TED
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MOLECULAR BIOLOGY CLUB

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Editor: Simay Yüksel
Supervisors: Ceren Anatürk Tombak
&
Zeynep Boyacıoğlu

Atatürk's Address to Turkish Youth

Turkish Youth!

Your first duty is forever to preserve and to defend Turkish Independence and the Turkish Republic.

This is the very foundation of your existence and your future. This foundation is your most precious treasure. In the future, too, there may be malevolent people at home and abroad who will wish to deprive you of this treasure. If someday you are compelled to defend your independence and your republic, you must not tarry to weigh the possibilities and circumstances of the situation before taking up your duty. These possibilities and circumstances may turn out to be extremely unfavourable. The enemies conspiring against your independence and your republic may have behind them a victory unprecedented in the annals of the world. It may be that, by violence and ruse, all the fortresses of your beloved fatherland may be captured, all its shipyards occupied, all its armies dispersed and every part of the country invaded. And sadder and graver than all these circumstances, those who hold power within the country may be in error, misguided, and may even be traitors. Furthermore, they may identify their personal interests with the political designs of the invaders. The country may be impoverished, ruined, and exhausted.

Youth of Turkey's future!

Even in such circumstances, it is your duty to save the Turkish Independence and Republic.
You will find the strength you need in your noble blood flowing through your veins!

Mustafa Kemal ATATÜRK

Dear Readers,

Angela Duckworth, the author of the New York Times bestseller book “Grit”, has written in her book, “Make a commitment to pursue something you love and believe in with singular energy, discipline, and hard work.” Inspired from this quote, I followed my desire to contribute to the TED Ankara College students who have similar interest or goals with mine by providing advocacy for their studies and future goals. As a result, the “TED Molecular Biology Club” was created in 2022 with lots of effort, elaboration, and dedication to molecular biology. In the first issue of our club’s magazine, we are extremely thrilled to share our studies and activities conducted throughout the year with you!

Molecular biology, emerging with the development of branches, such as genetics, biochemistry, cell biology and biophysics, has become a very popular discipline in the science world, catching the attention of multitudinous researchers. Consequently, new research and scientific developments in this field have been accelerating.

As we have gone deeper into molecular biology and related science areas, we have been amazed at the opportunities that science provides, and the promising potential of molecular biology for the future.

This year our club housed more students who are passionate about molecular biology, and this issue is focused more on the research studies of our members compared to our first issue.

In addition, one TED Ankara Biology teacher, Zeynep Boyacıoğlu, joined us, who graduated with a Molecular Biology and Genetics Major at Bilkent University. So starting from this year (included), we will be guiding our members with two biology teachers dedicated to do so!

We hope you enjoy our second issue while exploring the power of molecular biology.

Stay in science!

Simay Yüksel

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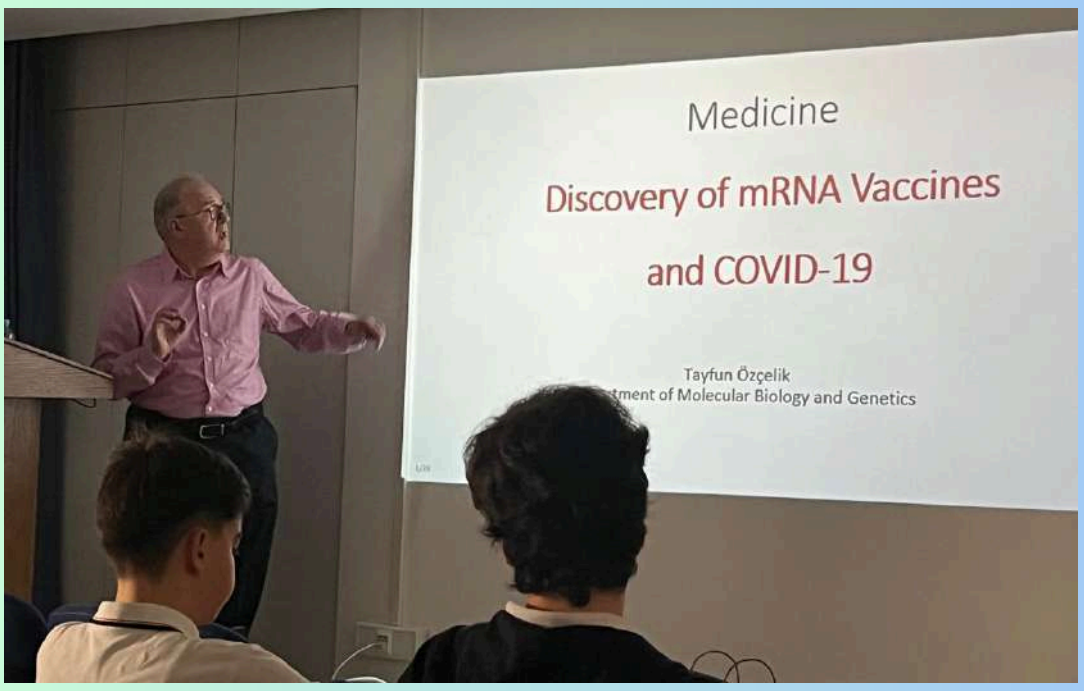
A TRIP TO THE DEPARTMENT OF MOLECULAR BIOLOGY AND GENETICS AT BILKENT UNIVERSITY

On 2nd April, we had a science trip to Turkey's one of the most reputed universities in molecular biology and genetics: **Bilkent University**.

When we arrived at Bilkent University, Prof. Dr. Tayfun Özçelik, the dean of the Faculty of Science and the Head of the Department of Molecular Biology and Genetics, welcomed us. He provided us with detailed information about the molecular biology and genetics major and answered all of our questions with a big patience and politeness.

Afterwards, we visited the research laboratories where the research studies of Master's Degree and PhD students are conducted. The laboratory supervisor, Seda Şengül Birkan, introduced us to the laboratories and the possible opportunities that can be conducted.

In this science expedition organized at our school for the first time by our club, we had an opportunity to learn more about the recent international research and projects done at Bilkent University and meet with reputed academicians in the university.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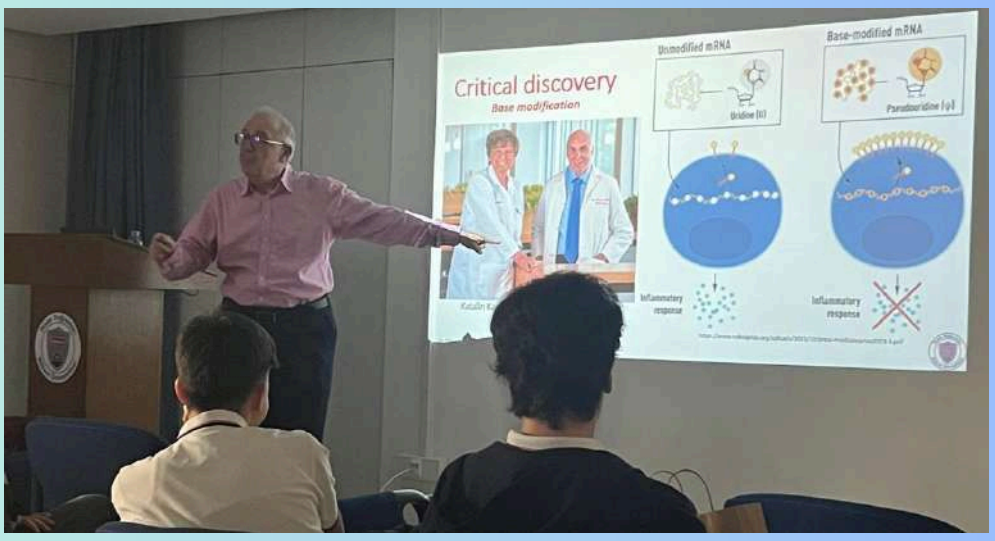
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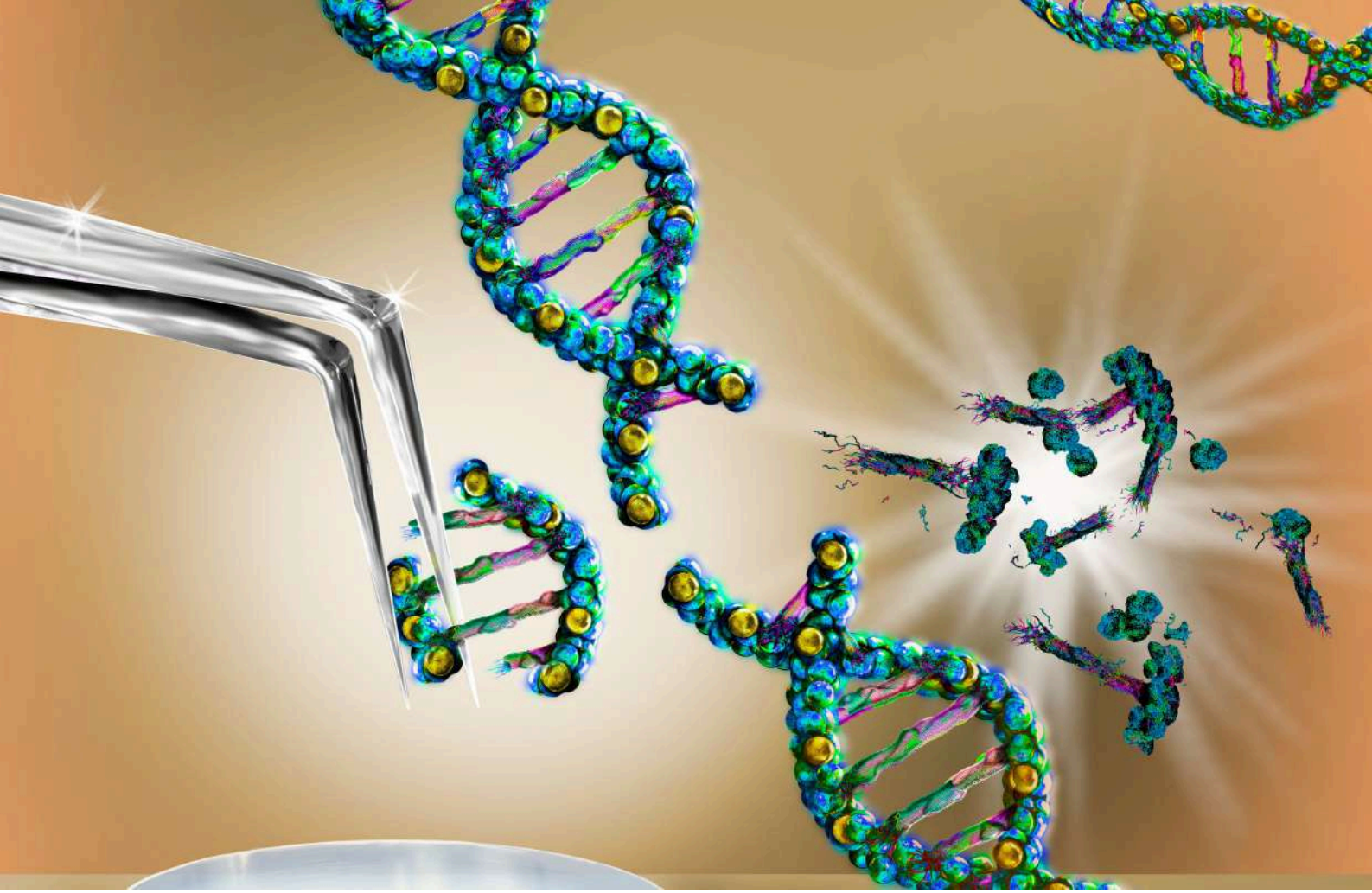

FANZOR VS. CRISPR

Zeynep Ece Yılmaz
11/A

Fanzor and CRISPR are both genetic modification techniques though both function differently. Gene modification is the process of editing an organism's DNA using laboratory-based technology. This could include changing a single base pair (A-T or C-G), deleting a segment of DNA, or inserting a new segment of DNA.

CRISPR technology has transformed the area of gene editing in recent years, winning its creators the Nobel Prize and serving as the foundation for countless scientific advances, including accurate genome changes and possible therapies for genetic illnesses. Later on, a new gene-editing technique called Fanzor, discovered by MIT researchers in August 2023, threatens to push the envelope even further. This discovery triggered fierce competition between two famous research teams, each eager to publish their findings first and eventually issuing preview articles to gain priority.

The main difference between these concepts is that CRISPR originated in prokaryotes and Fanzor is used in eukaryotes. CRISPR, which uses a Cas protein commanded by a single-guide RNA, is known for its high effectiveness and accuracy in modifying sequences of DNA. On the other hand, Fanzor's configurable RNA-guided system in eukaryotes uses its variety of proteins and RNA parts making it a fresh method for genetic engineering.

The divergence between prokaryotic and eukaryotic techniques plays an essential role in gene editing since they differ significantly in cellular structure, complexity, and gene regulation. Prokaryotic cells lack nucleus and membrane-bound organelles, resulting in simpler gene regulation and expression systems that frequently use operons. In contrast, eukaryotic cells have a separate nucleus with linear DNA, and complicated regulatory processes that include chromatin remodeling and RNA splicing. Gene editing techniques, such as CRISPR-Cas9, which began in prokaryotes, require specific modifications in order to function effectively in eukaryotes. Furthermore, delivery strategies for gene editing tools differ greatly between these cell types, with eukaryotic cells frequently requiring more sophisticated systems. Gene editing uses also vary; prokaryotic gene editing is used in industrial and environmental contexts, whereas eukaryotic gene editing has important implications in health, agriculture, and biotechnology. These distinctions demand customized methodologies to assure effective, safe, and ethical gene editing practices for each organism type.

