LUCIDITY

Issue 3
Science to Improve Human Life

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Editorial Introduction

It was only one and a half years ago when I sat down with Hyunjin in front of Pizza Alvolo, wondering how we were going to start this magazine that we named 'Lucidity'. We were full of anticipation to run a STEM (Science, Technology, Engineering and Mathematics) magazine where students and staff could exchange their knowledge and promote the Sciences at NLCS Jeju.

Publishing the first two Issues was chaotic in a positive way. It was a worthwhile experience to work as a writer, editor, designer and photographer at the same time as we could not recruit enough members. Often times, both Hyunjin and I were utterly baffled by the complexity of design softwares and panicked in dismay when we ended up with only two articles in three months.

However, all those experiments with publication that awed (and sometimes horrified) us made Lucidity as we see it now. Now a group of 30 students, Lucidity is an official school magazine fully devoted to STEM. We aim to provide a platform for STEM-holic students at NLCS Jeju to exchange their ideas and knowledge and, as we have always wanted, to simply have fun.

Lucidity releases an Issue every term with a distinctive theme. Issue 3 of Lucidity addresses the theme of "Science to Improve Human Life" from a variety of academic viewpoints, ranging from Medicine to Politics, Cryptology and Astronomy.

At no point in history has Science been at its pinnacle as it is today. It is not an exaggeration to say that we are approaching the point where humans become omnipotent, armed with our knowledge on Science. However, Science without ethics - that is, when Science is exploited against the wellbeing of people - is a fallacy into which we should always be cautious not to fall, even more so in this time of rapid scientific revolution.

This Issue of Lucidity, therefore, addresses the idea of ethics in Scientific breakthroughs by exploring various ways in which the Sciences can contribute to improve human life.

We hope this magazine delights and enlightens you with its plethora of knowledge on STEM.

Sincerely,
Ihyun Nam
Editor-in-chief

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Telomeres: Potential for Immortality?

Yr 12 Hyuntae An

Telomeres are repeated sequences of nucleotides at the ends of DNA strands, which prevent loss of genetic information during cell division. When cell division occurs, the genes within the cell needs to be replicated. Unfortunately, the process is imperfect, and lengths of DNA at each end are lost during replication. During DNA replication, the two strands of DNA are split, and RNA primers attach to parts of each strand and allow DNA polymerase to attach the complementary nucleotides to the strand template. However, parts of the DNA at the ends inevitably overhang, and the ends of the DNA strands are not fully replicated and shortened during each cell division. Loss of essential genetic information can prove fatal to cells; therefore, most eukaryotic chromosomes have telomeres - lengths of DNA with short repeating sequences of nucleotides - to protect the genes.

Since telomeres shorten as cell division occurs, they have been found to be associated with aging and cancer. When a gene is damaged as the result of insufficient telomere length, the resulting daughter cells go into senescence, the state at which they can no longer divide, and some eventually into apoptosis or cell death. Many research have discovered that senescent cells may influence the development of cancer and other diseases. However, researchers have had extensive interest in whether telomeres may hold the key to achieving human immortality. Although other factors such as epigenetic and external forces influence the process of aging, telomere shortening is often considered to be the major cause of cell senescence and death. For cells which need to continually divide, they have an enzyme to maintain the telomere length: telomerase. In most organisms, telomerase is mostly found in reproductive organs, where gametes are produced in extreme quantities. In addition, tumour cells have been found to produce telomerase to accommodate its rapid growth. Due to this characteristic, inhibition of telomerase function and gene expression has been researched for the development of cancer treatment.

Not only that, but scientists believe that telomerase may also hinder aging and potentially allow humans to achieve immortality. Theoretically, triggering expression of telomerase genes would allow the cells to constantly maintain telomere length and slow down or completely stop the aging process. However, there are obstacles to be overcome to achieve immortality. First of all, the presence of telomerase will significantly increase the risk of developing cancer, for the ability to divide infinitely is a major element for tumour growth. With telomerase, cells can divide without becoming senescent, and this increases the likelihood of the production of a mutated cell, which can divide rapidly and develop into a tumour. Normally, a mutated cell would be stimulated to become senescent or lead to apoptosis by cancer preventative systems in the body, but a cell which can divide infinitely is less likely to be controlled. In addition, there is simply an insufficient understanding of telomerases and what effect they may have on normal cells that naturally do not produce the enzyme. As is the situation with all discoveries in medicine, the knowledge about telomeres cannot be developed into a genuine treatment until all consequences and effects are understood and accounted for.

Overall, it is unlikely that human will be immortal within a few years, but the knowledge on telomeres may lead to significant developments in medicine. In fact, the research on telomere and telomerase has the potential to provide a basis for an effective cancer treatment. Telomere may indeed be the first step towards achieving human immortality.

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The Political Nature of Health

Yr 11 Hyeonseo Noh

"Science to improve human life" - this is the title of this Issue. When people face this phrase, most of them might head straight to Biology or Biochemistry. However, aspects of politics and its nature may also be considered as a branch of Science that may improve human life. If the Sciences make constant advancement and progress, how will people get the benefits of such development? Politics is a major area to consider when seeking an answer to this question as it is linked to health equality.

Scientific research on social imbalance in health has been conducted at an exponential rate in recent years. In spite of this, the impacts of politics on wellbeing of people and health disparities have not been widely recognised by society. Scholars of global health have conducted long, extensive research on the complex relationship between health and its determinants, one of which is politics.

Health is political in several ways (1):

- Health is political because, like any other resource or commodity under a neo-liberal economic system, some social groups have more of it than others.
- Health is political because its social determinants are amenable to political interventions and are thereby dependent on the political action.
- Health is political because the right to 'a standard of living adequate for the health and well-being' is, or should be, an aspect of citizenship and a human right.

(1) Clare, et al. "Towards a Politics of Health | Health Promotion International | Oxford Academic." OUP Academic, Oxford University Press, 18 Feb. 2005, academic.oup.com/heapro/article/20/2/187/827479.

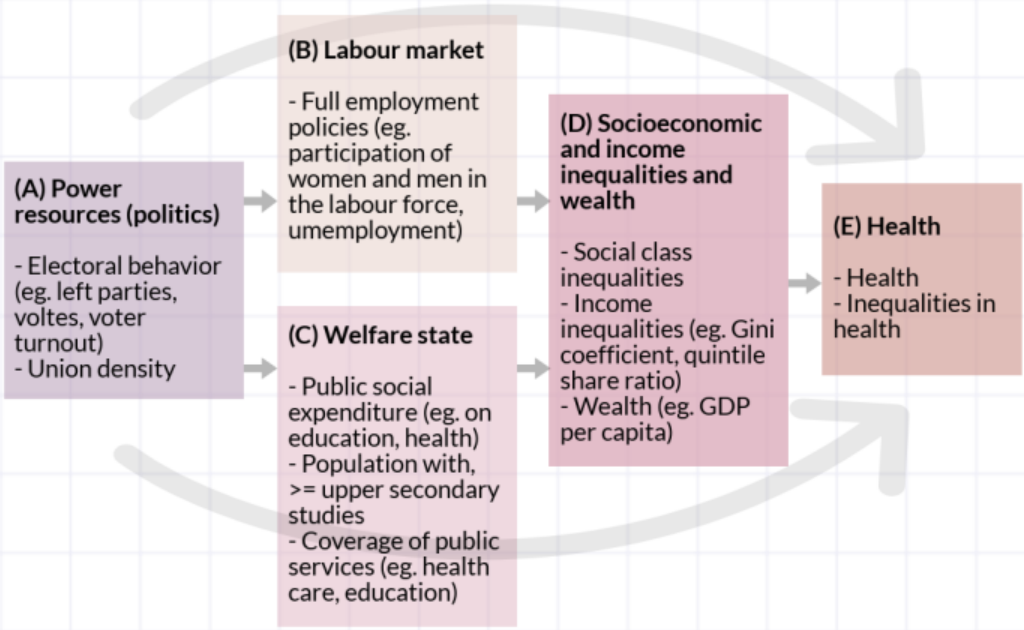

Figure 1: Model showing the relationship between power resources, labour market, the welfare state, socioeconomic inequalities and health outcomes (some examples of variables are also shown).

Health Inequalities

Individuals from different backgrounds, social groups and countries enjoy different levels of health. Thus, health inequality is defined as the unjust differences in health between groups of people who occupy different positions in society.

Health inequality is often observed along a social gradient in accordance with the established fact that health inequality among populations are related to their inequality in social status. The World Health Organisation (WHO) came up with six facts regarding health inequality (2).

Fact 1: Health inequalities are systemic differences in health outcomes
Fact 2: Everyday 16 000 children die before their fifth birthday
Fact 3: Maternal mortality is a key indicator of health inequality
Fact 4: Tuberculosis is a disease of poverty
Fact 5: 87% of premature deaths due to noncommunicable disease occur in low-and-middle income countries
Fact 6: Life expectancy varies by 34 years between countries.

Social gradient is present in every country and it can be observed via factors such as level of education, income, gender, geographic region and ethnicity (3). This suggests that people with economic stability and financial advantages will get a better healthcare service in terms of disease treatment or self-assessed physical and psycho-social health. Lack of education during childhood or disadvantages in working condition all play a part in the social gradient of health. It is, therefore, crucial that we understand and address the socio-economic determinants that influence health either directly or indirectly.

Examples of health inequality between countries

- Infant mortality rate (the risk of a baby dying between birth and one year of age) is 2 per 1,000 live births in Iceland but over 120 per 1,000 live births in Mozambique.
- Lifetime risk of maternal death during or shortly after pregnancy is only 1 in 17,400 in Sweden but is 1 in 8 in Afghanistan.

