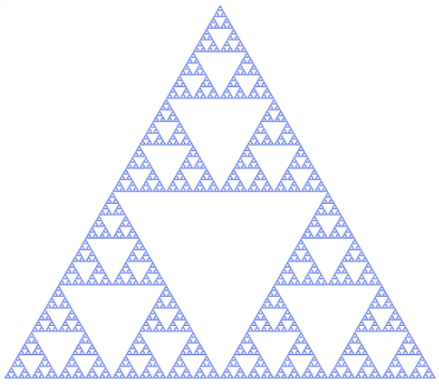
Now with the basic knowledge about fractals we can investigate their origin. Despite looking like an artificial creation of human mind, it is quite common in nature too. For ages we were able to see them on cauliflowers, properly formed ice crystals or ears of grain. The fact that someone noticed it can be proven by how traditional African architecture looks. For example, a circular village with circle-shaped houses quite closely resembles what we intuitively perceive as fractal. Nevertheless, the true beginning of fractal inquiry is attributed to Gottfried Leibniz, a German baroque philosopher and mathematician. His work on recursive self-similarity inspired next generations of superior mathematicians: Karl Weierstrass, Georg Cantor, Felix Klein and Wacław Sierpiński.

Firstly, Weierstrass came up with the definition of function with graph which was a fractal (it's worth mentioning that his work was a breakthrough in a 200-year-long silence in fractal-concerning mathematics). Then Cantor, Weierstrass's student, followed in his teacher's footsteps and created one of the most recognisable fractal called Cantor set (graphicly interpreted as a line which is divided into three with the middle part removed; to create Cantor set we would need to do the same thing with freshly formed parts ad infinitum). Another scientist, Felix Klein, came up with the idea of "self-inverse" fractals (most people associate him with Klein's bottle, an example of impossible object with only one side). For Poles, the most important of previously mentioned "superior mathematicians" is Wacław Sierpiński. Born in Warsaw in 1882, Sierpiński was the creator of Polish mathematics school and, most importantly for us, author of many fractals. To these days Sirpiński triangle is considered to be a milestone in study of fractals and his works devoted to continuum hypothesis are appreciated by many.

Now, let's look at wider range of fractals. The variety of shapes they take is just astounding. As previously mentioned, many of them are actually similar to some natural objects or simple shapes like squares or triangles. In this category we can put for example Barsley fern, which as the name implies, resembles a common plant – fern. Sierpiński triangle and carpet or Cantor set are more unnatural, however, shapes used to construct them are uncannily banal – only triangles, squares or just lines (obviously, I am not meaning to underestimate impressiveness of these pieces of fractal art). More impressive, more abstract and harder to describe are fractals such as Mandelbrot set or Julia set. The true beauty of these and many more fractals can only be uncovered when we magnify their images. In countless YouTube videos you can see how magnitude impacts the look of fractals and truly say: "Wow, how did they come up with this?!".

Overall, fractals can be considered "the artistic part of maths". This topic intrigued many scientist through centuries and the results of their curiosity can be now spectated in graphic form. The truly mind-boggling fact is that patterns like that widely occur in nature. That one thing opens a large space for further speculations, similar to those concerning the golden ratio and Fibonacci numbers. Much as it looks like a topic with insanity-driven development potential, nature can hide some secrets behind those well-organised structures. This seems far from being purely coincidental and it almost for sure is caused by some kind of benefits it gives. Still there's probably more to discover and topic of fractals might not be finished yet.

(Dawid Mazur)



Sierpiński triangle

CHEMISTRY NOBEL PRIZE

Most of Nobel Prize awardees nowadays are of a smaller general interest (at least in Poland) than those in the past, especially such renowned figures as Marie Curie-Skłodowska or Albert Einstein. The last time Polish people showed a greater interest in this matter was when Olga Tokarczuk (a Polish) received the Nobel Prize in Literature in 2019. Nevertheless, when asked, only few people would be able to name prize winners other than the most famous or those who come from their homeland. So, let me help you find out something new to broaden your horizons. Without further ado, I would like to introduce you to organocatalysis – a field of chemistry which gave Benjamin List and David W.C. MacMillan the Nobel Prize in Chemistry 2021.