As CRISPR has become a broad acceptance in studies, the field of biotechnology and medicine because to its many applications and simplicity of use, Fanzor is likely in the early phases of development so it demans greater investigation. CRISPR is simply a method of locating a specific piece of DNA within a cell. The subsequent step in CRISPR is generally to modify that portion of DNA. Nevertheless, CRISPR has been developed to do various functions, such as turning genes on or off without disrupting their sequence. CRISPR technology, which was originally created to modify specific DNA sequences, has expanded to perform a variety of purposes beyond gene editing. CRISPR interference (CRISPRi) and CRISPR activation (CRISPRa) are two key advances that enable precise gene expression regulation without changing the DNA sequence. CRISPRi uses a catalytically dead Cas9 (dCas9) protein to inhibit transcription, effectively turning genes off, whereas CRISPRa uses dCas9 coupled with transcriptional activators to increase gene expression. These features allow researchers to explore gene activity and regulatory networks in more detail. CRISPR has also been developed for base editing, which allows for the conversion of specific DNA bases without causing double-strand breaks, and for epigenetic alterations, in which dCas9 is fused with enzymes to change the epigenetic state of DNA, influencing gene expression patterns. CRISPR's varied activities broaden its applicability in gene therapy, functional genomics, and synthetic biology, allowing researchers to examine gene roles in health and illness, devise therapeutic techniques, and engineer animals with desirable features.

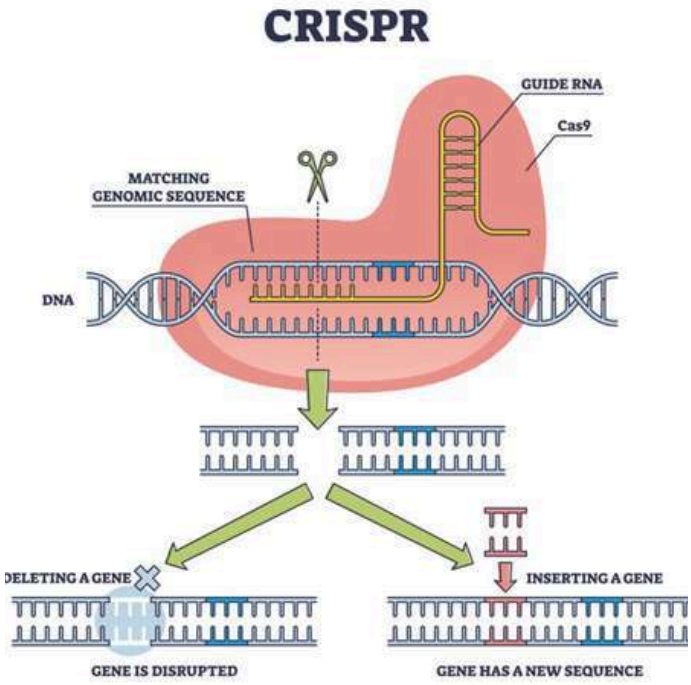

Figure 1: How CRISPR works

Before the CRISPR technology was introduced in 2012, certain plants and animals' genomes could be edited, but it took years and the cost was extremely high. CRISPR has made it simpler. Before CRISPR, One of the most significant ways was the use of zinc finger nucleases (ZFNs), which are created proteins that can cause double-strand breaks at specific DNA sequences, allowing for targeted genetic alterations. Another method was to use transcription activator-like effector nucleases (TALENs), which are similar to ZFNs but have distinct DNA-binding domains, allowing for more precise genome editing.

OMEGAs (Obligate Mobile Element-guided Activity) are a class of prokaryotic proteins hypothesized to be an early ancestor of the Cas9 enzyme, which works in the CRISPR system as programmable DNA "scissors". Molecular genealogy studying revealed that a single one of the OMEGA proteins, TnpB, most likely gave rise to CRISPR-Cas systems in microorganisms and may also be the ancestor of the eukaryotic Fanzor. This study shows that Fanzor is related to CRISPR and possesses gene-editing ability.

Fanzor systems, which vary from 400 to 700 amino acids, are more compact than CRISPR-Cas systems, which range from 1,000 to 1,600 amino acids, and may be easier to transport to cells and tissues.

The molecule known as guide RNA, which directs the proteins to the targeted DNA for cutting, is a mediator between Fanzor and CRISPR. When the target DNA strand and the ωRNA line up, the two strands zip together, allowing Fanzor to cut the DNA.

Both CRISPR and Fanzor methods have unique strengths and limitations. CRISPR's features include its great efficacy, accuracy, and adaptability, as seen by its use in gene knockouts, activation, interference, base editing, and epigenetic changes. However, its drawbacks include the possibility of off-target effects, delivery difficulties in particular cell types, and the requirement for certain modifications to act well in eukaryotes. Fanzor, on the other hand, despite its early development, shows promise due to its small size and potential for simpler distribution to eukaryotic cells. It proposes an alternate

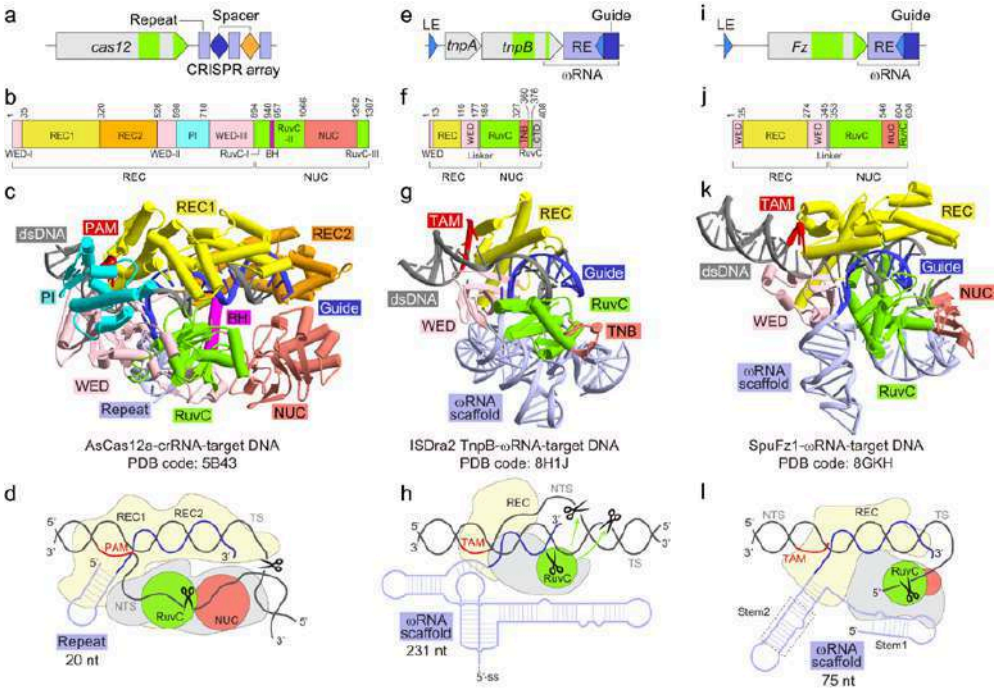

Figure 2: Examples of Fanzor usage

approach for overcoming some of CRISPR's shortcomings, including as off-target consequences. Despite its promise, Fanzor's complete capabilities and limits remain unknown at this time due to its early state of development.

Given these factors, CRISPR is currently better suited for well-established applications in functional genomics, gene therapy, and synthetic biology because to its substantial validation and adaptability. Fanzor, on the other hand, may have potential benefits in areas that need compact gene-editing tools, such as in vivo applications and medicines that must be delivered efficiently to complicated tissues. As Fanzor technology advances, it may supplement CRISPR, giving a more comprehensive toolset for gene editing customized to individual requirements and settings.

The introduction of CRISPR technology transformed gene editing by giving an efficient, accurate, and flexible tool for changing DNA sequences. This innovation has eased genetic changes in numerous organisms while also broadening the field of genetic research and medicinal applications. Despite its success, the development of new gene-editing systems like as Fanzor demonstrates the continued search for ever more adaptive and efficient tools, particularly for complex eukaryotic systems. While Fanzor is still in its early stages, its tiny size and unique RNA-guided mechanism make it potentially useful in eukaryotic cells, opening up new options for future study and applications. As these technologies improve, their complementary capabilities and different methods are anticipated to synergize, propelling greater progress in biotechnology, medicine, and agriculture. The continual improvement of these gene-editing technologies emphasizes the significance of specialized techniques for distinct cellular settings, which ensures the pursuit of effective, safe, and ethical gene-editing procedures.

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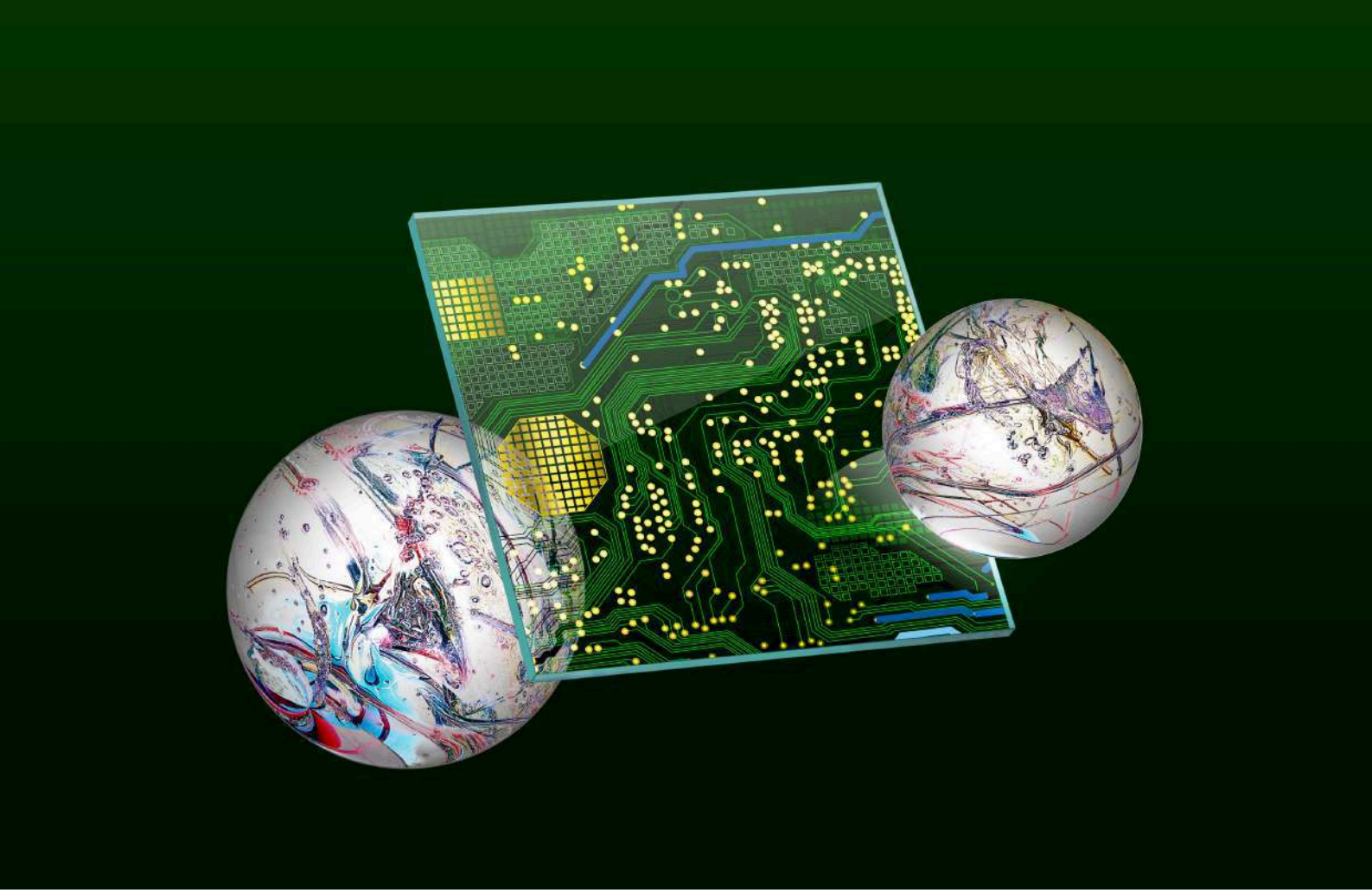

SYNTHETIC BIOLOGY

Azra Ulus
11/R

What is Synthetic Biology?

There are machines everywhere around us; cars, computers, elevators, vacuum cleaners, the list goes on forever. In the last 300 years, engineers have developed many very advanced machines, but humans are not actually the best engineers in the world, nature is much more capable. Millions of years of evolution have led to living organisms being versatile, capable, and adaptive selection.

Synthetic biology, to put it simply, is an interdisciplinary field that uses engineering concepts to tackle different issues by using these living machines that nature has provided. Utilizing life as a tool, synthetic biology builds biological systems with practical uses. When it comes to solving any given problem, a synthetic biologist and a traditional engineer approach it in exactly the same way; it's the tools that separate them. A synthetic biologist employs microorganisms, proteins, and gene circuits, whereas a traditional engineer uses gears, springs, and circuits. For instance, third-world nations are currently facing an increasing number of issues related to access to clean drinking water. A conventional engineer might use the principles of physics to create a device with multiple compartments to purify tainted water. Meanwhile, a synthetic biologist would modify organisms to clean the water.