(2) "10 Facts on Health Inequities and Their Causes." World Health Organization, World Health Organization, 21 Apr. 2017, www.who.int/features/factfiles/health_inequities/en/.
(3) Pierson, Anne. "Introduction." Health Inequalities, Health Inequalities, 29 Nov. 2016, www.health-inequalities.eu/about-hi/introduction/

Examples of health inequality within a country

- In Bolivia, babies born to women with no education have infant mortality greater than 100 per 1,000 live births, while the figure for babies born to mothers with at least secondary education is under 40 per 1,000.
- Life expectancy at birth among indigenous Australians is substantially lower (59.4 for male and 64.8 for female) than that of non-indigenous Australians (76.6 and 82.0, respectively).
- Life expectancy at birth for male in the Calton neighbourhood of Glasgow is 54 years, 28 years less than that of male in Lenzie, a few kilometres away.
- Prevalence of long-term disabilities among European male aged more than 80 is 58.8% among the lower socio-economic group while the figure is 40.2% among the higher socio-economic group. (4)

Every aspect of the government and economy has the potential to affect health and health equality – finance, education, housing, employment, transport and health to name just a few. While health may not be the main aim for policies in these sectors, they have a strong bearing on the issue.

Now that we have explored the political impacts on social health and welfare, we now ask the question "what are the causes of health inequality?" The short answer is, economics and social issues play a major role in causing health inequality, along with several other political aspects.

The following diagram shows how the social, economic and political aspects of a region lead to inequality in wellbeing.

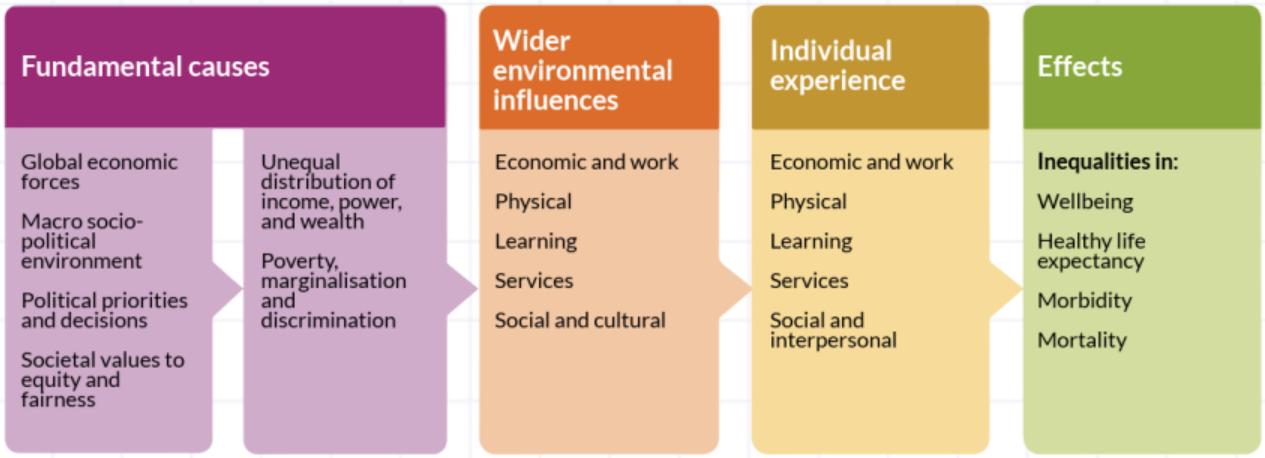

Figure 2 Causes of health inequality
Source: NHS. "What Are Health Inequalities?" NHS Health Scotland, www.healthscotland.scot/health-inequalities/what-are-health-inequalities.

Human right to Health

Human right to health means that all people have the right to the highest attainable physical and mental health including access to all medical services, sanitation, adequate food, decent housing and healthy working conditions. This right implies a clear set of legal obligations of states to ensure appropriate health conditions of all people without discrimination.

However, as mentioned before, health inequality is a major social issue, and it can lead to lack of attention to or violation of human rights related to health. This can lead to serious consequences such as a rapid increase in mortality rate and spread of diseases within a certain community. Discrimination in the delivery of health services within the workforce and between health workers and users is treated as a huge barrier to social health service. This problem has settled down as a major cause of poor health care. Violation of human rights not only contributes to poor health services but also to human rights abuses including coercive or forced treatment and procedure for people with disabilities, women living with HIV, sex workers, people who use drugs, transgender and intersex people. (5)

(4) "Key Concepts." World Health Organization, World Health Organization, 7 May 2013, www.who.int/social_determinants/thecommission/finalreport/key_concepts/en/.

To prevent such consequences, three core components of the right to health have been suggested by the WHO as follows:

1. Accessibility

Facilities, goods, and services regarding health care must be accessible by all people. It can be seen in four main dimensions:

- Information accessibility
- Economical accessibility (affordability)
- Physical accessibility
- Non-discrimination

2. Acceptability

Not only the healthcare and protection provided by the government but also the cultural acceptance and awareness are key elements for the human right to health. Acceptability requires health facilities, services, and programmes for people who need specific needs due to factors such as sensitivity to gender and suitability of culture with international standards of medical ethics for confidentiality and informed consent.

3. Quality

All services and facilities must be progressed under the approvement in the scientific and medical field. Quality health services include the followings:

- Safe - avoiding wound for people who took their action for the purpose of
- Effective - should be evidence-based and work on the general and individual need
- People-centred - providing care based on individual preferences, needs, and values
- Timely - reducing delays and time waste
- Equitable - providing care that does not vary in quality on account of gender, ethnicity, geographic location, and socioeconomic status
- Integrated - providing the full range of health service
- Efficient - maximising the benefit (6)

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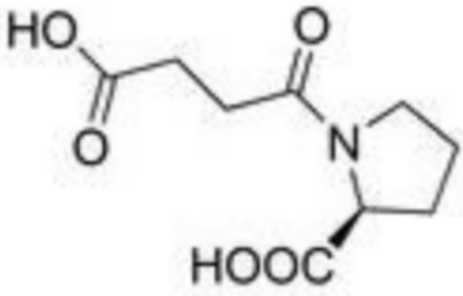
(6) Ibid; "Human Rights and Health"

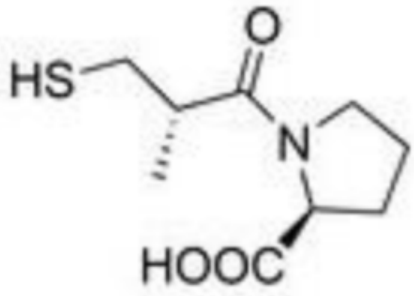
ACE Inhibitors: Their Creation, Mechanism and Development

Yr 10 Serin Lee

ACE inhibitors, also known as angiotensin-converting-enzyme inhibitors, may be a familiar name if you know someone with high blood pressure. With the advent of Captopril, a type of ACE inhibitors, in 1977, ACE inhibitors have been used to treat hypertension(1) and congestive heart failure(2), often being the first choice of prescription. Currently, 9 Tier One(3,4) derivatives of Captopril and the inhibitor itself are prescribed around the world, garnering over 6 billion US dollars. (2013) How was this class of medication found and what developments did it undergo till now? But before we begin to discuss the ACE inhibitors, we must learn what those molecules inhibit, and why we wish to give patients those molecules.



Succinyl-(*S*)-proline



Captopril

ACE inhibitors inhibit angiotensin converting enzymes(5). ACE is the enzyme that converts the hormone angiotensin I to its active cousin angiotensin II, which causes vasoconstriction(6). Because the precursor to the vasoconstrictor has no biological activity, doctors prescribe ACE inhibitors to prevent angiotensin II from stimulating blood vessels and causing their constriction.

Captopril, marketed as Capoten, was the first of its kind when it was first introduced to the general public as the first ACE inhibitor. Developed as a highly specific enzyme inhibitor, the chemical was found while studying the venom of the lancehead viper, whose bite causes an instant drop in blood pressure and paralyzes its prey. Within the venom, researchers found a nonapeptide that inhibited the angiotensin-converting enzyme. The peptide contained proline residue at the C-terminal(7), and the enzyme contained zinc. Using those two characteristics, researchers studied the catalytic mechanisms of other zinc-containing enzymes and created zinc-binding molecules that also contained proline. Out of the various proline-containing compounds, researchers found that succinyl-(S)-proline was effective; then they replaced the succinyl group with the sulfhydryl group, increasing the ACE inhibitor activity by more than 1000-fold. The sulfhydryl-containing compound was Captopril, and after various tests, the compound was released as a treatment for hypertension.

1 Elevated blood pressure
2 A weakness of the heart that leads to a buildup of fluid in the lungs and surrounding body tissues
3 Preferred in prescription
4 Benazepril, enalapril, fosinopril, lisinopril, moexipril, perindopril, quinapril, Ramipril, trandolapril
5 a.k.a. dipeptidyl carboxypeptidase I, peptidase P, dipeptide hydrolase, peptidyl dipeptidase, kininase II, angiotensin I-converting enzyme, carboxycathepsin, dipeptidyl carboxypeptidase, "hypertension converting enzyme" peptidyl dipeptidase I, peptidyl-dipeptide hydrolase, peptidyldipeptide hydrolase, endothelial cell peptidyl dipeptidase, peptidyl dipeptidase-4, PDH, peptidyl dipeptide hydrolase, DCP
6 An agent that causes the constriction of blood vessels, which increases blood pressure
7 End of an amino acid chain

Deduced from the first trial, the compound wasn't that bad, seeing as it is still in use today(8). However, it had various limitations: a cough, rash, taste disturbances, and a short half-life led to various derivatives of Captopril.

Coughing is an adverse drug reaction shared among the ACE inhibitors and is a reaction that is inevitable when using them. ACE does not simply convert angiotensin I into angiotensin II; it is also involved in the breakdown of bradykinin (consult footnote 6), a vasodilator(9) substance that has also been suggested as a compound that sensitizes the cough reflex, in the airways. Subsequently, bradykinin levels rise, and because bradykinin stimulates prostacyclin production, prostacyclin levels rise.