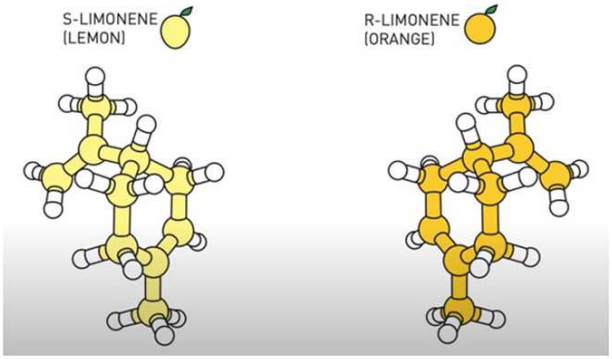
Firstly, to give you a glimpse on the topic, let's explain the term organocatalysis. Simply put, it is focused around researching potential applications of quite simple, low-mass organic molecules in reactions which need to be catalysed (sped up) in order to produce satisfying yield (a percentage of obtained product, compared to theoretical mass). The whole concept is quite simple: we use substances classified as organic to make chemical processes more efficient. But there's more to it than meets the eye. Not only does it do that, but it also has two other advantages over the old-fashioned catalysts: it makes the reaction yield only the wanted product and be less energy-consuming, thus more eco-friendly. For the sake of clarity, I will only ponder on the last two aspects in what follows.

In the organic chemistry a few molecules are as flat as a pancake. Many substances, such as proteins, can take very complicated three-dimensional structures. This fact gave rise to a chemistry field called stereochemistry. One of the most important concepts developed by it is chirality – property of molecules to be in form of two non-identical mirror images. This might seem like a fact that has no real implications observable in everyday life, because why would location of atoms in space make any difference? Shockingly, this distinction might mean for instance lethal or therapeutic effect of a drug as in case of thalidomide (one enantiomer, a mirror image, can give birth defects while other prevents morning sickness). Another example emerged during the Nobel Prize ceremony (as "a justification for rewarding the chemists), when the speaker mentioned a substance called limonene, present both in lemons and oranges, giving them their characteristic smell. Depending on which enantiomer (mirror image) is present, we can sense the smell of orange (R-limonene) or lemon (S-limonene). Now you understand why it's so crucial to produce only one enantiomer during a reaction. Not only does it save time and reagents used to separate one product from another, but it also decreases the amount of chemicals wasted on production of unwanted molecule. Hence the increasing popularity of the process, with its profitability added to not less important value of natural environment protection potential.

The aspect of better energy and molecule economy was also decisive in the Nobel Prize success. Compared to classic synthesis routes requiring oftentimes enzymes, proteins with mass of thousands of molecular mass units, using simpler chemicals, such as naturally occurring amino acid called proline (whose mass and number of constituent atoms are far smaller than of the enzyme) saves a lot of atoms which would normally be disposed of after finishing the process. It goes without saying that not all of the reactions are favoured. As an example, you can name Benjamin List's first organocatalytic rection, which gave rather poor results. In spite of this miniscule-seeming success, many continued List's research and found catalysts that are even better than enzymes.

In the article I aimed to explain briefly what organocatalysis is and why is it of such a great importance that two chemists got awarded the most prestigious title in world of science. However, why is it an almost obvious concept? Even for those interested in this field, going through the research behind this discovery is more or less of a painstaking labour. However, when Benjamin List was asked how he came up with the idea for his research, he responded that at first he thought that what he came up with was nothing new and it must have been documented in other scientific publications. To his great surprise, there was no mention of such reaction in any papers he had browsed through. This story, to my mind, truly proves that nothing should be treated as obvious and your ideas, no matter how cliché they seem, might turn out to be revolutionary.