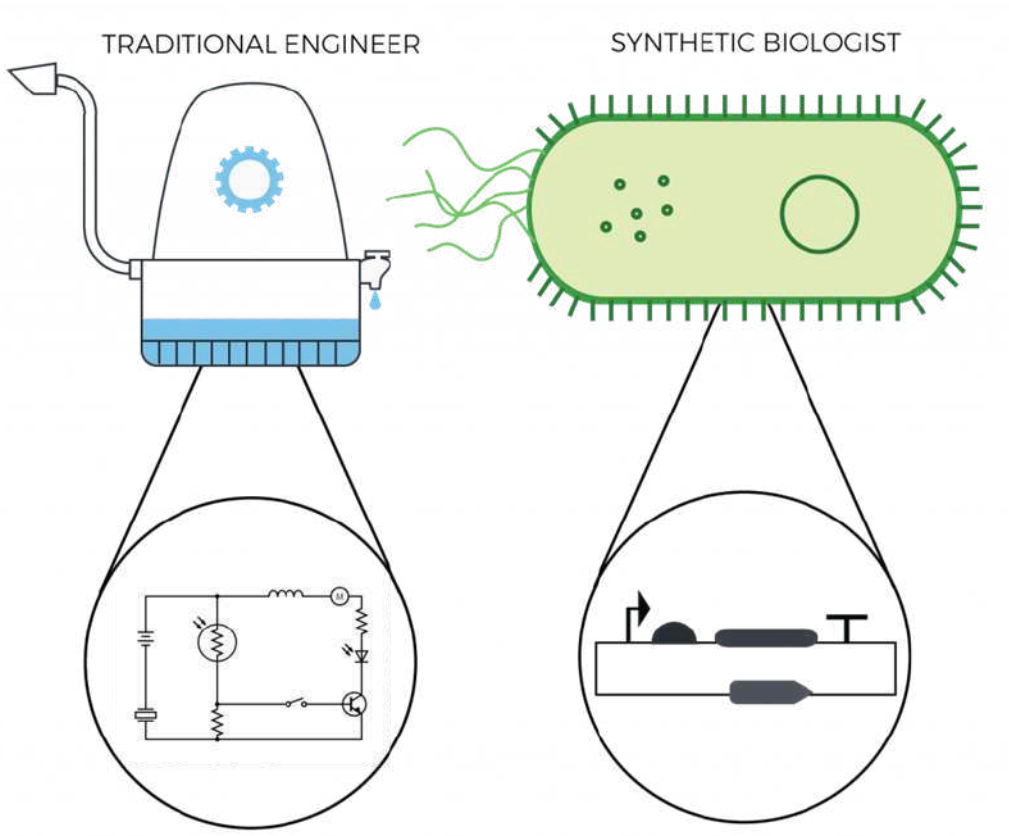

Figure 1: Dirty water cleaning methods (Adapted from: https://web4.bilkent.edu.tr/unambg/tr/sentetik-biyoloji-nedir/)

It could appear that silicon, metal, and polymer-based devices have far greater potential than live, carbon-based devices. However, due to their significant differences, the two are improper. The machines made of silicon and metal were constructed by humans, who have also spent many years perfecting them and are aware of their capabilities. However, biology is something that humans invented, and as such, we are still in the study phase and are working to understand it.

The foundation of synthetic biology is the development of new biological systems or the modification and fusion of preexisting ones. It does this through tampering with DNA, the "blueprint" of life. Proteins are the building blocks of biological systems, and DNA encodes proteins. We can change systems by modifying proteins, which is made possible by modifying DNA. "Genetic circuits" are the DNA segments that code for biological systems. Computer-like logic gates can be created by combining genetic circuit elements like "Initiator" and "Finisher." The control is more responsive the more intricate the circuits. Thus, utilizing genetic circuits, synthetic biologists may program different systems into living cells, which can then be employed for a variety of purposes.

Synthetic biology has many applications and can be utilized to solve a wide range of issues. The six primary industries of current synthetic biology applications are energy, food, medicine, environment, diagnostics, and manufacturing. It is possible to engineer microorganisms to detect and cure a wide range of illnesses. For instance, scientists at the J. Craig Venter Institute are developing probiotic bacteria that will allow diabetics to recognize rising glucose levels and generate insulin. Another method being utilized to counteract global warming is synthetic biology. A US-based startup wants to use genetically modified bacteria to take carbon from the atmosphere and turn it into biofuels. These living devices can also be utilized to detect and eliminate environmental pollutants, make goods for the market, produce food, and more. These applications have only been tried before. As our understanding of biology deepens, we are able to manipulate living things more effectively. In the future, we

may be able to cure cancer, build buildings, improve computers, colonize planets, and more.

The field of synthetic biology has great promise for the advancement of humankind. Living machines are low-cost, strong, and versatile tools with a wide range of possible uses in various fields and daily life. When using synthetic biology as a tool, unexpected things can happen. From an ethical perspective, a number of contentious uses of synthetic biology, including the revival of extinct species and the production of genetically modified offspring, must be taken into account. Of course, none of these uses are meant to cause harm. However, there are a lot of factors to take into account before doing them. Since these applications may have unanticipated repercussions, they are usually avoided. Resurrecting dinosaurs, for instance, may seriously upset food chains and result in the collapse of ecosystems. Making genetically modified offspring The field of synthetic biology has great promise for the advancement of humankind. Living machines are low-cost, strong, and versatile tools with a wide range of possible uses in various fields and daily life. When using synthetic biology as a tool, unexpected things can happen. From an ethical perspective, a number of contentious uses of synthetic biology, including the revival of extinct species and the production of genetically modified offspring, must be taken into account. Of course, none of these uses are meant to cause harm. However, there are a lot of factors to take into account before doing them. Since these applications may have unanticipated repercussions, they are usually avoided. Resurrecting dinosaurs, for instance, may seriously upset food chains and result in the collapse of ecosystems. Making genetically modified offspring necessitates altering the human genome, which may result in unintended modifications that can be fatal or cause genetic illnesses and diseases. It is necessary to identify and reduce any potential dangers prior to conducting such risky research. One can potentially use synthetic biology for malicious purposes. To build biological weapons, it might be utilized, for instance, to create a deadly infection that targets various populations and animals. Because species and ecosystems are interrelated, this might result in the collapse of ecosystems and possibly the entire biosphere.

The study of synthetic biology is thriving as a result. Synthetic biology is becoming more and more popular as more affordable and user-friendly methods for sequencing and modifying DNA have been developed. The human genome took 13 years and 2.7 billion dollars to sequence many years ago. These days, a modern lab can complete the task for two to three thousand dollars and in a few days. Whole genomes can be sequenced for less than ten dollars in the future, right in people's basements. The capabilities of biological engineering are being expanded by the quick development of synthetic biology

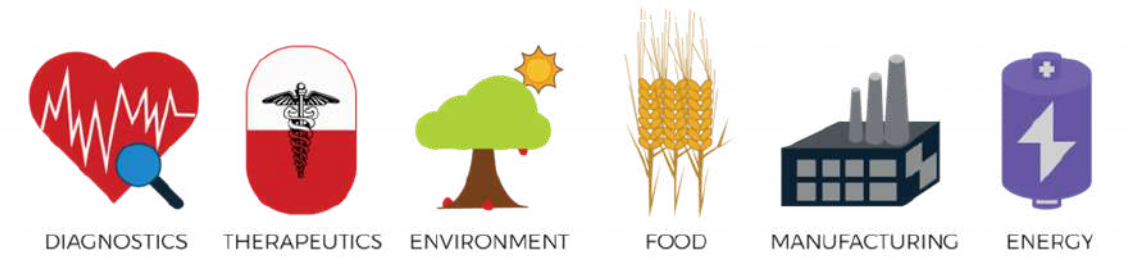

Figure 2: Applications of synthetic biology (Adapted from: https://web4.bilkent.edu.tr/unambg/tr/sentetik-biyoloji-nedir/)

techniques. Future advancements in human development could be attributed to synthetic biology, much to those brought about by the industrial revolution and the widespread use of conventional machinery. Synthetic biology is a promising tool that could solve some of the world's most pressing problems, such as climate change, cancer and hunger. However, synthetic biology can also be used for nefarious purposes, for misuse, leading humanity into a dystopian future. Nevertheless, this should not keep us away from synthetic biology; it should be used in a controlled manner and with caution, taking into account ethical and social concerns.

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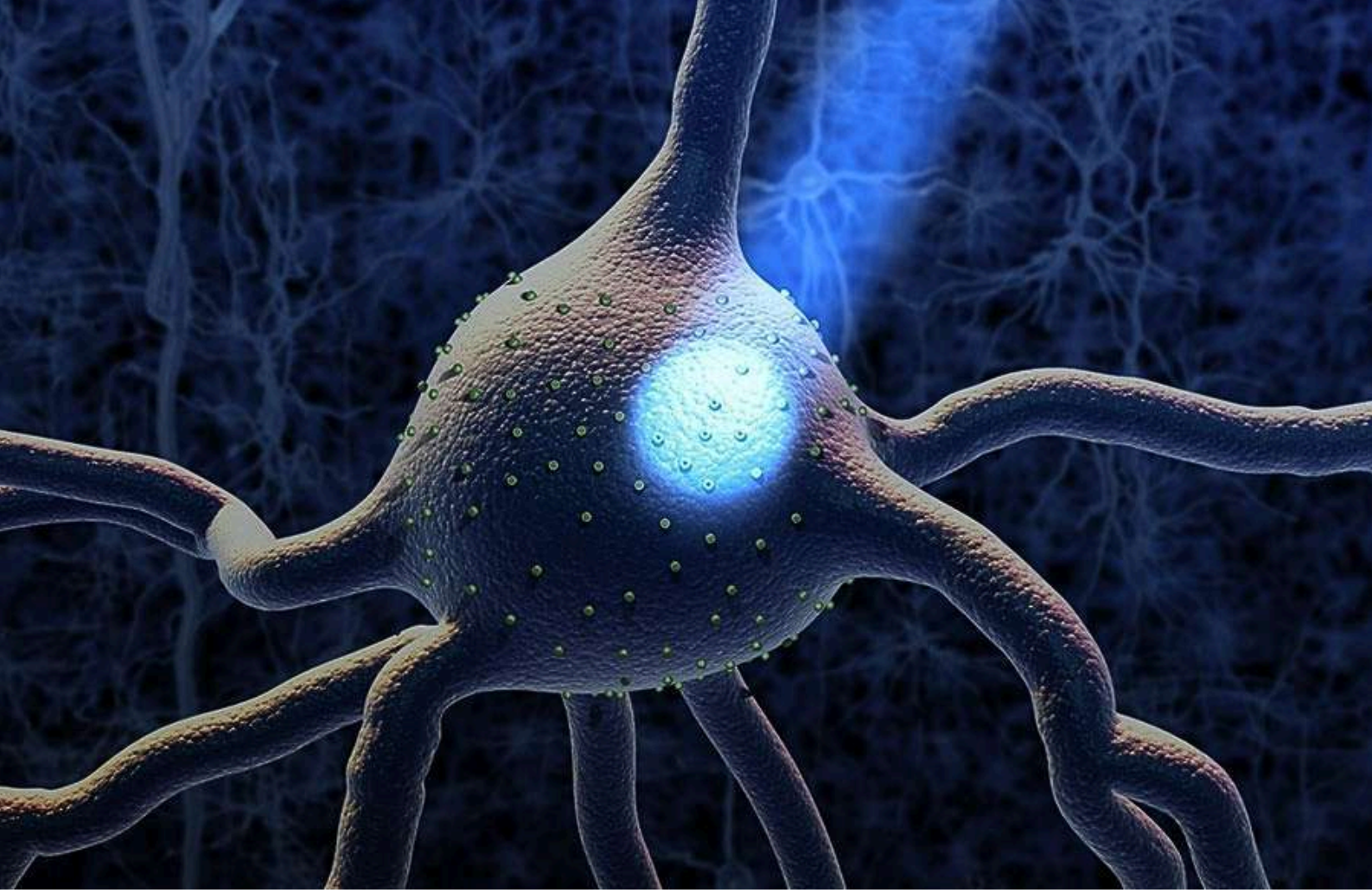

OPTOGENETICS

Eylül Ada Bozkurt
11/C

Optogenetics' journey, started in the late 20th century, continues to develop itself by numerous studies that are dedicated to improve the way to control the activity of neurons or other cell types with light. Under Francis Crick's leadership, this journey began with a suggestion stating that controlling all cells of one type in the brain, while leaving the others more or less unaltered, is a real challenge for neuroscience. Crick hypothesized that a technology utilizing light might be helpful to control neuronal activity with temporal and spatial precision. However, there was no method at the time to make neurons responsive to light. The discovery and application of microbial opsins, or light-sensitive proteins found in algae, such as channelrhodopsins, in the early 2000s marked a significant advancement. Researchers could precisely control the firing of these neurons using light by genetically engineering neurons to express these opsins. This cutting-edge method transformed the study of neuroscience by providing previously unattainable insights into the structure and operation of the brain as well as the neural circuits that underlie behaviour. Since then, optogenetics has moved beyond neuroscience and been used to investigate a variety of biological systems. It also keeps developing as a result of developments in complementary technologies, opsin engineering, and light delivery techniques.