The enzyme also degrades substance P in the airways. By inhibiting kinin degradation and substance P degradation, ACE inhibitors inadvertently cause the buildup of kinins, substance P and prostacyclin in the respiratory system, leading to a cough. It has also been observed that the inhibitors increase nitric acid production, which irritates the lungs. While most patients will not be seriously affected, physicians prescribe ARBs or angiotensin receptor blockers instead for those whose reactions are severe. Rash and taste disturbance, rare side effects that led to complaints to the drug manufacturers, contributed to the development of captopril derivatives, one of them being enalapril. Researchers had attributed those side effects to Captopril's unique thiol moiety, and rid subsequent ACE inhibitors of Captopril's sulfhydryl moiety. Then, to enhance the half-life of following ACE inhibitors and therefore patient compliance and oral bioavailability, researchers synthesized most inhibitors as prodrugs, leaving only captopril and lisinopril as a non-prodrug.

Over time, ACE inhibitors' ranks have grown to include derivatives of the original ACE inhibitor, Captopril. After various attempts to enhance qualities and lessen adverse side effects, doctors are well equipped with 10 Tier One ACE inhibitors and are able to couple them with various other medication such as thiazide, thiazide-like diuretics and calcium channel blockers to produce overall antihypertensive effects. While the search for more effective inhibitors are still ongoing, we are well covered in the area of hypertensive diseases and heart failure with our current arsenal.

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8 Less effective drugs are still used, because different drugs have different interactions with other drugs that the patient may be on.

9 An agent that causes the dilatation of blood vessels, which decreases blood pressure

How Tall Can a Tree Grow?

Yr 12 Gyuree Bae

The world's tallest tree is a California redwood (Sequoia sempervirens), which is 116m tall and reaches 8.9m in diameter at breast height. To give you a background on this species of tree, it is a giant evergreen, monoecious tree that lives 1200-1800 years or more. This tree occurs naturally in about 8500km2 along the coasts of California and the south west coasts of Oregon in the USA, where there is a high level of precipitation due to oceanic moisture. Their root system is composed of shallow and wide-spreading lateral roots. The branches and leaves are cumulated on the quarter top of the tree. The leaves are 15-25mm long, flat, and thin. They are dark green above and have two blue-white stomatal bands below the leaf. The leaf arrangement is spiral, but the larger shade leaves are twisted at the base to lie in a flat plane for maximum exposure to light.

The height of a California redwood is closely related to fog availability; trees tend to grow taller in presence of massive fogs. Since gravity restricts trees from absorbing water through their roots, the abundance of atmospheric moisture, which can be absorbed directly through the epidermal tissues of leaves, is pivotal. Trees also collect water from fogs through their bark. Such uptake of water through leaves and bark reduces xylem embolisms, which occur when cavitations form in xylem. Heavy rainfall leaches nutrients from soil, causing trees to depend even more on the biotic community of the forest.

There are two main opposing factors for tree growth. One is gravity. Trees need to transport water from roots to leaves in order to survive. However, due to the gravitational force, this process is very energy-inefficient. There is also a limitation on the distance for which water can be sucked up by a tube (xylem). Generally, the maximum distance is 10m. This phenomenon can be explained by a physics law. The force that ascending water has is equal to the difference between atmospheric pressure and the pressure on water inside the tube times the volume of water ([Pa-P]*A). This force is the same as the mass of water times its density and the gravitational field strength (Ah*p*g). Then we can conclude from these that the pressure difference is equal to the density of water times its height and the gravitational force (Pa-P = p*g*h). When we substitute numbers in, the maximum possible height is only 10.3m. Hence, for California redwoods to suck up water over 100 meters, they have to make a pressure difference of 10 atmosphere.

There are several contributing factors to this far-from-normal ability. For one, transpiration helps this suction, but it is still not enough for trees to suck up water for over 100m. If the water surrounding the roots have less solute than the water inside the roots, trees would be able to absorb water from the soil through osmosis. However, as some trees live in mangroves with salty water, the water molecules are lost from the trees into the soil, meaning that the trees need additional pressure to push up the water.

Actually, in trees, the necessary pressure difference of 10 atmosphere is formed. In a liquid, this pressure can take a negative value. As water evaporates from the pores of cell wall, it forms immense negative force of approximately negative 15 atmospheric pressure. Since the pore is so minute (2 nanometer in diameter), the meniscus does not break despite of air-water interface in the pore. The pressure at the top of a tree is negative 15 atmosphere pressure and the pressure at the root is 1 atmosphere pressure, overall forming a pressure difference of 16 atmosphere. Water at the top of the tree is not boiling regardless of the low pressure because its xylem does not contain any air bubbles that may allow water to change into gas. The change of phase from liquid to gas only occurs at a nucleation site, for example, a tiny air bubble. However, xylem is filled with water from the start and it does not contain any air bubbles, meaning that water can stay as liquid even when it should be boiling in theory.

The main force that makes a tree grow taller is the competition for sunlight against other trees. When we grow one plant in exposure to a small amount of sunlight through a hole in the box it is in, and another plant in plenty of sunlight, the former tends to grow taller. This is a form of phototropism, which means the growth of an organism in response to a stimulus by light. Plant cells have a chemical called auxin. Auxin causes the plant to have elongated cells on the farthest side away from the light. Furthermore, different organs of the plant cause different phototropic reaction to different wavelengths of light. For example, Cryptochromes are photoreceptors that absorb blue light and help control the circadian rhythm in plants and timing of flowering, while Phytochromes are another type of photoreceptors that sense red light. The right question to ask now is: 'why is sunlight so important to plants?'

Plants are autotrophs that produce energy through a process called photosynthesis. Chlorophylls in plants absorb energy in the form of light from the Sun. ATPs are released within plant cells through the process of splitting water molecules into hydrogen and oxygen molecules. These reactions use light as a trigger. Enzymes in plants catalyse hydrogen and carbon dioxide to create a carbon compound, which is referred to as the intermediate. In plants, the intermediate is called phosphoglyceraldehyde (PGAL). This intermediate is used in the process of producing glucose, which the plant converts into energy for survival. Therefore, for plants, sunlight is pivotal in sustaining their lives.

There are also various other chemicals that affect the growth and development of plants. Gibberellins are one of them. Gibberellins are produced in plastids - double membrane bound organelles responsible for making 'food' in plants. Once the plant release gibberellins, thousands of its cells are elongated, resulting in an overall growth. Another growth hormone is auxin that is produced in the apical meristem. As stated previously, auxin also elongate plant cells.

According to many researches, transporting sufficient amount of water to the top of a tree is the hardest process for trees that are over 100m in height. However, even after trees have managed to suck up water for such a long distance, tremendous amount of water evaporates through the leaves. In average, only 1 percent of water is used for photosynthesis, 5 percent for growth, and the remaining 96 percent of the transported water evaporates from leaves.

In order to prevent such a wasteful water loss and retain as much water as possible, a tree should have thin leaves. Thin leaves prevent water molecules from evaporating easily. Large-surfaced leaves get more sunlight, which increase the absorption of carbon dioxide, causing further evaporation of water. Therefore, the evaporation rate of coniferous trees with more leaves is much lower. However, coniferous trees tend to show more apical dominance. It is “the phenomenon whereby the main central stem of the plant is dominant over other side stems; on a branch is further dominant over its own side branchlets (wikipedia research of apical dominance)”. It produces typical chemicals that block other branches from growing stably. So, the phyllotaxis should be in a generative spiral shape, so that all the leaves can get relatively even amount of sunlight and does not get affected much from apical dominance. The root should grow deep and wide in order to absorb water through a wider area. Xylem should be narrower than those in the ordinary trees, so that the xylems can have slightly more capillary force when absorbing and transporting water from underground. And there should be more xylems to transport more amount of water at once.

Even in the presence of more xylems, thinner leaves occurring, and wider and deeper roots, a tree cannot be much higher than 130m. There is a limit on the atmospheric difference between the top of the tree and the surrounding air. The minimum pressure that water can have is negative 15 atmosphere, which is not much different from the figure for California redwoods. To conclude, California redwoods, despite having all the beneficial factors for growth, cannot grow higher than 130m due to the ceiling on pressure difference.

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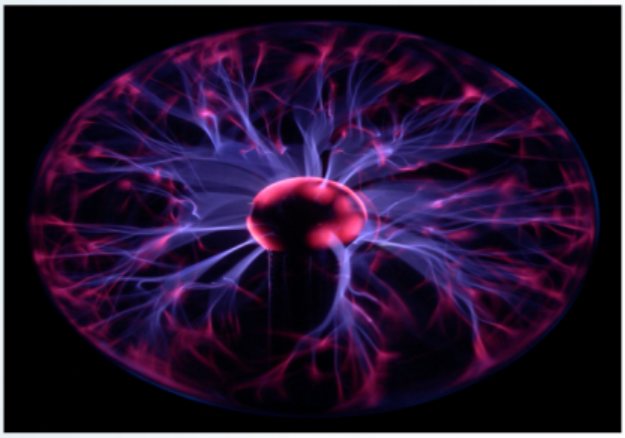
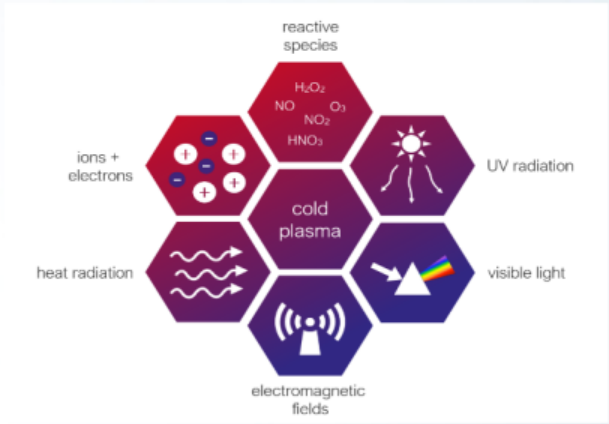
The Fourth State Of Matter

Yr 7 William Wen





"A plasma lamp, showing some of the more complex things a plasma can do. The colors come from the gas in the lamp. Each type of gas makes a different color" by Luc Viatour. Posted on January 1, 2004.