Benjamin List (on the left) and David W.C. MacMillan (on the right) – laureates of The Nobel Prize in Chemistry 2021



Two enantiomers of limonene – only difference in their structure is atom arrangement in space, however it's enough for them to be perceived by our body as different compounds

THE SECRETS OF IMMORTALITY

With a great dose of confidence I can say that everyone has thought about this topic at least once in their life: will human ever become immortal? Many scientist are bending over backwards to make our species immune to the process of aging, with some quite interesting (but still being far from reaching the final goal) results. But what if I told you that immortality is already a thing? Selaginella lepidophylla, also known as rose of Jericho, can serve as an example of extraordinary resistance to unfavourable external factors. In fact, it is almost impossible for it to die of water shortage, unlike all the other plants we see every day. How is it possible, you might ask? Well, let me give you a brief insight into the mechanisms of this plant's immortality.

For a start: the description of the process from a more substantial point of view. Rose of Jericho, whenever it has enough water, looks like a normal plant, with green leaves resembling (at least to my mind) those of thuja. Unsurprisingly, when exposed to harsh, hot and dry conditions, it immediately starts turning brownish yellow and its leaves shrink, forming a shape resembling a ball. What's special about this is that the process can be easily reverted on condition that the plant is given enough water in time (several years). Those two forms, one being the normal one, while the other - extreme state of metabolism's inhibition called anabiosis, look like this:

Now let's take a look at the microscopic level of this process. Only when we investigate the plant on its cellular level, we can discover that the concentration of trehalose (disaccharide, made of two glucose molecules) is greatly elevated. It's caused by the fact that while being exposed to draught, rose of Jericho starts synthesising enormous amounts of this sugar, which is stored in plant's tissues. It serves as something called osmoprotectant – a substance that helps the organism survive extreme osmotic stress. You must know that in the microcosmos osmosis (the phenomenon of water flowing through membrane of cells to the inside or outside of it) plays a ginormous role.

When surrounding environment has a greater concentration of dissolved substances, a cell loses water, thus finally dies as a result of osmotic stress. And that's were trehalose comes into play, helping with equalising those concentrations by taking over the role of water, therefore preventing the described process from occurring. What's more, this disaccharide protects proteins present in the cells and prevents the destruction of cell membrane. Once the rose of Jericho gets some water, crystalline trehalose is dissolved in it and all the organism's functions are reactivated, making the plant seem to rise from the dead.
What's also interesting is what happens during the water-prosperity time, when Selaginella lepidophylla comes to life. Living in the desertico-lous places, it has to save every resources. That's why this and some other plants have developed unique process of photosynthesis – CAM photosynthesis. Plants during hot days close their stomas (small gaps on the plant's surface) preventing them from losing water, releasing produced oxygen and drawing fresh carbon dioxide. This causes occurrence of photorespiration – process where oxygen is attached to a molecule called rubisco in place of CO2. In short terms: it results in extreme loss of precious energy. What's more: plants normally incept carbon dioxide during the day time, which is impossible in hot and dry conditions, when the stomas are closed. Solution to those problems is the CAM photosynthesis. The main difference is that instead of straight-forward entering a chain of chemical reactions called Calvin's cycle, another series of reaction occurs during the night. It ultimately leads to CO2 being stored in a form of organic substances – malates. Those are further used during the day, giving off stored carbon dioxide in gradual decarboxylation reaction (simply put: a reaction in which a molecule loses CO2 moiety). This solves a problem of photorespiration (constant concentration level of CO2 is kept, thus oxygen is not attached to rubisco) and plant's inability to acquire carbon dioxide during the day (enough of it is stored during the night time). Obviously the CAM photosynthesis has some downsides, one of the main ones being lower effectiveness of it. This and many other reasons make for the look of the rose of Jericho, having maximum height of only 5 cm.
Now you know some of the secrets of immortality. Maybe they are not as impressive as you might have imagined, but still they can be quite astounding if we think how simple, yet effective those are. It seems that nature always pursues simplest solution to problems. The way that plants preserve themselves from dying might not necessarily find use in us, humans, however analysing the topic might give us some interesting hints. One of them being the fact that nature oftentimes operates on quite simple principles and it might that solution to the problem of human's mortality is fairly trivial, but we lack more in-depth understanding of biology to see it. Well, as always it boils down to the fact that nature is fascinating and most assuredly we won't solve all of its mysteries in upcoming years. [Dawid Mazur]