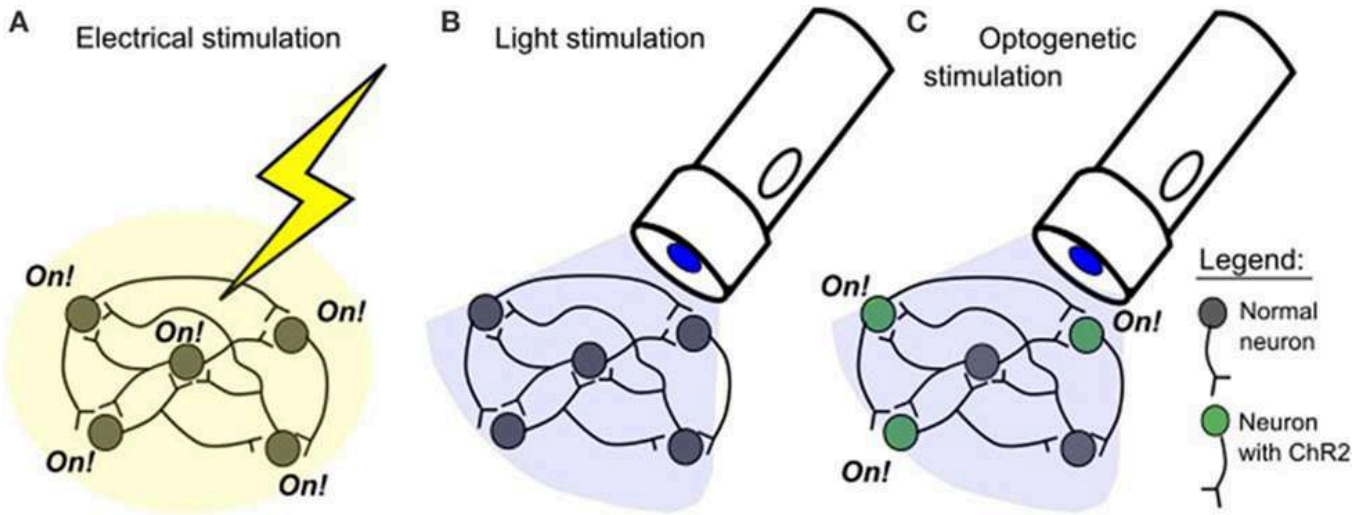

Figure 1: Lim, D. H., & LeDue, J. (2017). What is optogenetics and how can we use it to discover more about the brain? Frontiers for Young Minds, 5.

What is Optogenetics?

Optogenetics is an approach to accurately controlling and monitoring the biological functions of a cell, group of cells, tissues, or organs with high temporal and spatial resolution by using optical systems and genetic engineering technologies with the help of light. Through the introduction of light-sensitive proteins like channelrhodopsins into particular neurons, scientists can manipulate neural circuits with precise timing and location. This method has revolutionized the neuroscience field, enabling extensive study of brain functionality, behaviour, and neural links. Optogenetics is classified depending on the types of opsins used and their specific roles in either activating or inhibiting neuronal activity.

Figure 2: Forsythe. (2023, January 25). Optogenetics: Using light to excite the brain - IEEE Pulse. IEEE Pulse.

Future of Optogenetics

Future medical applications and scientific research may be revolutionized by optogenetics. Developing more sensitive and versatile light-responsive proteins will enable better regulation of brain activity which is the aim of opsin engineering developments. Future innovations like transcranial light delivery systems and wireless optogenetic devices should improve in vivo applications reducing the level of invasiveness and increasing the therapeutic benefits of the approach. Furthermore, even more precise manipulation and observation of biological processes can be achieved by combining optogenetics with state-of-the-art techniques like CRISPR gene editing and sophisticated imaging tools. In the end, optogenetics will become a fundamental aspect of both applied and basic biomedical sciences as a result of these advancements which could lead to breakthroughs in personalized medicine and promising new treatments for neurological and mental illnesses.

Conclusion

In conclusion, optogenetics is a revolutionary combination of genetics and photonics that offers unprecedented precision in the regulation and study of cellular processes, especially those related to the nervous system. Since its inception, it has revolutionized neuroscience by providing deep insights into behaviour, brain function, and the processes underlying disease. Not only is its ability to influence single neurons with light revolutionize basic research, but it also holds significant therapeutic promise. Integrating opsin technology, light transmission methods, and other biotechnologies, optogenetics is expected to extend beyond neuroscience and impact many areas of medicine and biology as the field evolves. Optogenetics is expected to continue to advance, making it an important tool in both clinical therapy and research.

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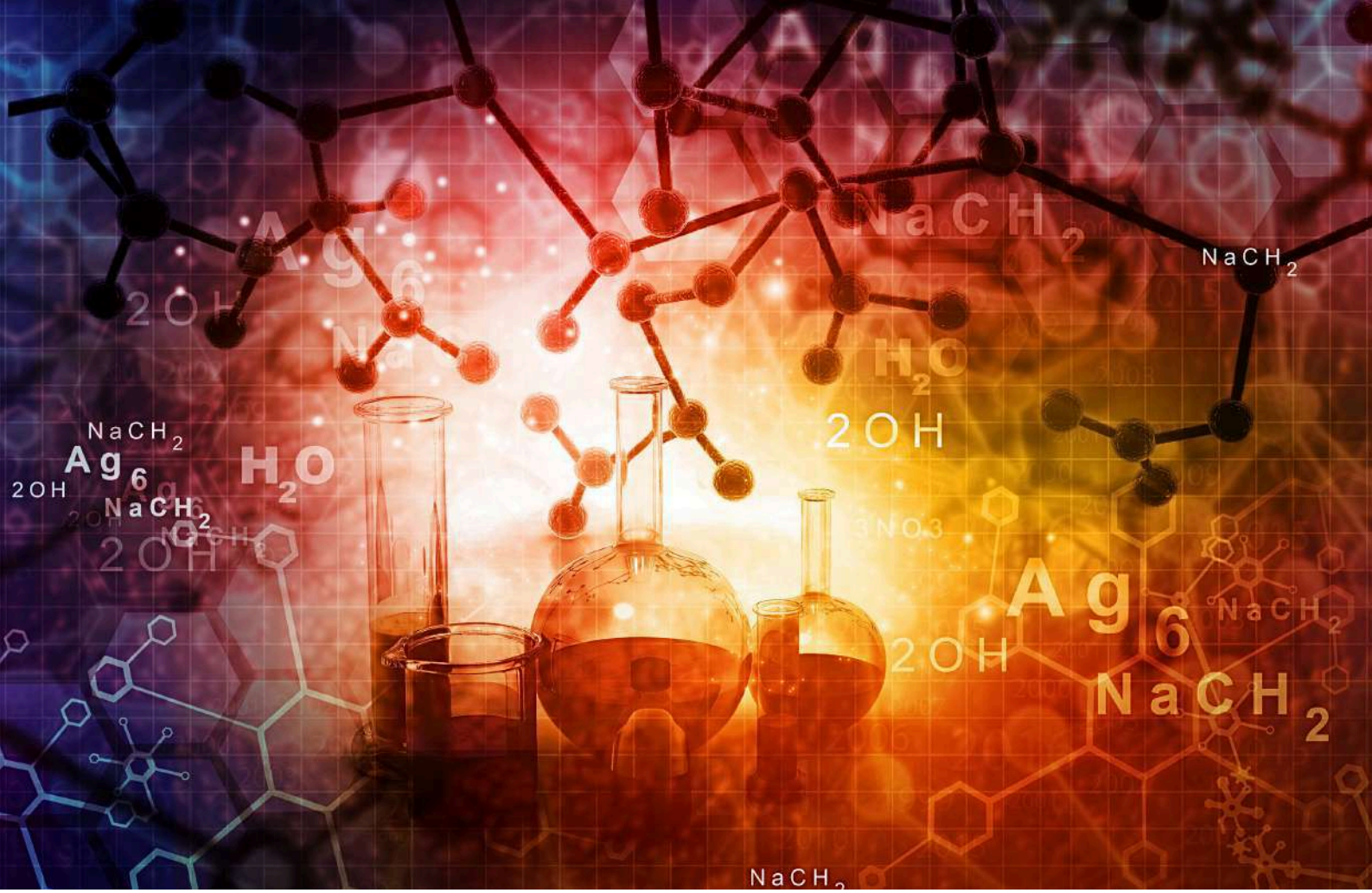


CELLULAR BIOCHEMISTRY

Kardelen Oktay
11/J

Cellular biochemistry is one of the branches of biochemistry that concentrates on analyzing the chemical reactions and substances present in living cells. This branch examines molecular mechanisms underlying numerous molecular activities such as signal transduction, gene expression, cell structure, etc.

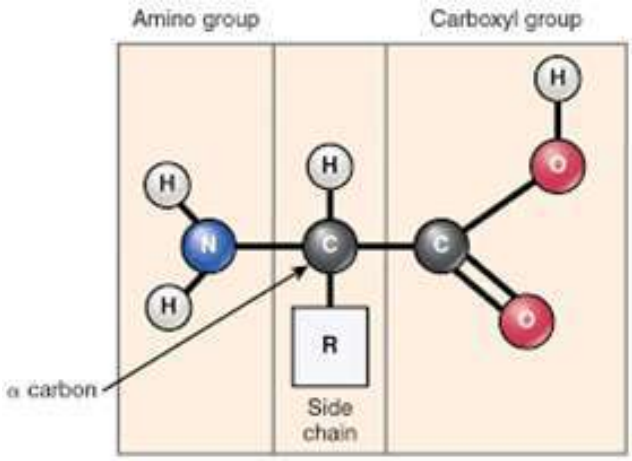
Cellular biochemistry investigates the structures, roles, and interactions (necessary processes like DNA replication, neurotransmission, glycolysis, protein synthesis, etc) of biomolecules, for instance, lipids, carbohydrates, nucleic acids, and proteins, within the cells.

General Structure of Biomolecules

Biomolecules are classified into 4 main groups: proteins, carbohydrates, lipids, and nucleic acids.

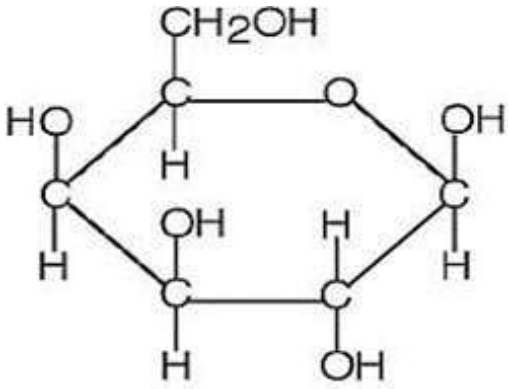
1) Proteins

Proteins are made up of long chains of amino acids, this means monomers of proteins are amino acids. These amino acids are proteins' primary structures and are linked by peptide bonds. These amino acid chains fold into different shapes (forming secondary structure) and are named following their shapes. Amino acids have an alpha carbon (central carbon atom), an amino group (NH2), a carboxyl group (COOH), a hydrogen atom, and an R group that specifies amino acid's properties.



2) Carbohydrates

Monomers of carbohydrates are simple sugars such as glucose and fructose named monosaccharides. Carbohydrates are composed of carbon, hydrogen, and oxygen atoms, typically in a ratio of 1:2:1 (CH2O)n. monosaccharides form rings while polysaccharides are either straight or branched chains. The organizing and bond types of polysaccharides specify their properties and functions in an organism.

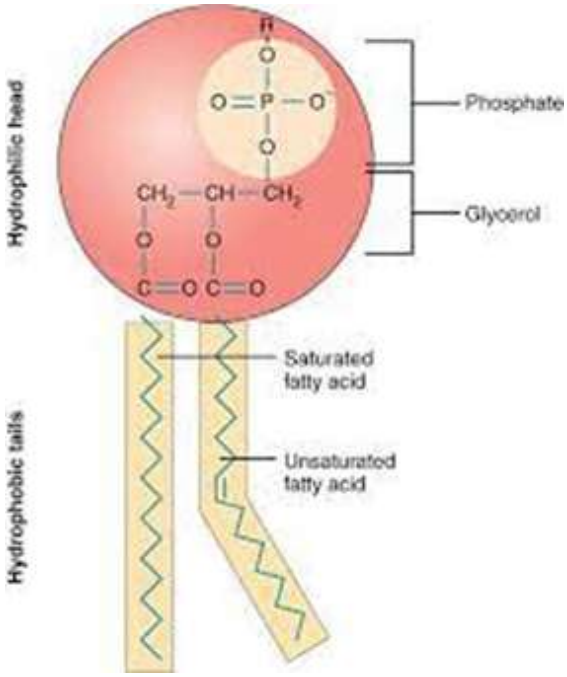


3) Lipids

Fatty acids and glycerol are the monomers of lipids. Lipids have numerous structures but in general, consist of long hydrocarbon chains or rings is their structures. Triglycerides (a combination of glycerol and three fatty acids), phospholipids (composed of a phosphate group, glycerol, and two fatty acids), and steroids (four fused carbon rings) are ingredients of common lipid types.

Fatty acids can be saturated or unsaturated. Saturated fatty acids have no double bonds between carbon atoms and their carbon chains bonds while unsaturated includes one or more double bonds.

Phospholipids have hydrophilic (wafter-attracting) heads and hydrophobic (water-repelling) tails. This structure of phospholipids forms bilayers in cell membranes.