Everyone knows that there are three states in this world: liquid, solid and gas. However, many scientists now believe that there is another, new state. No element in the periodic table is in this state. This magical state is called plasma.

Plasma was first discovered by William Crookes in 1879 and he named this state "the fourth state of matter". Plasma is made up of free electrons and ions of an element. Ball lightning and Northern Lights are two examples of plasma.

Nowadays, it is hard to find natural plasma, but there are many man-made plasmas. Fluorescent light bulbs are an example of using a man-made plasma. It uses electricity to charge gases up, which creates a plasma. The plasma glows and so the fluorescent light bulb lights up. Neon sign is another example of plasma, and it is similar to fluorescent light bulbs because it also contains gas. Different kinds of gas make different colours. Gases like Helium, Neon, Argon and Xenon are used in neon signs.

Although many of people do not know anything about plasma, it is still a useful state, and it creates lots of beautiful things. Maybe in the future, scientists will explore more about plasma.

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Korean Politics Society

Political Science on Mandating Organ Donation

Yr 10 Sean Choi

The South Korean parliament regularly brings this topic to the table: "Why not mandate Organ Donation? It is the right thing to save lives." This claim is then, regularly, rejected. In Korean Politics Society at NLCS Jeju, we look at the motion of mandating organ donation in terms of the role of the country and how policies should respect the rights of individuals. To begin evaluating the suggested policy of mandating organ donation, it is necessary that we understand the foremost duties of the South Korean government - actually any government - and whether making organ donation mandatory aligns with these. The government's primary role is to protect human rights that might be violated by 'immoral' people. (I agree that the last sentence is quite redundant so I deleted it)

Are people who show disapproval to organ donation "immoral"? Organ donation might be judged a benevolent process for those people whose life can be extended with donated organs. However, opting out of organ donation does not kill people (maybe indirectly but not accordingly). It is the disease that kills them, which cannot be prevented by laws. Hence, we should not fall into the fallacy of believing that the human rights of patients who cannot be saved due to lack of donated organs are infringed by 'evil acts' of some immoral people. This is why the government does not punish people for not donating their organs. By the same logic, citizens should not be persecuted for choosing not to give up their organs.

Furthermore, People who support mandating organ donation often say that people do not hold human rights after deaths or that even if the rights do persist, violation of those rights of the deceased is an opportunity cost that can be overwhelmed by saving lives. None of these arguments are necessarily legitimate. All human beings hold inalienable rights, like the rights to choose and to believe in certain religions. People have bodily autonomy, meaning that no government is in charge of its people's bodies. People are in charge of their body, so they must have the right to choose what to do with their body even after death.

In death, does a dead person notice when people take their organs? Is this proven? In some religions, one's body should be preserved to receive salvation. In several other religions, one's body should return to its origin simultaneously with one's death. If one is a fond believer of such ideas, which is perfectly in line with the inviolable right for freedom of religion, isn't it also his or her right to opt out of organ donation?

If mandating organ donation is to go ahead, the government could potentially be creating a strange merit-based society in which it's citizens are never given the choice to not donate organs and a society develops where people are regarded as a tool to maximise utility with their fundamental human rights ignored.

I would like to suggest an example to point out the illegitimacy of the underlying idea of mandating organ donation: Is it right to push a fat man onto the road to stop a car which in turn could potentially collide with a bus transporting 10 students thereby saving the students in this bus? Ideology says yes, but people say no. Political Science is a tool to support the people's reaction: All individuals' rights are sacred, and can never be and should never be subjected to violation by any laws.

In this article, we have looked at the organ donation policy in a broad philosophical point of view. However, this is merely one out of countless ways to look at the issue of mandating organ donation. Some scientists say that there is absolutely nothing unethical about mandating organ donation because they know that the dead are 'actually dead'. Many politicians also do not think that the suggested policy is impossible to realise. Although this article features an inclined point of view, a philosophical view it is also accepted that the view shared is not undeniably the most correct or right idea. We, the Korean Politics society, regularly have discussions on controversial policies like this and try to approach alternative views through gathering and exploring different thoughts. We look forward to your brilliant ideas on this topic.

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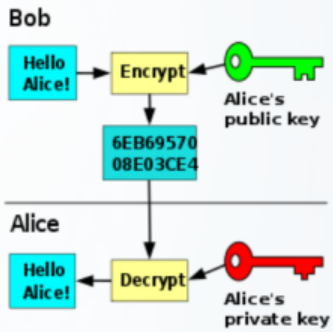
Cryptology Enterprise
Usage of Cryptology in the Modern World

Yr 9 Lauren Lee

Cryptology Enterprise at NLCS Jeju studies Cryptology, which is the art of encrypting private information and decrypting it so that only the designated recipients can read it. Cryptology is and has been a truly valuable asset in society. Hence, the ultimate question is: what exactly is Cryptology used for? Cryptology provides protection and security to basically any form of transaction that happens across the Internet. Without the security provided by Cryptology, any kind of information stored on the Internet would be in a state of chaos. In modern days, Cryptology is employed everywhere in our daily lives, from when you message your friends to when banks use the blockchain technology. This article will cover the different uses of Cryptology online and offline and how this technology improves human life.

These days, Cryptology is most commonly applied to online messaging, particularly emails. Emails are formal yet easy to use so they are widely adopted as the main means of communication in many schools and universities, as well as in businesses or simply among friends. However, emails are not encrypted when passed on from server to server so they can easily be intercepted. If one wishes to communicate more private matters over email, he or she should consider using Public Key Cryptography, also known as asymmetric encryption, to encrypt the messages. Asymmetric encryption is when two different keys are used to encrypt and decrypt a message. The sender uses the receiver's public key to encrypt the message. What a public key is is pretty self-explanatory; it is a public formula that is open to the 'public'. When the receiver receives the coded message, they can then decode it using their private key. The public and private key can be thought of as a username and a password, where the username can be however public as you like but the password should be kept for yourself. In this way, Public Key Cryptography allows people to email each other privately.



Furthermore, Cryptology is used when withdrawing money from an ATM. Taking out money from a machine instead of directly going to a bank and confronting a banker could be a potentially dangerous task because there might be people trying to take money out from other's bank accounts or using hoax cards. Therefore ATM is armed with strong encryption. First of all, to prevent the so-called phantom withdrawals with hoax cards, when a user inserts a card into ATM, the machine sends out what is called an Authorization Request Cryptogram to card issuers to authenticate the card and card data to verify that the user is really the cardholder. Then, Advanced Encryption Standard (AES) is used for encrypting personal identification numbers. AES uses a variable length encryption key, with a length of 128, 192 or 256 bits, and encrypts data in 128-bit blocks which is much more secure than Data Encryption Standard (DES) that uses only 64-bit blocks. The only way to hack into the system of AES is by using a brute force attack - basically trying out every single possible sequence until the hacker hits the right one.

Just knowing how much modern life depends on Cryptology is mind blowing that it is impossible to put it all in a single article. After reading this, go ahead and do some research on codes and write notes in Morse code with your friends. You could also write a happy birthday card in Vigenère cipher and make it thousand times more interesting. Cryptography is a field full of infinite potential and possibilities, helping make the world a better place.

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Medical Society
Euthanasia and Its Agents

Yr 10 Serin Lee

A subject of much controversy, euthanasia is the act of inducing death without pain. While it is widely accepted as a 'humane' way of killing, many groups have protested against the practice citing various ethical reasons, one of them being the classic "God did not allow men to play with life." Amid movements to stop euthanasia, the practice is still done; when and how exactly is it used?

Euthanasia is viable for animals suffering from weight loss, failure to gain weight (in a growing animal), severe pain that cannot be mitigated, inordinate tumor growth or ascites, generalized alopecia or any other phenomenon where it is obvious that euthanasia is the best solution. When doctors decide on euthanasia, they have a variety of drugs from which they can choose to apply, and those drugs must fit some conditions. Because euthanasia strives to give animals a swift and painless death, those requirements include lack of pain perception by the animal, rapid rapidity and irreversibility, and minimal stress and fear in the animal and surrounding animals. If the drug does not meet those imperatives, the drug cannot be applied.

Recommended means of euthanasia all include initial central nervous system action depression to cause rapid unconsciousness and insensitivity to pain. Because of this, most euthanizing agents take the form of an overdose of a chemical anesthetic. After this stage, the fatal blow varies: hypoxia, depression of vital neurons, or damage to brain tissue is the norm.

The most widespread euthanasia agent is pentobarbital, a drug usually used as a seizure medication. As a member of the barbiturate family (pentobarbital sodium is a barbituric acid derivative), it acts as a central nervous system depressant, slowing the activity of the brain and nervous system. This is ideal for an euthanizing agent and causes death by respiratory arrest and subsequent cardiac failure.

Other widespread methods are T-61 and KCl. T-61 is an injectable non-narcotic agent that is composed of embutramide, mebezonium iodide, and tetracaine hydrochloride. Embutramide, a general anesthetic, depresses the respiratory center in the brain. Mebezonium iodide, a neuromuscular blocking agent, paralyzes the skeletal muscles, and with tetracaine hydrochloride, a potent local anesthetic, T-61 neatly meets the conditions mentioned earlier. Although studies have not been conducted to compare the drug against pentobarbital, there is evidence to suggest that it may be advantageous in certain species: the terminal gasping pentobarbital incites has not yet been seen in T-61 application. However, as tissue residue problems have not been studied yet, T-61 is used cautiously.

KCl is either injected intravenously or intracardially and leads to death from cardiotoxic effects. Due to an increase in serum potassium levels, delayed electrical conduction between myocytes, sinoatrial and atrioventricular block is observed, and at high enough levels, a complete block in ventricular conduction, ventricular fibrillation, and fatal asystole are the causes of death. Because it does not have any depressing effect on the nervous system, general anesthesia must be given to the animal.