4) Nucleic acids

Nucleic acids like DNA and RNA are composed of long chains of nucleotides, making nucleotides monomers of nucleic acids. A nucleotide includes three components: a phosphate group, a five-carbon sugar (deoxyribose in DNA and RNA), and a nitrogenous base. The base nitrogenous base of the nucleotide determines its type and name (adenine, thymine, guanine, cytosine in DNA, and adenine, uracil, guanine, cytosine in RNA).

Observing the Roles of Biomolecules

Biomolecules are crucial for essential interactions in the human body as well as for cellular biochemistry. They play major roles in extremely diverse critical living processes, though, this section will explain fewer examples to outline the importance and general roles of biomolecules.

DNA Replication

DNA replication is the routine by which a cell duplicates its DNA before cell division. There are some head enzymes to synthesize the new DNA strands such as DNA helicase and DNA polymerase. DNA helicase unwinds the DNA double helix and DNA polymerase replicates the DNA by adding the complementary nucleotides.

Blood Clotting

Blood clotting is a crucial process that prevents inordinate bleeding. A soluble protein in the blood plasma, fibrinogen, is reformed into fibrin (fibrin is an insoluble form of fibrinogen) by the thrombin enzyme. Fibrin prevents bleeding by forming a mesh and keeps blood cells in the blood vessel. Small cell fragments named platelets play a critical role in wound healing by aggregating at the injury site, releasing clotting factors.

Neurotransmission

Neurotransmission is essential for brain function (including muscle controls, mood regulation, etc) and the process by which nerve cells communicate with each other and with other cells with the help of neurotransmitters. Biomolecules like acetylcholine and serotonin are some of these neurotransmitters that are stored in synaptic vesicles. Neurons communicate by releasing these neurotransmitters into the synapse (refers to the site of electric nerve impulses between two nerve cells) and they receive a nerve impulse from another one. These neurotransmitters are synthesized from another biomolecule, amino acids.

Gluconeogenesis (Glucose Synthesis)

Gluconeogenesis is the metabolic process through which organisms synthesize glucose from non-carbohydrate sources such like lactate, amino acids, and glycerol (they are the biomolecules that play a role in glucose synthesis). Key enzymes like pyruvate carboxylase, phosphoenolpyruvate carboxykinase, and glucose-6-phosphatase streamline gluconeogenesis and facilitate the maintenance of blood glucose levels and energy homeostasis which is crucial for living.

Glycolysis (Energy Production)

Energy production (glycolysis) is a metabolic pathway that breaks down biomolecule glucose (also a carbohydrate) into pyruvate, fabricating ATP and NADH in the process and providing energy for cellular activities. Enzymes like hexokinase, phosphofructokinase, and pyruvate kinase catalyze some steps of the glycolysis process, ensuring the productive reforming of glucose into energy.

Photosynthesis

Photosynthesis is the process by which plants produce nutrients from light energy with the help of the pigment in plant chloroplasts (chlorophyll). Biomolecule chlorophyll absorbs light energy and converts it into chemical energy. As a result of this light-dependent reaction, glucose and oxygen are produced. Photosynthesis is essential for the survival of aerobic life forms because one of its products is oxygen and is essential for plants because of the product glucose (plant nutrient).

Conclusion

To wrap up, cellular biochemistry is a crucial discipline to unravel the molecular underpinnings of life. Biomolecules such as proteins, nucleic acids, carbohydrates, and lipids are essential for the continuation of critical cellular processes. Understanding the roles and structures of these molecules is crucial in the sake of clutching and recovering the molecular mechanisms of illnesses.

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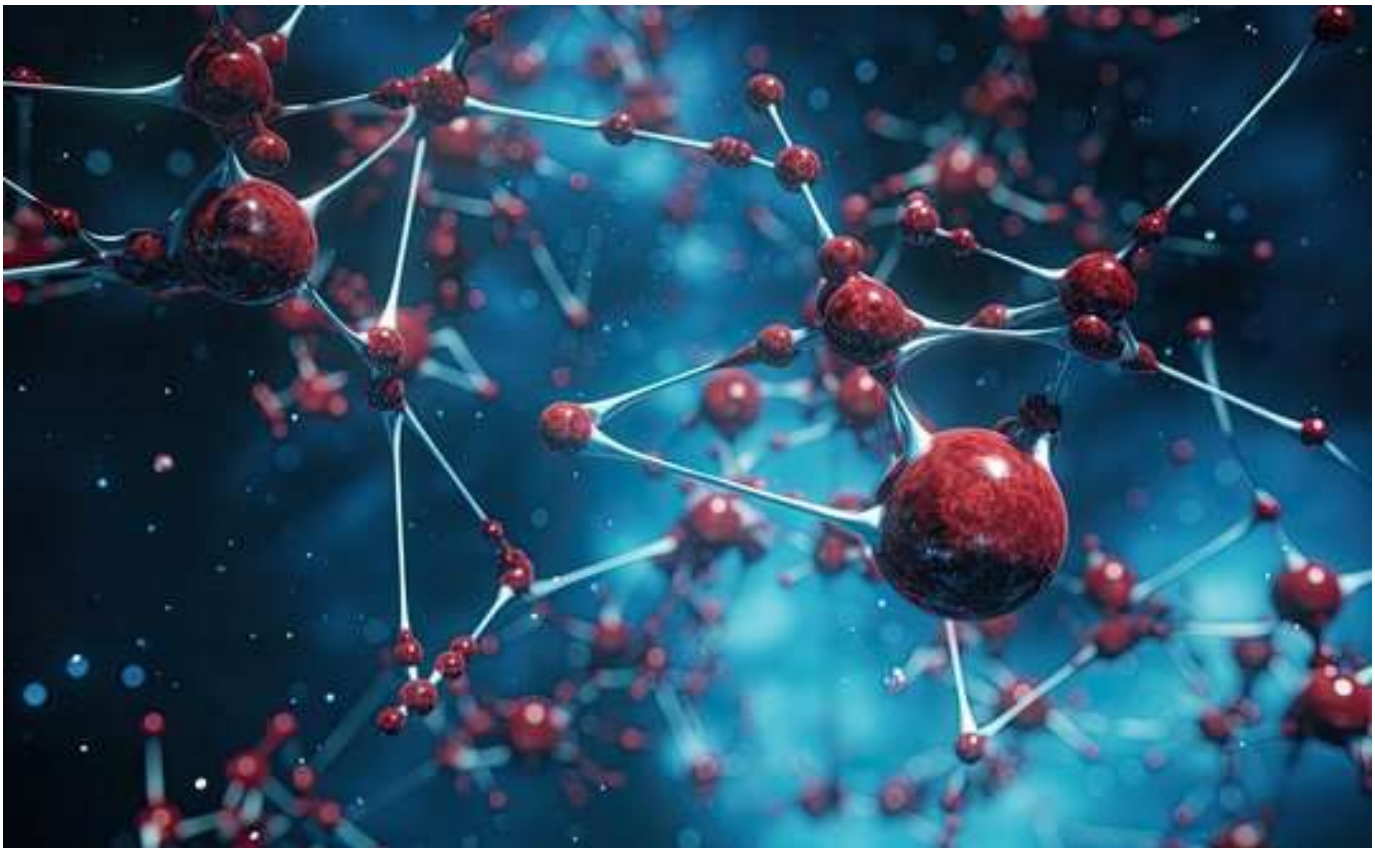

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BIOMEDICAL ENGINEERING

Defne Aslı Gürcan
11/K

Advancing technology has contributed to the development of various scientific fields. One of the engineering fields that merges medicine and biology with technology is Biomedical Engineering, also known as Bioengineering. This engineering discipline aims to improve human life and treat people. Biomedical engineers take advantage of advances in medicine to design biomaterials that are compatible with human anatomy and biological systems, as well as prosthetics, diagnostic tools, and various other medical equipment. Tissue engineering, as well as biomedical engineering, is a field dedicated to repairing and healing human tissues. Tissue engineers and biomedical engineers work together, particularly in the design of medical imaging devices based on biomechanics. While tissue engineers focus more on faulty tissues and medical imaging tasks, biomedical engineers concentrate on the design and construction phases of these devices.

Biomedical engineering is used in many different fields today. It is divided into three different categories from the medical field. The first is diagnostic devices. An ultrasound device can be given as an example of these diagnostic devices. The second category is treatment devices. Pacemakers, insulin pumps, dialysis machines, and surgical robots can be shown as examples of treatment devices.

The last category is prostheses and orthoses. Medical imaging devices are also one of the things that biomedical engineers have introduced into human life. MRI, CT, and PET are a few examples of machines made for this purpose.

Another aspect of biomedical engineers' job is managing clinical settings where medical devices are used. They ensure devices are used correctly, train clinic staff on proper usage, and fix any issues that arise. Although the most important work in this field has been done in the 21st century, its history dates back much further. Biomedical engineering has existed from ancient times to the present. Wax prosthetics from ancient Egypt and medical tools from ancient Greece laid the groundwork for biomedical engineering. During the Renaissance, one of the greatest artists, Leonardo da Vinci, contributed to the field with his anatomical studies and mechanical designs, marking the first Renaissance contributions to biomedical engineering. The roots of these studies extend to modern times, leading to the development of many contemporary medical devices. For instance, the EKG device, which helps detect patient issues, was influenced by Renaissance and ancient innovations.

In the 19th century, Willem Einthoven discovered X-rays. Later, these X-rays led to the invention of the EKG device. Significant inventions by biomedical engineers in the 20th century include MRI and CT scanning systems, which enabled advanced and detailed medical imaging. Artificial hearts and pacemakers, introduced by biomedical engineers during this period, are examples of impactful devices.

The article "How do we ensure that bioelectronic devices revolutionize medicine and healthcare?" authored by Samit Chakrabarty, Gerald Loeb, George Malliaras, and Heyu Yin, published by Cambridge University Press, provides a comprehensive overview of the current state and future potential of biomedical engineering, particularly focusing on bioelectronic devices.

Bioelectronic devices offer transformative potential in a wide range of medical fields. Their ability to provide real-time monitoring, targeted treatment, and improved patient outcomes positions them as a critical technology in the future of healthcare. Continuous research and development is important to fully understand the benefits and solve the associated challenges.

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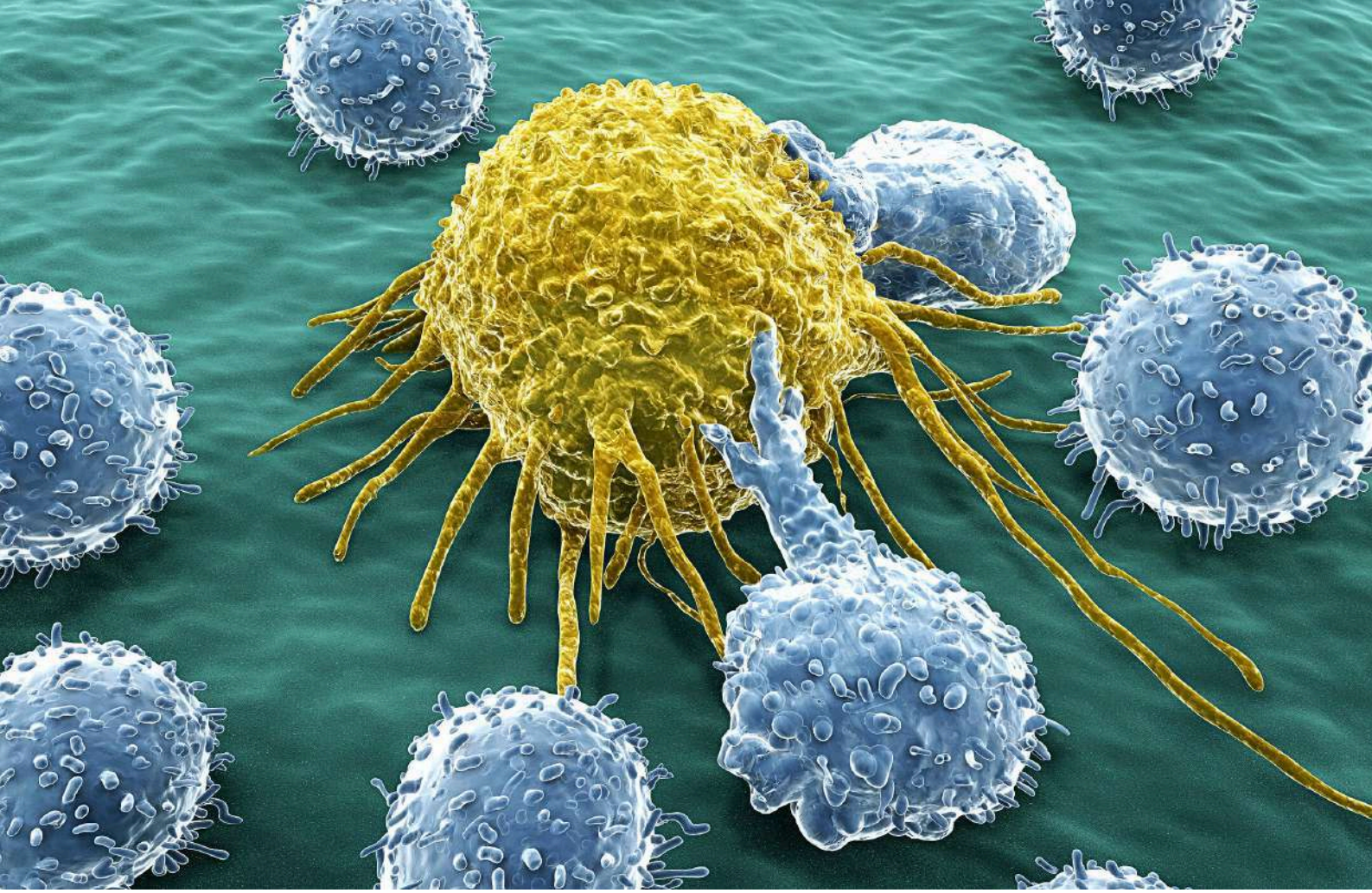


CANCER BIOLOGY

Mustafa Umut Okur
11/J

Cancer is the most death-causing disease globally. According to WHO, every 1 in 5 women and every 1 in 12 men get diagnosed with cancer. Despite the advancements in medical treatments and inventions, it has protected its complex structure and continues to pose a challenge to modern medicine. Understanding its work mechanism plays a crucial role in the early diagnosis and treating the disease.

What is Cancer

Most basically, cancer is a type of abnormality in cell structure that prevents cells from performing apoptosis when unfixable DNA damage has been done. With this abnormality, the damaged cell continues to divide uncontrollably into multiple pieces until it kills the patient.

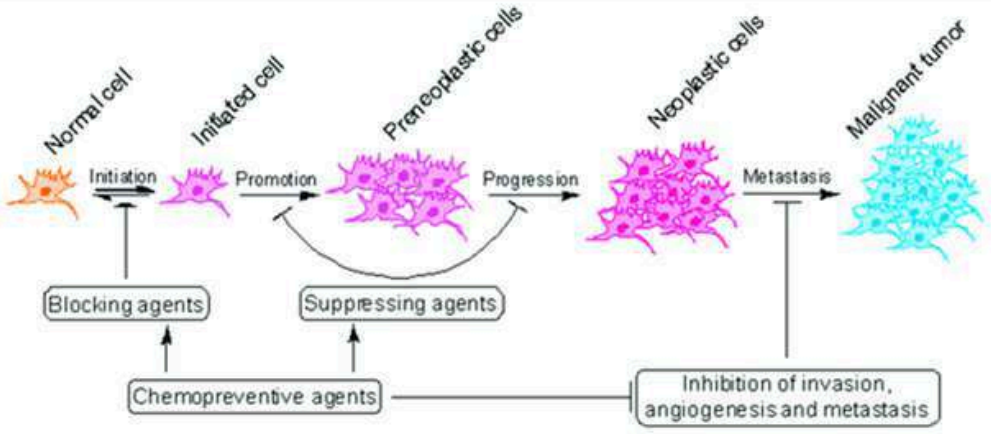
Types of Cancer

Cancer can emerge from every type of cell in living organisms such as lung, brain, blood, and rarely heart. It can also grow slowly or rapidly and can treated effectively or can be deadly.

An experiment done in the USA showed that in 2024 the most diagnosed cancer types are breast (16%), prostate (15%), lung (12%), and colon (8%) cancer. The research also shows every 20 in 100 patients die due to lung cancer.

Mechanism of Developing Cancer

Cells cooperate with each other to form a multicellular structure. Cancers are cells that turn into individual cells instead of being cooperative and create a new multicellular structure inside you. This structure uses your body resources to survive which leads to death. Some structures can cause death due to its weight like brain cancer. It can cause pressure on the medulla oblongata which has lethal results.



Causes of Cancer

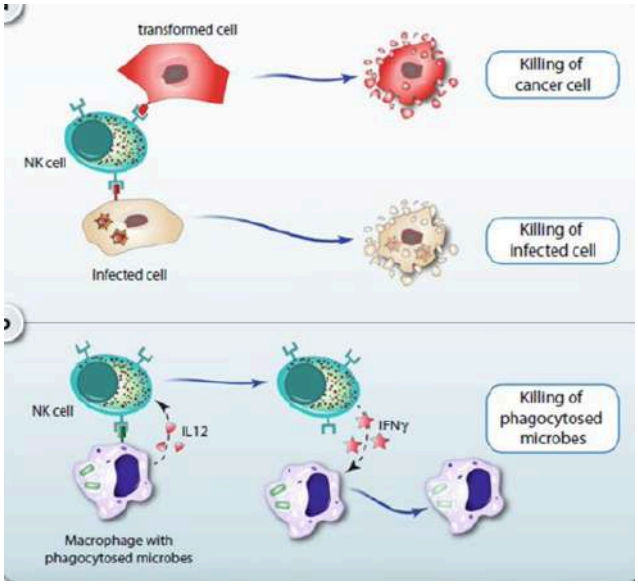
Any damage in DNA can lead to cancer. These damages can be done by smoking, alcohol consumption, obesity, UV, viruses like HPV, and aging. There are also scenarios where mutation occurs without any outer causes.

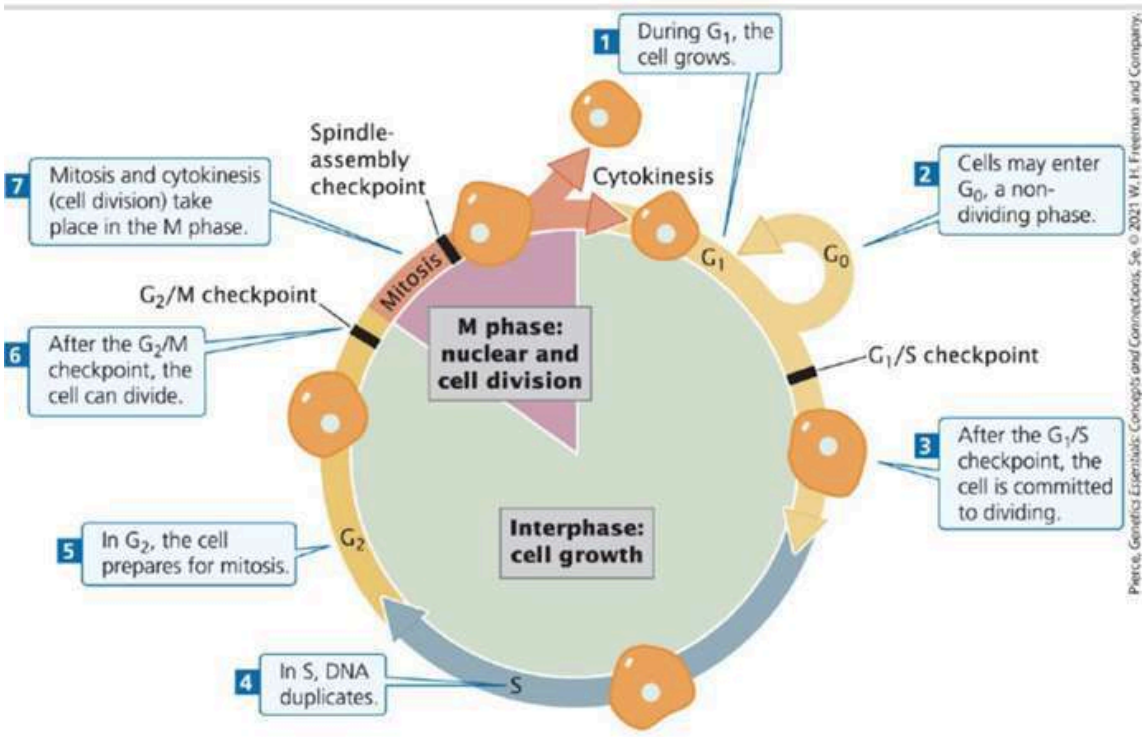
Damages Causing Cancer

Cancer needs some key mutations to arise, one of them is the "TSG (Tumor Suppressor Gene)" mutation. TSGs are scan mechanism that seeks DNA damage to repair and they prevent regular cells from multiplying recklessly.

The second gene that plays an important role in cancer is "oncogenes" Oncogenes are active when an individual is inside the carrier's womb. It helps multiply rapidly to form a living creature in months. When an individual grows enough oncogenes stop being active and cells divide in a regular speed. The reason of cancer being uncontrollably divide is because when these genes are damaged due to mutation in their structure they become active again.

The third gene is "suicide genes". These are groups of genes that cause apoptosis when a cell grows abnormally. One of the suicide genes is HSV-TK (herpes simplex virus thymidine kinase). If these genes get damaged cell cannot enter the apoptosis process.





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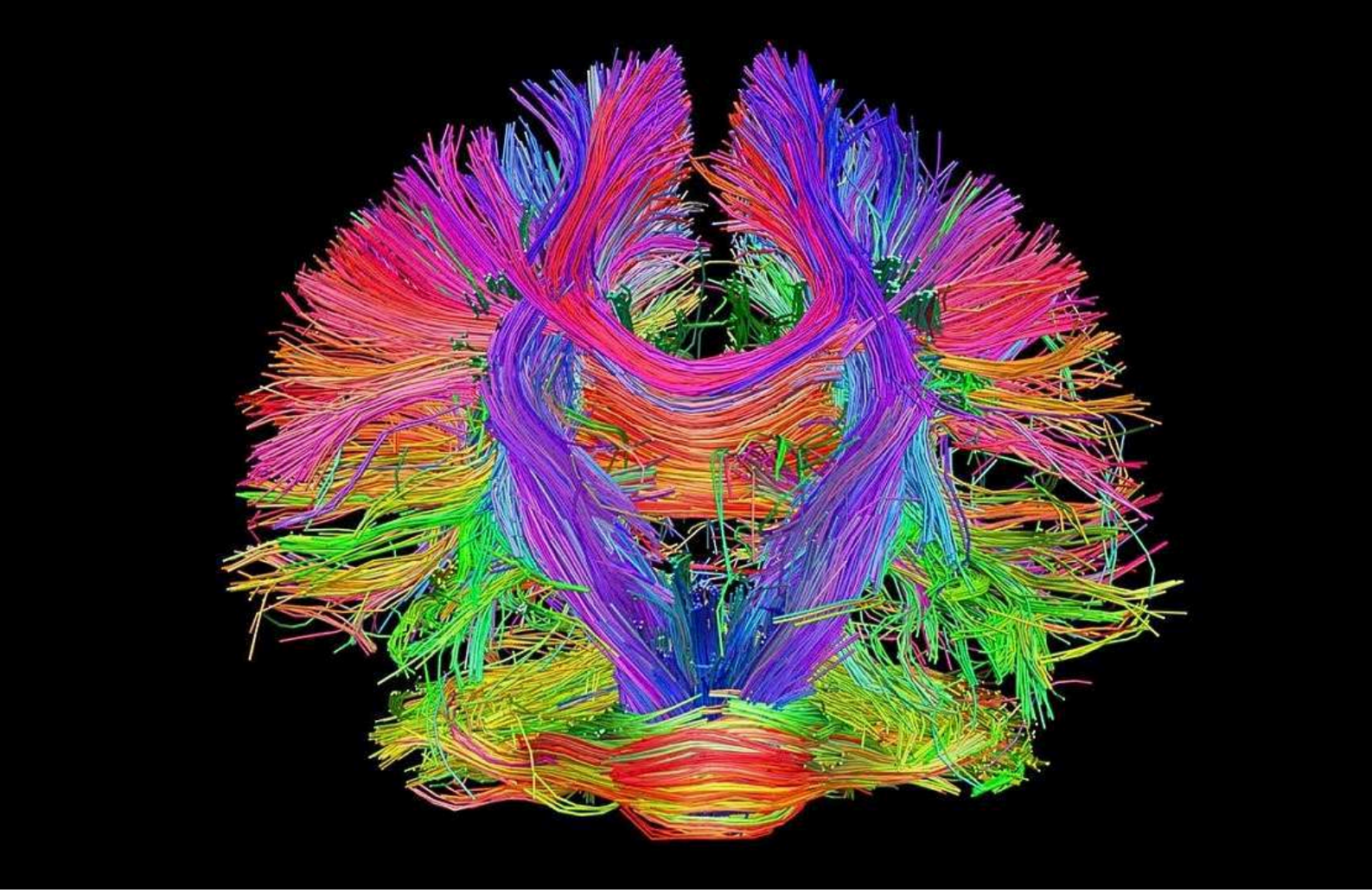


CONNECTOMICS

Melis Özkardeş
10/U

Humans have to use our nervous system in order to do any kind of daily life activities, which can vary from going to school to eating. Connectomics is the branch of neuroscience that studies the production of connectomes which are comprehensive maps of connections within an organism's system.

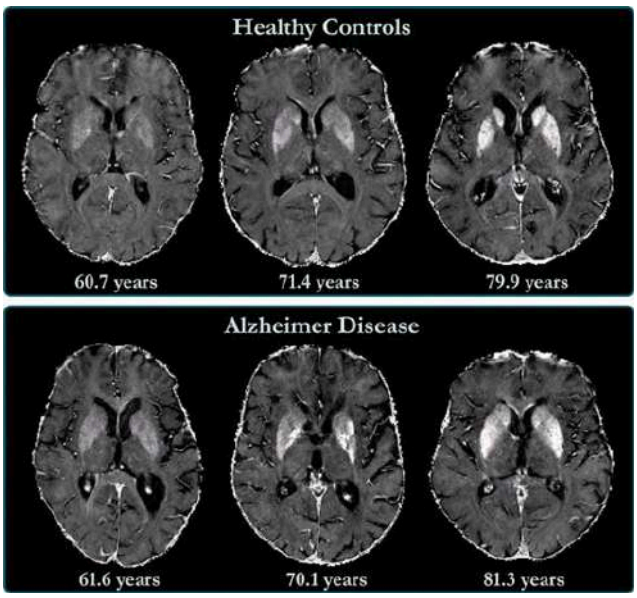
The goal of connectomics is to understand how individual neurons are connected to create functional networks. Creating connectomes, or complex structural maps of connectivity in which every neuron and link is visible, is the aim. What sets it apart is how extensive the connectivity is: We would be able to determine how each neuron is related to each other in a complete connectome. You are your connectome, according to some. During the night, your ideas and feelings are disrupted by a major change in brain activity. However, upon waking up, your thoughts and feelings continue uninterrupted, maintaining your sense of self. This is probably because your brain's connection hasn't changed all that much over the night. Our "self" is essentially the structure of our neuronal wiring, and connectomics holds the key to comprehending this structure.