All three methods are efficient, humane ways of killing. However, as they are chemical methods of killing, they are not preferred in the euthanasia of some animals, one being cattle. To cite, that is because "the use of anesthetics for euthanasia is costly and complicates carcass disposal," as chemical residue might be harmful. Instead, physical methods such as gunshots or captive bolts are used to dispose of animals.

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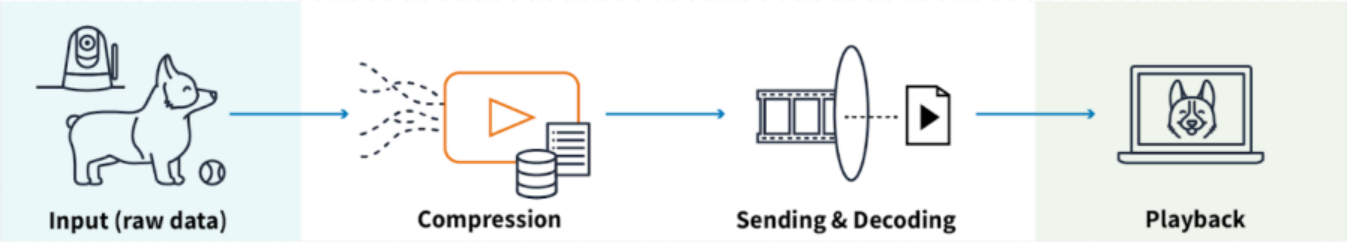
Computer Science Society Media Streaming

Yr 12 Hyun Jo Jang

When was the last time you downloaded a song to listen on the go? Probably a few years back. Nowadays, if you want to listen to music, you would just pull out your favorite music streaming app on your phone and in seconds the songs are in your playlist. The same applies to all kinds of content: videos on YouTube and Netflix, podcasts on iTunes and so on. Streaming technology has developed exponentially in the past few years. 1 billion hours of YouTube videos are watched every day worldwide, and the quality of its content has also improved by a huge extent. Now, streaming is used in homes, schools, public transport... literally everywhere. There is no denying that it has boosted our quality of life significantly. We will be diving into some fundamental procedures of the technology, as well as some concepts which may prove useful in daily life. This will be newbie-friendly, so do not worry about technical details!

The process



Firstly, raw media placed in a hosting server (the provider), is compressed and converted to drastically reduce its size. Secondly, the data are divided into many "parts" which are then sent bit by bit to the receiving client (you). Usually, data is sent slightly more than the current playing rate and stored in a temporary container called a buffer within the client. This is done in case the data being sent cannot catch up with the playing speed. Lastly, a special translator is used to convert the digital data back to actual content and the final result is shown to you. This translator is called a decoder.

Let's take a look at streaming done in real life (audio streaming in Melon):
The three main process is working fine but do have a closer look.
Notice the icon: "AAC 320K" on the top of the player? "AAC" indicates the codec, while "320K," tells us the bitrate of the stream.

What are these?

a. Codec

A codec is an actual entity which performs compression on raw data. It is sort of like a translator (like a decoder!), which takes in information and outputs them in a different "language". Examples of this "language" are mp3, mp4, aac, FLAC, avi, wav, aiff, and more.

b. Bitrate

A bit is the fundamental unit of information in the digital world. It can be either 0 or 1, which are added up to form bytes, then kilo, mega, giga, and even terabytes. The bitrate of a streamed media file indicates the size of information delivered per second. A common bitrate used in audio streaming is 128kbps (128*1000 bits per second) – which provide "enough" quality for the average person to listen to. Some Hi-Fi enthusiasts, however, even stream content up to 1000, and even 3000kbps. Obviously, a higher bitrate means the requirement of a fast connection with the server.

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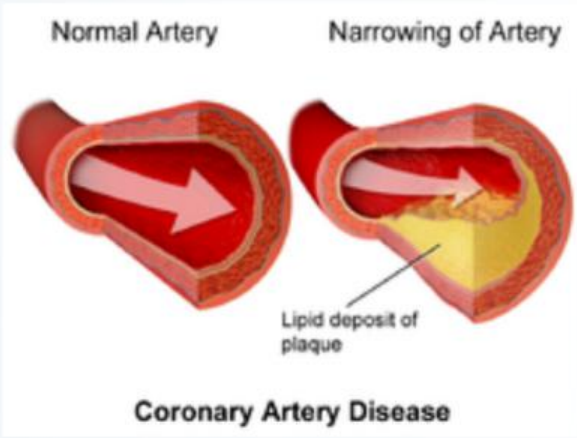
Physics Society

Improvements That Sciences Brought to Humans

Year 10 Amy Son, Annette Cho

We are living in the 21st Century where we can call or leave a message to the ones on the opposite side of the Earth. Like this, all developments originated from 7 letters: Science. Specifically speaking, we are now going into a winter when the wind blows so hard and leaves crumble to the ground. However, to overcome this horrible coldness, many brilliant people around the world have discovered a way to stay warm during winter. Which brilliant people? Scientists. They brought huge improvements in many areas.

When we take a look at a thermometer, the red liquid in it, which is often times mercury or alcohol, goes up and down in accordance with the surrounding temperature. When the liquid goes up, we, humans take off layers of clothes but when it goes down and down, not only humans but also all other living organisms protect themselves from the freezing cold. This is why animals like squirrels, snakes, and frogs hibernate and recharge energy during winter. Scientifically restructuring this statement, hibernation is a deep sleep that helps animals to save energy and survive the winter without eating as much as in other seasons. So, during hibernation, animal's temperature drops, and its heartbeat and breathing slow down so that it does not use much energy. Who discovered these facts? Scientists! Without their help, we would not have been able to survive this harsh weather.



Coronary Artery Disease

Furthermore, thanks to Sciences, we can live a luxury life. For example, think about Cancer. Imagine that you have a cardiac problem, maybe Chronic Heart Disease (CHD). This could have been caused by smoking cigarettes, unbalanced diet, genetic predisposition or intense stress. To prevent this severe disease, we can take care of our diet, lower blood pressure or even get some assistance of medicine. Once a person has developed CHD, there are various treatments that can help to mitigate the impacts of this disease. A doctor would normally prescribe drugs for the patient as soon as he or she is diagnosed with CHD. The artery made out of living cells gets narrower because cholesterol deposits from a plaque, and increases the blood pressure. Then blood clots form which gets stuck in a smaller blood vessel to stop the blood from getting through.

Had it not been for these world-breaking discoveries, we would not have been able to maintain our lives. Again, a great thanks to Sciences.

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IGCSE & IB STEM Subjects

Yr 11 Hyunji Lee

I conducted interviews with Dr Levett, Ms Quinn and Mr Robbins to learn more about what STEM subjects NLCS Jeju has to offer. In case you do not know the interviewees, Dr Levett teaches Physics, Ms Quinn teaches Biology and Mr Robbins teaches Mathematics.

1. What do we learn in IGCSE?

Dr. Levett: IGCSE is an alphabet and grammar of the language of Physics. Throughout the course, you will exercise the fundamentals of the study and learn experimental skills as well.

Ms Quinn: Basically a lot! You will learn life processes in animals and plants, ecosystems, inheritance, body processes, and also develop your experimental skills.

Mr Robbins: We learn what we have to do to get the essential knowledge of Mathematics.

2. What do we learn in IB?

Dr Levett: IB course requires you to be creative - to think outside the box. Whereas IGCSE has more emphasis on memorising and utilising formulas, IB gives you a formula book, and let you focus on thinking. You will also conduct a 10 hour-long practical by yourself, while you only need to sit a practical paper in IGCSE.

Ms Quinn: There are six core areas and one option area. The core areas include human physiology, cell biology, molecular biology, genetics, ecology, evolution and biodiversity. For options, you can choose one among animal physiology, metabolism, plant biology and more.

Mr Robbins: IB expands your base from IGCSE by exploring several advanced topics.

3. Why should we take your subject in IB?

Dr Levett: Apparently, Physics is the best subject in Group 4; you can utilise the knowledge in various fields of study, including Computer Science, Engineering, Geography, Economics, Architecture and other quantitatively related subjects. It also helps you to improve your problem-solving skills, which you will need throughout the entire IB curriculum.

Ms Quinn: Biology is the most important subject. When you understand how your body works, you will greatly appreciate yourself and be conscious of your body. Moreover, as environmental issues are emerging nowadays, learning about ecosystems and the environment let you be conscious of the world around you. We are alive, therefore, we can learn. Biology explains the basic properties of ourselves.

Mr Robbins: IB Mathematics is required for everyone. Still, it offers a wide variety of topics and techniques in the area of mathematics.

4. Any tips for struggling students?

Dr Levett: First, study hard and enjoy Physics! Try many questions, including past papers, and ask for help when you are stuck.

Ms Quinn: You really have to engage yourself in the subject. Read the textbook for basic guidelines and expand your understanding. Ask questions rather than copying or memorising answers. Break the learning down into small chunks so that you can easily retain them. The best thing to do is to get into groups and verbalise the knowledge.

Mr Robbins: If you have trouble understanding concepts, find sources for simplified explanations. After each lesson, you can talk to your Maths teacher, find some videos on YouTube or reach out to somebody in your class or House who is good at Mathematics.

Thanks to: (Editor) Yeobin Han, (Designer) Hee Won Choi

What Is It Really Like To Be a Researching Biologist?

Yr 10 Hyeyeon Seo

Dr Kim, a professor of Biology at KAIST (Korea Advanced Institute of Science and Technology) visited NLCS Jeju on the 16th of November 2018. He is currently conducting a research on degenerative retinal nerve diseases. This interview was done collaboratively by Taehyun Kim, Yoorim Park, Serin Lee, Hyeyeon Seo and Ihyun Nam of Lucidity.

Why and how did you become a researching biologist?