Application of Connectomics

The connectome can be measured with a wide range of different imaging methods, but magnetic resonance imaging (MRI) is the most used due to its commonness, non-invasiveness and high spatial resolution.

How is connectomics used in personalized medicine?

Structural and functional brain connectomics are considered a basis for a person's behavior and awareness. As a result, variations from normal connection patterns may point to disease processes or even act as biomarkers for certain diseases. Thus far, there has been no direct clinical use of brain connectivity measures for either diagnosis or therapy. However, the literature that is now available on basic and clinical research applications shows significant advancements in our knowledge of the structure and function of the typical and atypical brains.



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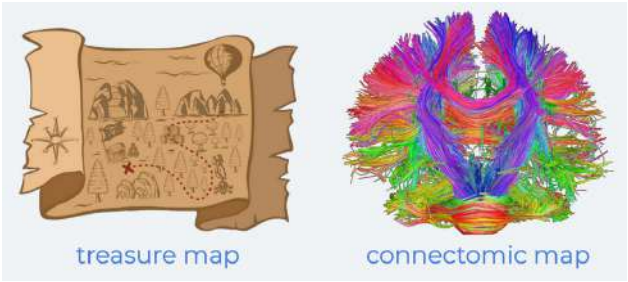


Figure 2: K., A. (Aug.13 2021) An introduction to connectomics. Medium. https://thealexk.medium.com/an-introduction-to-connectomics-10b16d599fe2)

How is connectomics used in the diagnosis of neurological diseases?

Wang et al. reported a highly innovative study revealing how brain networks break down Alzheimer's disease. They use rsfMRI and graph theory, a branch of mathematics used to study networks in order to comprehend how functional connectivity degrades in people with amnestic mild cognitive impairment, (MCI). MCI is a condition associated with a significantly elevated risk of AD; each year, 15% of individuals with amnestic MCI experience symptoms adequate for an AD diagnosis.

How is connectomics used in mental health issues?

Functional connectomics has provided beneficial instruments to define depression as a brain network dysfunction and guide treatment decision-making. Recent research indicates that abnormalities in the functional connectivity and network structure of several brain networks may be associated with mental health disorders such as depression as stated, bipolar disorder and other disordered emotional states.

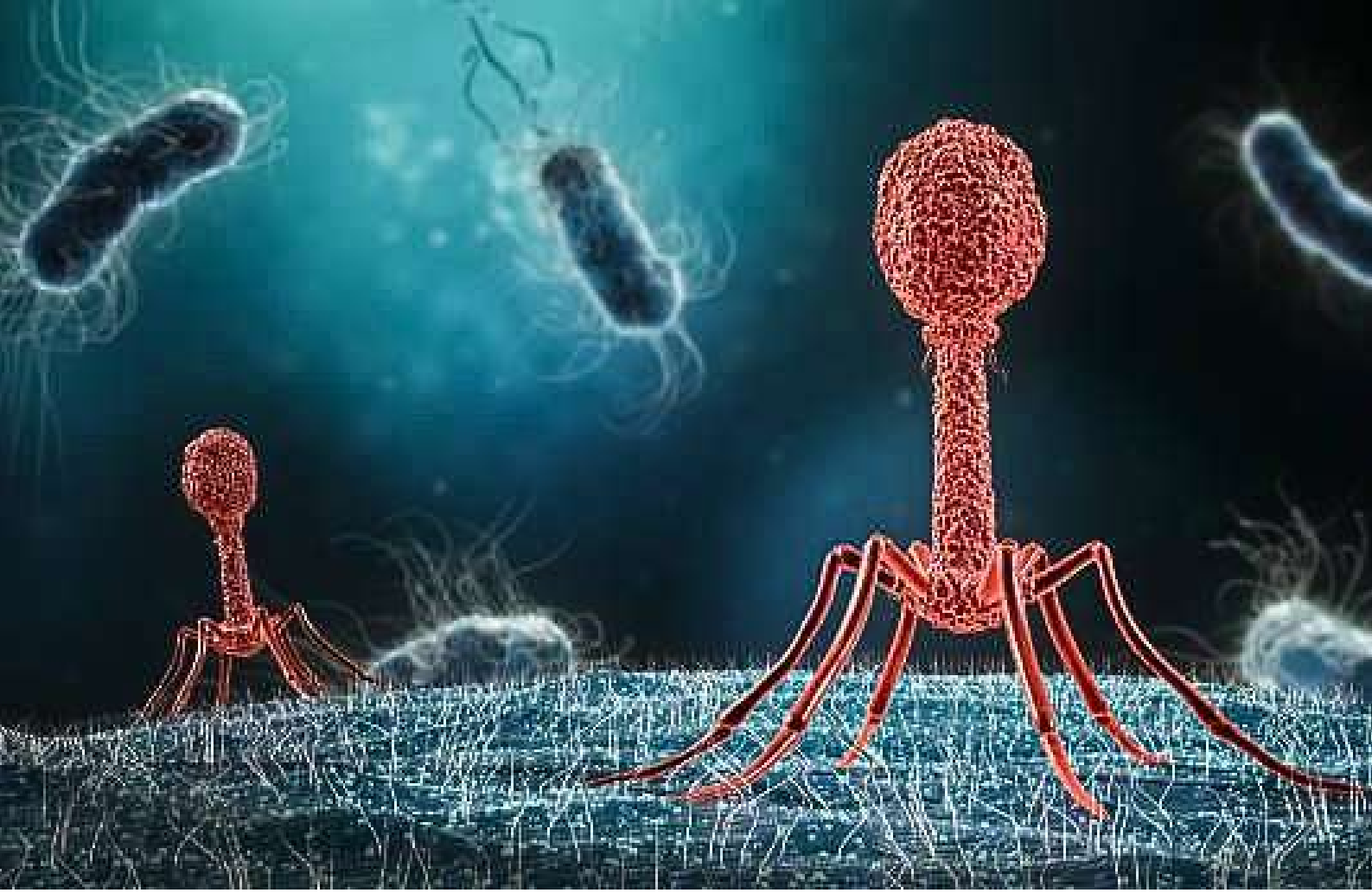
How is connectomics used in tracking brain functions after brain injuries, surgeries, etc?

The classic method of surgical selection, tumor topography was the primary determinant of treatment method for brain gliomas. A paradigmatic shift away from the modular explanation of cerebral anatomy and toward a meta-network approach has resulted from the evolving field of connectomics' quest to map brain connections. Adaptive behavior is really mediated by large-scale delocalized brain networks that support awareness, cognition, and emotion, and whose connections are dynamic. Here, optimizing the once-functional balance of glioma surgery entails moving toward a connectome-based resection that takes into account the connections between the tumor and critical distributed circuits.

How is connectomics used in understanding consciousness and brain plasticity?

Consciousness is generally understood to be explained in terms of one's own, basic feelings. A new understanding of consciousness is suggested as an interacting, adaptable issue adapting to social effects in contrast to this incorrect duality. The explanation of consciousness is based on the finding during human development. As a result, other recent studies on macroscopic brain networks show how encultured social behaviors rely on and affect visual and reflective awareness and may mold a person's very own "connectome".

Although clinical neurology was mainly built on the strict theory of localizationism, various publications have detailed functional recovery following injuries in areas thought to be non-compensable under a rigid understanding of brain function. In this case, the goal is to review new findings from neuroimaging data, along with new insights into the functional connectome and the mechanisms underlying neurological plasticity, obtained from surgical electric stimulation mapping and real-time behavioral monitoring in awake patients.

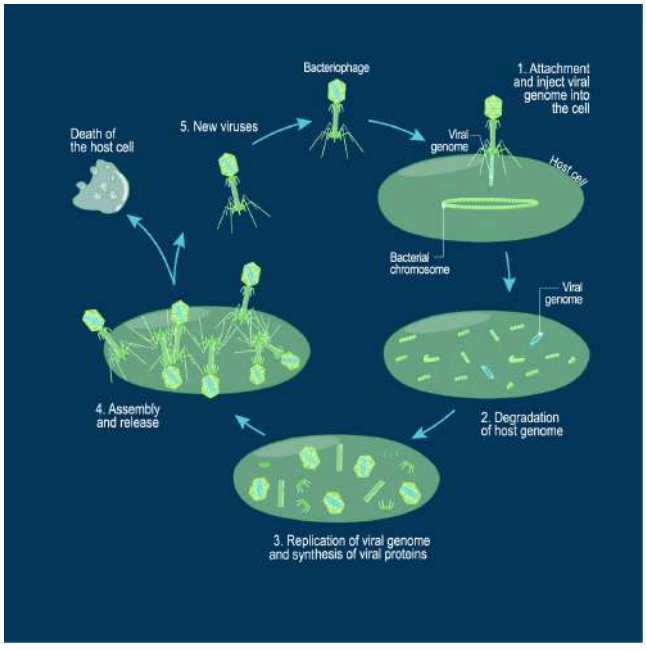


A NEW METHOD FOR COMBATING ANTIBIOTIC RESISTANCE: BACTERIOPHAGES

Ulya Şahin
10/O

The search for alternate medicines is being prompted by the serious threat that antibiotic-resistant bacteria represent to world health. The capacity of phages to specifically target and eliminate bacteria has made them a potential option in the field of bacteriophages. These viruses, which infect bacterial cells naturally, have the potential to revolutionize the treatment of bacterial illnesses and reduce the development of antibiotic resistance.

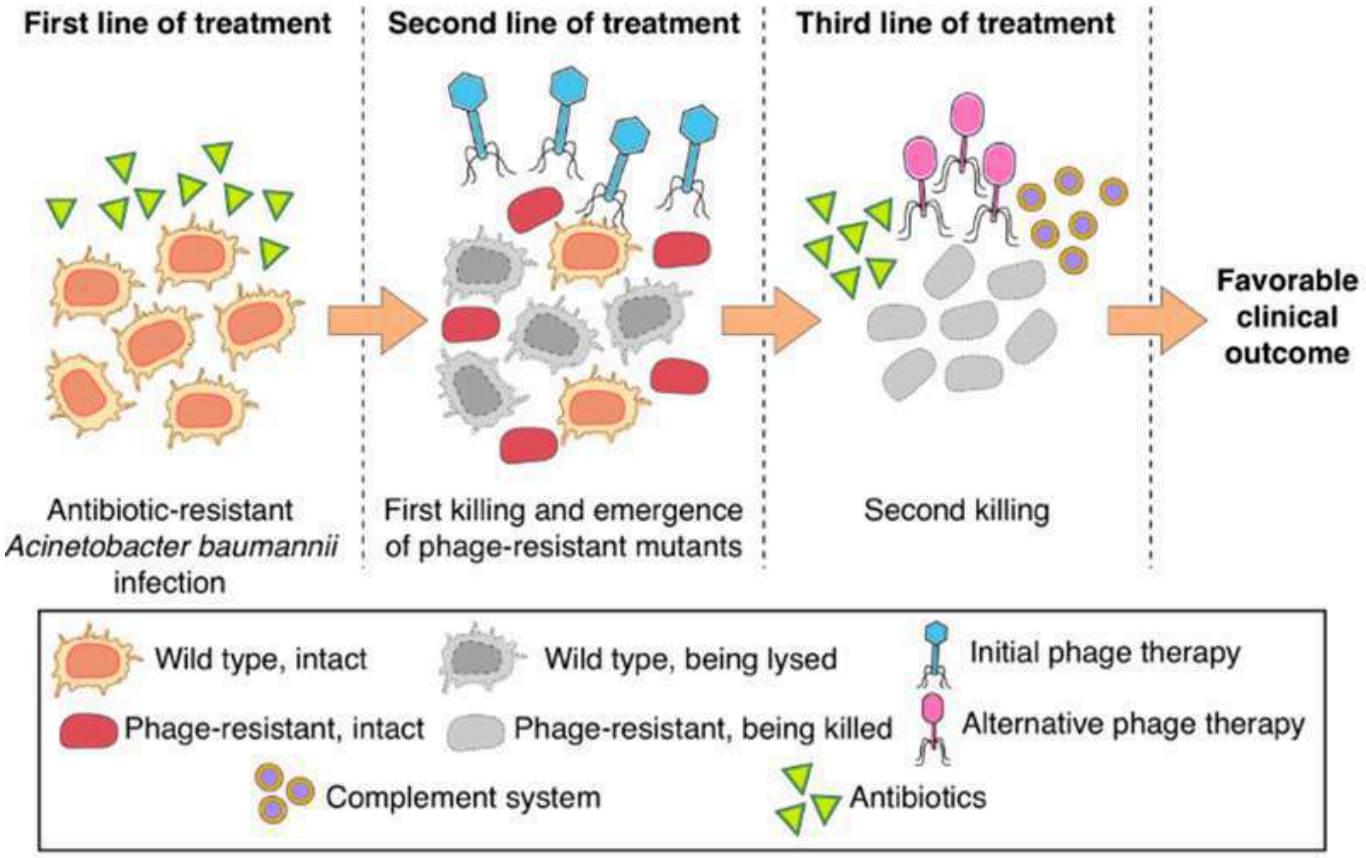
To create new phages, phages attach to certain receptors on the surface of bacteria, amplify their genetic material and take control of the bacterial machinery. Ultimately, this process causes the bacterial cell to disintegrate or burst, releasing fresh phages that infect more bacteria. The special mode of action of phage therapy is one of its most important advantages. Phages specifically target harmful pathogens and protect a healthy microbiota, unlike broad-spectrum antibiotics, which can harm beneficial bacteria and alter the overall microbiota.Phage therapy offers significant advantages because phages can co-evolve with bacteria. Through this constant evolutionary struggle, phages can overcome phage resistance mechanisms, which solves a major shortage of conventional antibiotics. Fago can also be used in combination with antibiotics. By breaking up bacterial biofilms, which are complex communities of bacteria with high resistance to antibiotics, they can improve the effectiveness of these drugs.