Dr Kim: The main reason was that I had an interest in Biology. At high school, I was not really good at maths but still preferred Sciences over any other subjects. Also, my Biology teacher, who was one of my favourite teachers of all time, posed a positive influence on me that led me to pursue Biology. However, I did not want to become a doctor because I just cannot see blood and wounds.

What does your normal working day look like?

Dr Kim: I always start my day by checking my email inbox. From 8:30 in the morning, I stay in my office doing paperwork. Teaching is not the top priority in my career, so I spend 80% of my time researching and 20% teaching graduate students. I only teach 3 hours a week during the spring and fall semesters. These days, I also travel a lot due to conferences where I collaborate with other scientists and researchers to update each other on the progress in our researches.

What are some of the experiments you do?

Dr Kim: In the lab, my research team is concentrating on the visual system such as how our eyes capture and build images. Furthermore, we are researching how neurones develop during foetus stage and how eyeballs develop their sphere shape. As we cannot experiment directly with humans, we experiment on mice and human genes from certain patients. During these experiments, we consider questions like 'one particular gene has a relationship with another gene. If we have a problem with both genes, then that's the genetic problem. However, if we have a problem in only one gene, then that's a problem with the eye. What's the difference?'

What are some challenges in conducting a research in Biology?

Dr Kim: Research itself is a challenge because Biology is a field of Natural Sciences. Discovering new things are meant to be difficult. We need to have a hypothesis and prove it, which makes me think everyday, 'is it really working or not?' However, the 'real' motivation that we get when our hypothesis is proven true drives us forward.

What would you say are the characteristics required for a researching biologist, or a scientist in general?

Dr Kim: I would definitely say 'consistency'. Doing research is a long way to study because we always encounter an end. Out of 100 hypotheses, only a few succeed. Those few successful conjectures give me energy and happiness. What I want young scientists to keep in mind is to not be disappointed if your hypothesis turns out to be false. There are so many different ways to approach a question and you have just eliminated one!

How do you collaborate with experts from other fields?

Dr Kim: After the development of the Internet, scientists around the world are getting really close. In the past, when I wanted to ask someone else for help, I had to post a written letter sealed in an envelope, which was written by me and edited by several people. These days, if somebody knows something, I ask them to share it with me via email or Skype. I read science journals (and also publish my works on them), which is open to everyone. If I find anything interesting that may assist me in my research, I just contact the writers. Once, I asked a doctor from the USA for a sample of genes that are not available in Korea, after reading about the research in a journal. I sent an email straight away.

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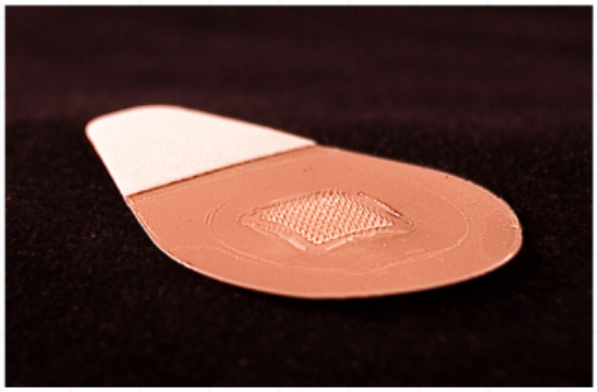
Microneedle Vaccination Patches

Yr 10 Eunice Lee



Many parents around the world would agree that one of the greatest horrors that their newborn infant could face is undoubtedly the pain of countless vaccinations. Pediatric hospitals are always filled with wails of young children attempting to escape from the sharp needles that penetrate and inject fluids into their arms. Though vaccinations are crucial for humans to prevent any light or fatal diseases, pain is unquestionably a distressing factor that can be intimidating for many receivers. Realizing such problems, scientists recently developed a technology that would ease the process of immunization to a great extent by utilizing the nanoworld.

A spin-off company named Micron Biomedical and a team at Georgia Tech have been collaborating to develop this vaccination patch for years and recently tested their first trial on 100 volunteers. Surprisingly, the results were equivalent to that of current syringe vaccines as excellent immune responses were shown. The patch did not display any side effects and effectively reduced pain for users. These patches consist of numerous nano-needles that dissolve when pressed on the skin and deliver the vaccines onto the outer epidermal layer. This layer contains immune system cells that act as the first line of defence against antigens such as viruses or bacteria, and absorb the vaccinations to become immunized.

A remarkable advantage of using this new type of vaccination is certainly the absence of pain, but there are several other factors as well. While the syringe vaccines must stay refrigerated, the patches can be kept in room temperature. This allows an easy transport of patches to users through mail or packages, which makes the operation much more convenient. Moreover, vaccine receivers do not have to bother scheduling an appointment to a hospital since microneedle vaccination patches are self-injectable. The band-aid-like structure can be taped on one's skin domestically without any additional time or effort. Such benefits make them applicable to people of all statuses from youths to the elderly and the impoverished to the affluent.

Scientists estimate that microneedle vaccination patches will be implemented into practice within a few years. This invention is considered as a method that might ultimately save countless lives through appropriate immunizations and open the future world of nanotechnology.

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New Treatment of Paralysis

Yr 10 Junyeong Kim

On October 31, several news articles were posted on prominent online Science journals such as "Science news", "National Geographic", "News-week" and "The scientist", all addressing the same topic. Three men, who were paralysed from the waist down, are now able to walk again with the help of a new treatment for paralysis that involves electrical stimulations.

This project on electrical stimulation treatment was conducted by a team of Switzerland scientists, led by Grégoire Courtine and Jocelyne Bloch. After months of practice and training, three patients who had been paralysed for many years were able to move their legs. Within a few days after this mind-blowing progress, they were able to walk on the ground, with support, while the electrical stimulation was on. Five months later, they could walk hands-free with 35% of their body weight supported. Following this was a yet greater breakthrough; after an electrical stimulation was applied once, the patients could move without an ongoing stimulation. Two of the patients also went from sitting to standing and moved for short distances with crutches, while the third was able to walk and move his legs as he willed.

I think this project is a global revolution in medical science. While this project is not yet ready to be properly introduced to the world, it is clearly portrayed in multiple articles that this piece of technology will someday help heal a vast number of paralysed people. We do not know when this renovation will be available in the market, but there are definitely people waiting for this.

However, this new treatment method is not without some side effects. Just like any other new technology, it is bound to be more expensive than conventional treatments for paralysis. Also, due to its newness, although scientists will try to make it 'perfect', some unexpected errors and strains might emerge when this new method of treatment is released.

"I think it's brilliant, I think they should carry on with the study", the Noro House gap-year student Charlie at NLCS Jeju said. "But I also think they should be wary in case there are any potential side effects or any long-term negative effects", he added.

I hope this new piece of technology is provided soon, but at the same time, it is indispensable that it is nearly 'perfect' with no severe side effects.

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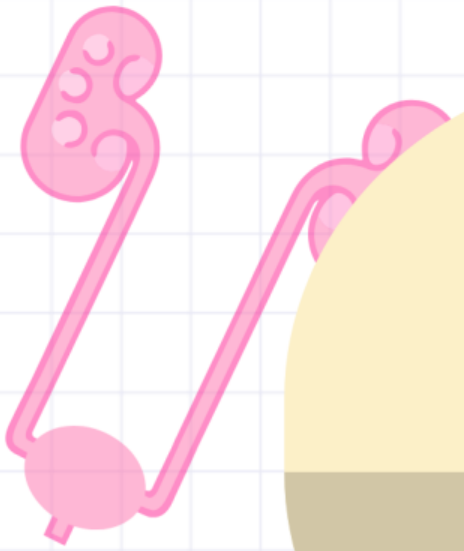
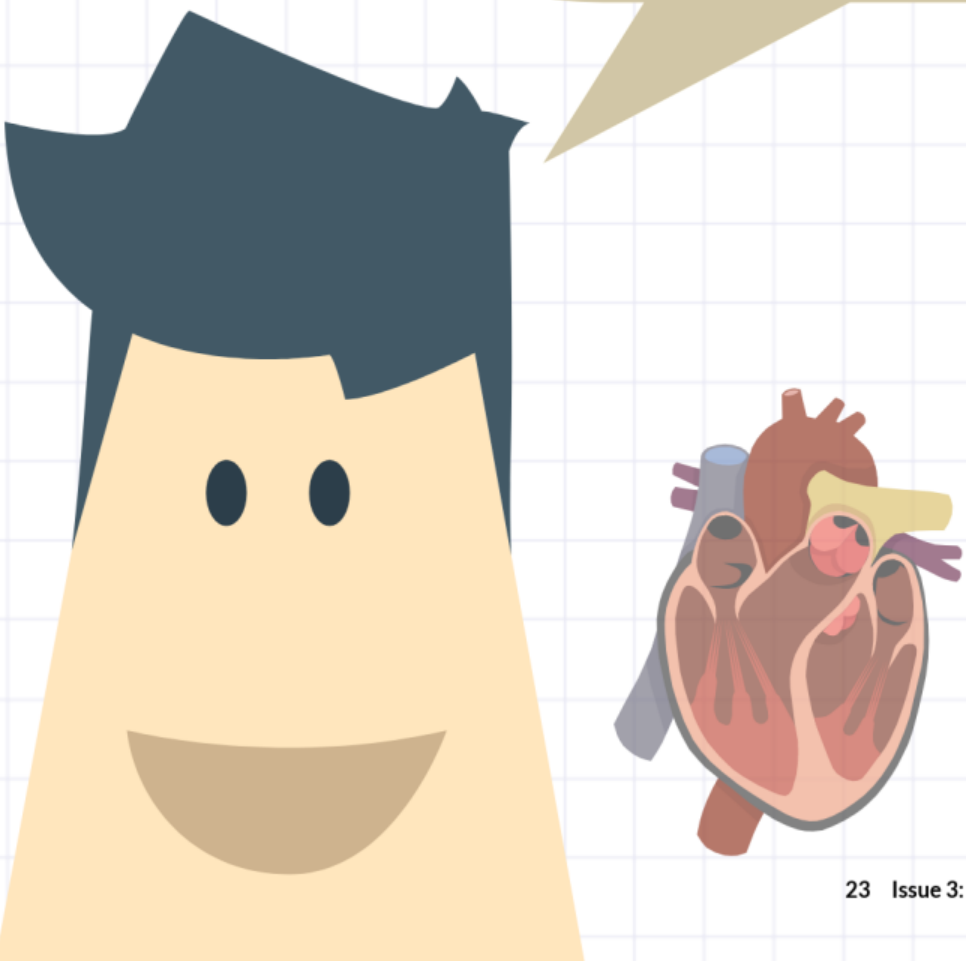
Thanks to
Editor: Hyeyeon Seo
Designer: Yun Jae Lee

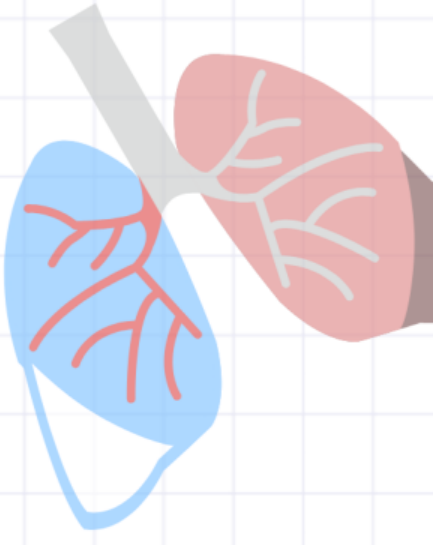
Should Organ Donation Be Compulsory?

Yr 8 Jungyoun Lee



I disagree with the question, and I strongly believe that organ donation should not be compulsory for everyone because it is simply wrong. It is true that organ donation is important as a patient might need specific organ replacements, which would be impossible unless there are donated organs. However, every citizen is subject to human rights that should not be violated under any circumstances, and demanding one's organs even after his or her death is a violation of such human rights. The government cannot and should not take away the right of people to refuse to give up their body parts, which are rightfully owned by individuals.





Thanks to
Editor: Eric Jaeyoung Kil
Designer: Yoorim Park

Loquacious, Agile and Belligerent: The Human Species

Yr 12 Ihyun Nam

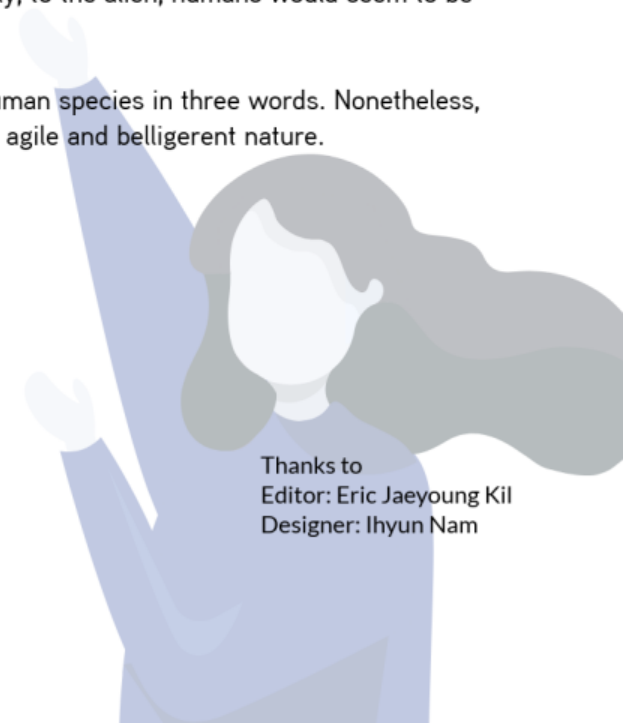
An alien during its cosmic jaunt decides to have a sojourn on the Earth. It soon singles out a species dubbed Homo sapiens, because they are so talkative and adept with using their hands! And one more - they are ferocious.

Humans are loquacious. Nonetheless, it would be pretentious of us to claim our excellence in lingual communication based on the complexity or diversity of human languages. Our way of talking is not any more intricate than other animals'. Bats can communicate using telepathy and sound waves, some of which are too high frequencies for human ears to detect - how sophisticated is that? Still, the interstellar traveler would find humans noticeably garrulous, because we use linguistics for incompatibly many purposes. To convey information is the universal category, under which there exists a myriad of subcategories, such as to convince someone of a cause, gossip, express emotions, or to boast about one's social status. These are what many other species do with body language. For example, two chimpanzee alphas would have a violent fight to manifest their echelons in the herd. Humans in the same situation would rather talk about one's prestigious alma mater or about one's new Lamborghini to overpower the opposition with a seemingly higher social hierarchy. Our great affection toward talking makes us a singularly talkative species.

Humans' fingers are extremely nimble. Each of the ten fingers is accustomed to moving in different directions and performing distinctive tasks simultaneously. Therefore, I can easily type this essay on my MacBook, while it would be implausible for my dog to do so with its pint-sized paws. One theory regarding humans' proficient use of hands suggests that our bipedalism has forced us to adopt hands as tools. Performing complicated tasks, such as making a spear, with our free hands boosted our intelligence, leading to an even more elaborate use of hands. Of course, limbs adept to work are not peculiar to humans, but in an alien's perspective, human hands would appear strikingly apt.

The alien would be awe-inspired by Homo sapiens, equipped with these wonderful skills. It would no longer be, however, when it glimpses into war. Humans battle not only for their necessary survival but also for splendid prosperity that is, in my opinion, not worth the life of millions. Was it because the Germans were unjustly threatened by Jews, homosexuals, and the retarded that the Nazis killed 6 million of them? Not at all. And was it because Cristopher Columbus and his Spanish crew did not have food and shelter that they atrociously wiped out 99.8% of the indigenous population of Haiti? Again, absolutely not. Just as humans are attached to talking, they are attached to violence. Unreasonable homicide like the aforementioned cannot be justified by 'human nature', because it is not. What is in our nature is to struggle for survival, not for villain means of suppressing others for one's splendor. Sadly, to the alien, humans would seem to be embracing the latter.

As unique as everyone is, it is not an effortless task to sum up the whole human species in three words. Nonetheless, from an outsider's viewpoint, we would be characterized by our loquacious, agile and belligerent nature.



Thanks to
Editor: Eric Jaeyoung Kil
Designer: Ihyun Nam

Pluto the Asteroid

Translated by Yr 12 Ihyun Nam

This essay was originally written in Korean by Yaewon Jang of Daejeon Science High School. It has been published in Lucidity with the consent of the original writer.

We all know the asteroid 134340. We know 134340, although we may not know 134339 or 134341, because it was once a planet. Asteroid 134340 - that is the forgone ninth planet, Pluto. Pluto is commonly made the subject of literature, often as a symbol of bitterness. This is probably because Pluto was once a planet at the centre of everyone's attention but now just one of many asteroids. Then, how did Pluto lose its status as a planet all of a sudden?

Pluto was discovered by the American astronomer Clyde Tombo in 1930 to become the ninth planet. Then in 2003, the celestial body 'Eris' was found by Professor Michael Brown. Since Eris was of a similar size to Pluto, it was argued that Eris should be acknowledged as the tenth planet. However, many more bodies of similar size had been discovered since then, and the International Astronomical Union (IAU) established a more strict definition of a planet. Following the redefining process, in 2006, not even a century after the discovery of Pluto, IAU voted to disqualify Pluto as a planet and renamed it to asteroid 134340. Meanwhile, IAU reestablished the following three prerequisites of a planet:

1. It is in orbit around the Sun.
2. It has sufficient mass to assume hydrostatic equilibrium (a nearly round shape).
3. It has "cleared the neighbourhood" around its orbit.

Pluto lost its status as a planet because it does not fulfil the third condition of "clearing the neighbourhood" around its orbit. This condition means that a planet has to be a celestial body that is "in control" of the gravity affecting its orbit, so that except for bodies such as asteroids that are under the influence of the planet's gravity, there exist no bodies of a similar size to it. The relationship between another celestial body called Charon and Pluto does not obey this. It was discovered that Charon orbits around Pluto while influencing the orbit of Pluto in turn, which shows that Pluto does not play a dominating role in its region of revolution .This lead to its disqualification as a planet.

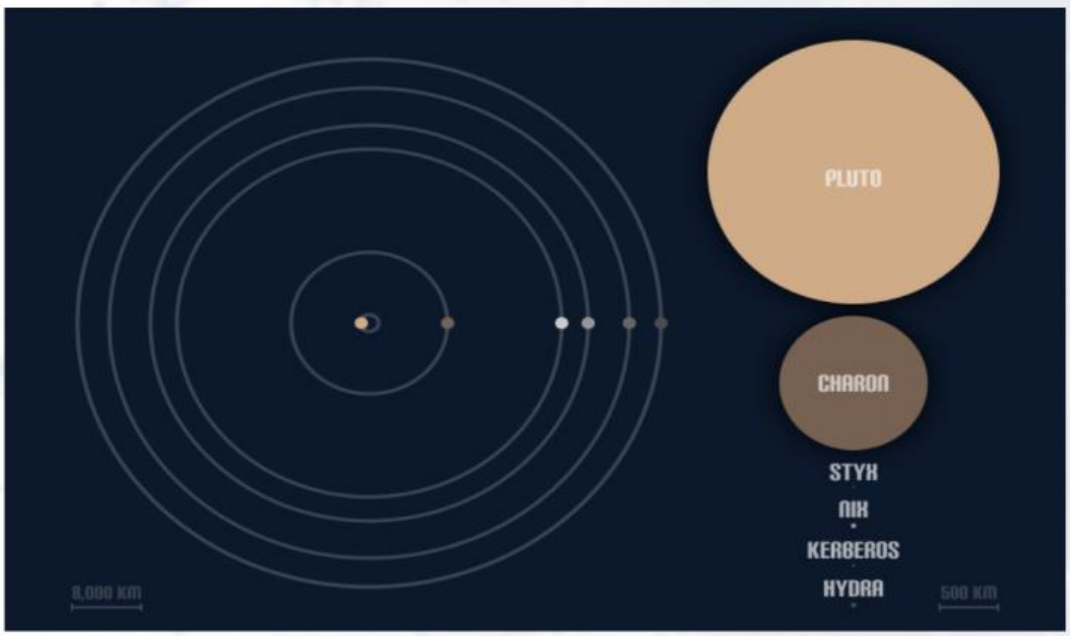


Figure 1: Diagram showing the orbits of Pluto and its moon, Charon

However, the movement to make Pluto a planet again has been unabated even after its disqualification. Over the course of 12 years, the controversy over Pluto has repeatedly faded and come back to life. Eventually, this year, as a new thesis has been released in an attempt to make it a planet again, the debate is reignited. The research group led by Dr Philip Metzger of Central Florida University asserts that the third condition of a planet, which was the key factor to disqualify Pluto as a planet, is historically baseless, based on their review of documents from the 19th Century up to now. As a result of their extensive review of 200 years of documentations, they have found that there has been only one research to adopt the 'third condition' after the discovery of Ceres in 1802, but even this was proven to be false.

Dr Metzger argues that the IAU's definition of a planet was created based on concepts that no one employs for their own research. Dr Metzger's research team further claims that there has been over 100 precedents in which the word 'planet' was not used in accordance with the definition from the IAU, implying that the word 'planet' was used due to its technical usefulness. Along with this, Dr Metzger also makes a point that the definition of a planet should originate from a more inherent characteristic of it rather than variable qualities such as the orbit. He suggests that any celestial body with a high enough gravity to maintain its spherical shape be classified as a planet, adding that this is not an arbitrary definition but a crucial milestone as it is widely accepted that a planet begins its rigorous geological activities since the moment it stays as a sphere.

However, Dr Konstantin Batygin of California Institute of Technology brands it as 'ridiculous' as calling an island a continent to label Pluto as a planet and that there is no need to be obsessed with namings. This again raised the dispute regarding Pluto's qualification as a planet. Now that Pluto is once more becoming the hottest issue among astronomers, it reminds me of a line in a poem that portrays the forgotten, bitter Pluto.

Fool, this is the forgotten star Pluto.

The image that this narrator has created for Pluto might be one of a forgotten star (although Pluto is not a star), but right now, on this Earth, Pluto is a reignited issue, at the centre of everyone's attention more than anything.

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Designer: Tae Hyun Kim

Rain Scent

Translated by Yr 11 Hyunji Lee

This essay was originally written in Korean by Seoyeon Im of Daejeon Science High School. It was published in Lucidity with the consent of the original writer.

We all have that fantasy- waking up late, finding a romance book and hearing rain greeting the window. We then reminisce the scent of rain: the clean, light and natural fragrance rising from wet soil, arousing serenity in our minds. We definitely love that smell - but not many of us know where this pleasant scent actually comes from.

Our love towards the so-called 'rain scent' roots back to the far past. Records on rain scent even exist in mineralogy books from the 19th Century. However, this mysterious, earthly odour was not identified until the previous century. In the 1960s, a team of scientists from the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) led Isabel Joy Bear and Richard G. Thomas named rain scent as 'Petrichor'. The word Petrichor is composed of two Greek words - 'petra' and 'ichor'- which respectively refer to stone and God's blood, as the scent originates from rain and stone.

Dead plants eventually decompose and leave their decomposed bodies in the soil, or ideally, in the rock. We all know from various rock decorations within NLCS Jeju that rocks have a lot of holes. Since those decomposed bodies can fill out the holes in the rock, they permeate into the rock, and rain dissolves these plant-decomposed bodies, hence allowing particles from them to float in the air. There is another odour you can smell when it is raining: the so-called 'soil scent'. A few people suggest that this is the smell of earthworms' excrement but this is certainly not true. Soil scent is rendered by a substance called 'geosmin'. Geosmin is released by certain bacteria, especially when they die and are left on the soil.

Then why do rain scent and soil scent become so strong when it is raining?

When raindrops hit soil, they are flattened and rebounded. During this movement, air bubbles are formed between the raindrop and soil. When raindrops fall to the ground, especially soil or rock, this air bubble expands since air is supplied, and the scent from decomposed matters dissolves into the air. After, this air bubble bursts and releases aerosol, a fine liquid droplet that carries scent. We then smell those scent-carrying aerosols.

Now that you understand the great science beyond rain scent, you might be able to appreciate the odour of rain even more!

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Thanks to
Editor: Jin Chun
Designer: Tae Hyun Kim

Fun Science Facts

Yr 8 Sua Yoo

At NLCS Jeju, you learn many scientific and mathematical facts like a chemical equation, Einstein's theory of relativity or Pythagoras' theorem. However, there are plenty of facts that you probably would not have heard about before, which would surely fascinate you.

1 **Water can boil and freeze at the same time.**

In other words, water can exist as solid, liquid and gas at the same time at 0.01°C and 611.2Pa. This is called the 'triple point' of water. Also, there are actually a lot of states of matter other than the three we know of, such as excitonium, degenerate matter, superfluid and time crystal.

2 **There is enough DNA strand in an average person's body to go from the Sun to Pluto and back 17 times.**

Each DNA molecule is 5 to 8cm long when it is uncoiled. A human body has approximately 37 trillion cells. If all the DNA molecules in the cells are uncoiled and joined end to end, the total length would be approximately 2x10^14cm, which is enough to travel go from the Sun and back to Pluto 17 times.

3 **Average human body carries ten times more bacterial cells than human cells.**

This was discovered by Carolyn Bohach, a microbiologist at the University of Idaho. However, they are mostly helpful bacteria, so it is not a problem at all that they dwell in our body in such a large number. Indeed, we cannot live without them. Carolyn Bohach also discovered that there are more living organisms on a single human than the number of humans on Earth.

4 **Octopuses have three hearts, nine brains and blue blood.**

Two of the hearts are behind their gill. The other one is the 'main' heart used for circulation of blood. Actually, this heart stops beating when the octopus swims. Also, it has a brain at the end of each tentacle and one in the head, making a total of 9 brains. Blood of octopus is blue because it contains copper-based cyanoglobin, while humans use iron-based haemoglobin.

5 **E-mail has existed for longer than the World Wide Web(WWW).**

In 1894, people could send emails by using a computer and a rotary telephone to connect to a service called Micronet. Although it was a very inconvenient, slow method, it was the pre-WWW.

6 **It takes 12 days for a million seconds to pass but 32 years for a billion seconds.**

This is proven with simple calculations. Moreover, it takes 31,709.8 years for a trillion seconds to pass.

7 **In a room with 23 people, there is 50% chance of 2 people sharing the same birthday.**

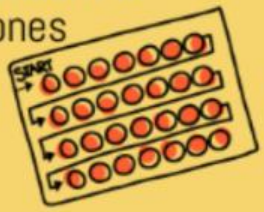
This is known as the birthday paradox. When the 23 people's birthdays are compared to each other, the first can be compared with 22 birthdays, the second with 21 (because the first person had already been done), the third with 20 and so on. Therefore the total possible comparisons are (22 + 21 + 20 + 19 + ... +1) 253, which is just over the half of 365.

Thanks to
Editor: Ihyun Nam
Designer: Chee Won Choi

Contraceptive pills

Women take the pill by mouth to prevent pregnancy

The contraceptive pill contains a small amount of man-made estrogen and progestin hormones



P

it is up to 99% effective.

N

it does not protect against sexually transmitted diseases, including HIV

- change the cervical mucus to make it difficult for the sperm to go through the cervix and find an egg.
- prevent pregnancy by changing the lining of the womb so it's unlikely the fertilized egg will be implanted.

The contraceptive implant (Nexplanon) is a small flexible plastic rod that's placed under the skin in your upper arm by a doctor or nurse.

P

99% effective.
long-term protection from pregnancy for up to 5 years
totally free or low cost with most health insurance plans, Medicaid and some other government programs
provides total privacy

N

it doesn't protect against STDs
it requires doctor's prescription

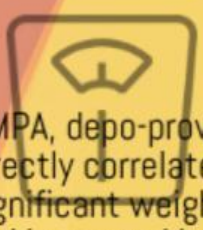
Side effects...?
weight gain / headaches / mood swings
breast tenderness / irregular bleeding
hair loss / skin rash and acne

- Progestin thickens the mucus on the cervix, which stops sperm from swimming through to your egg.
- Progestin can also stop eggs from leaving your ovaries (ovulation), so there's no egg to fertilise.

Hormone progestin is in the shot and helps prevent the release of an egg every three month.

P

it is more than 99% effective
it lasts for 8 or 13 weeks depending on which injection you have
it can be useful for women who can't use contraception that contains oestrogen



DMPA, depo-provera, is directly correlated with significant weight gain and increased body fat.

N

it requires a doctor's prescription
it doesn't protect against sexually transmitted infections (STIs)

- Making cervical mucus thicker in the female body, which prevents sperm from getting into the eggs
- Keeping eggs in the ovaries, so they can't join the sperm

ALL ABOUT USB

WHAT IS IT?

USB is a serial port that provides a standard method of connecting external devices. Tiny memory stick we use is only an example of USB.

EXAMPLES

Memory stick
Printer
Keyboard
Computer mouse

HOW DOES IT WORK

#1
An USB port is connected to a computer.

#2
Computer detects the USB.

#3
Device driver is loaded for effective communications.

#4
For a new USB, a new device driver is loaded.

THE FUTURE OF USB

ASAP connect:
Reversible in both ends of the cable/
Magnet connection/
Larger size - transport mass data/
Connect and disconnect more easily with less damage/
e.g. cell phone charger

Photo reference

"Scientists Confirm the Universe Has No Direction." *Phys.org - News and Articles on Science and Technology*, Phys.org, phys.org/news/2016-09-scientists-universe.html.

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