Phage therapy has the potential to eliminate many drug-resistant bacteria, including Pseudomonas aeruginosa, Klebsiella pneumoniae, and methicillin-resistant Staphylococcus aureus (MRSA). Phage therapy is a useful substitute for traditional antibiotic treatment of these bacteria due to the known resistance of these bacteria. Furthermore, the ability of phages to break through and disrupt biofilms once biofilms are prevalent is essential for the treatment of persistent diseases.

Phage applications extend beyond medicine; they can also be used in agriculture and environmental contexts to lower bacterial pollution and stop the spread of bacteria resistant to antibiotics. But before phage therapy is extensively used, a few issues must be resolved. Regulatory obstacles are substantial since the approval procedure for biological entities, such as phages, necessitates a careful assessment of their effectiveness and safety. Phage resistance can occur in bacteria, however, because phages can co-evolve, this is frequently less serious than antibiotic resistance. The large-scale synthesis of phages and their stability during storage and transportation present additional technical obstacles.

The main goals of current research are to better understand the interactions between phages and bacteria, optimize phage therapy techniques, and incorporate phage therapy into conventional medical therapies. Advances in genetic engineering allow the engineering of phages with greater efficiency and wider host ranges, further increasing their therapeutic potential. Taken together, bacteriophages represent a promising and innovative approach to the treatment of antibiotic-resistant infections. With continued research, development, and regulatory advances, phage therapy can become a cornerstone of modern medicine, offering a targeted, adaptable, and effective alternative to traditional antibiotics.



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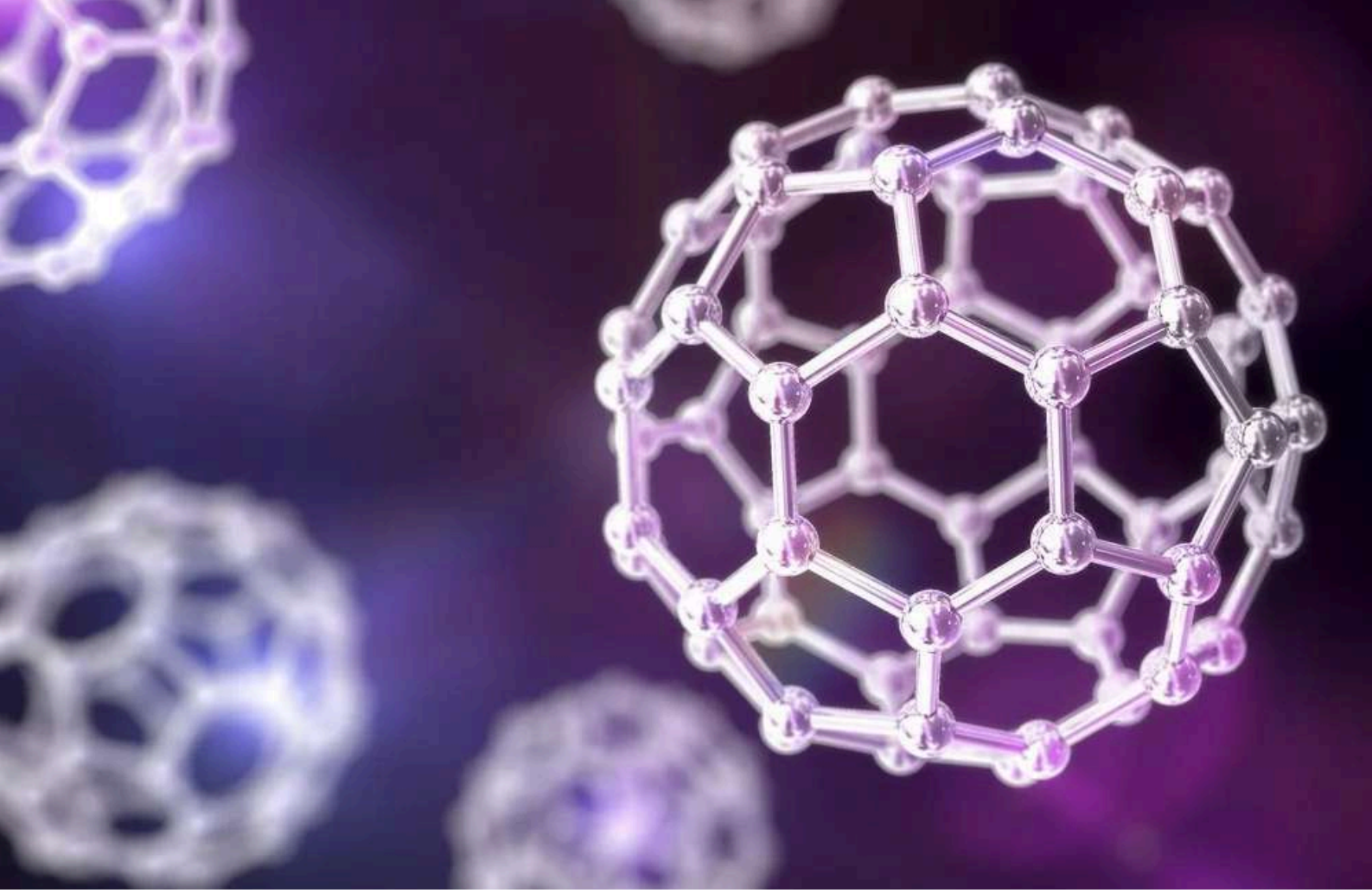
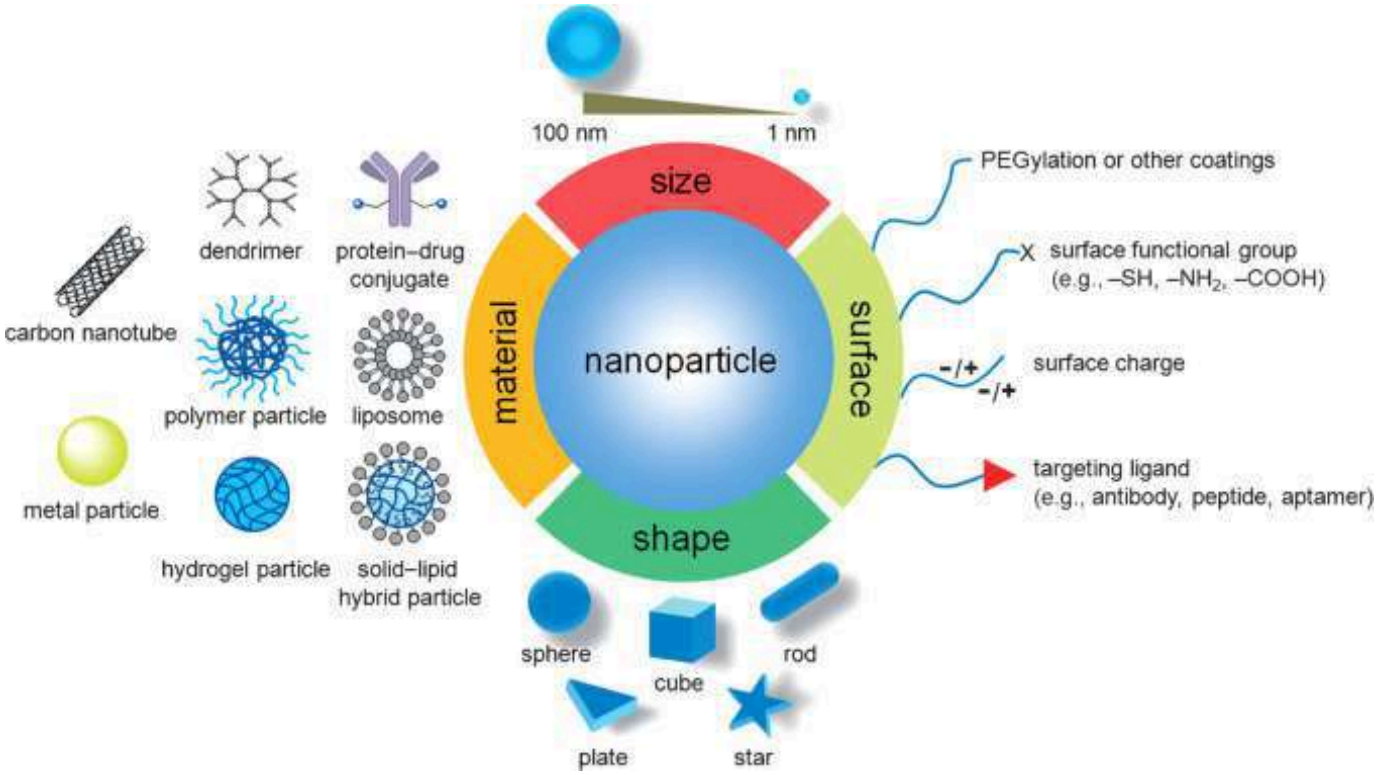


NANOPARTICLES: A CLOSER LOOK AT THE TINY WONDERS

Derin Aktaş
10/C

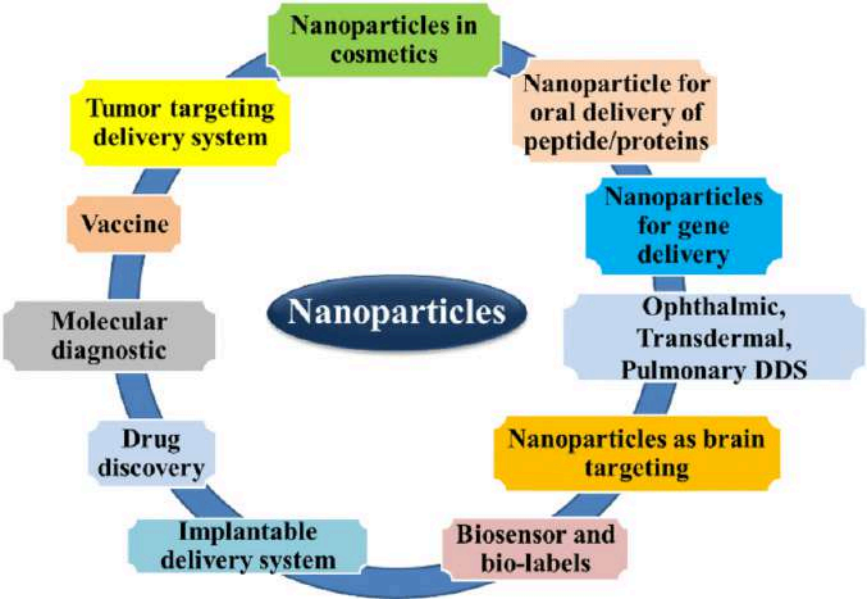
A nanoparticle is a very small particle that ranges between 1 to 100 nanometers in size. For a better perspective, one nanometer is one billionth of a meter, which means a nanoparticle is thousands of times smaller than a thread of hair. Nanoparticles are typically formed by breaking down large particles or with controlled assembly processes. In most cases, a smaller material would be mostly obsolete in the presence of its larger. However, in this case, it is the opposite. Nanoparticles are a lot more useful than their own, larger, substance.

Despite their incredibly small size, they exhibit different and stronger physical and chemical properties compared to their large counterparts- if they are formed by the breaking down of material-. This characteristic of nanoparticles is what makes them so flexible and adaptive to almost any industry. For example, while iron itself is an opaque material, iron nanoparticles have unique characteristics in optics, such as Plasmon resonance. Plasmon resonance is when a photon, at a certain angle of incidence, collides with the surface of a metal, which causes a portion of the light energy to couple through the metal, causing the electrons in the metal surface to move due to excitation. Special characteristics like these lead to them being used in different industries, such as biomedical imaging.



While having countless applications in our daily lives, one of the most important ones could be medicine. As said before, nanoparticles prove to be of great use in biomedical imaging, which is also the industry of MRI and CT scans. Not only imaging but also these small particles are able to penetrate the cell membranes easily, therefore are able to smoothly deliver drugs for targeted tissues and organs.

One of the most popular fields of research recently is electronics, which is also a field where nanoparticles shine. Not only do they provide great ease in circuits such as solar panels, they are also efficient to use for charging and long-lasting batteries. The applications of nanoparticles in technical fields like these simply show more of their potential, and provide a glimpse of what they can create in the future.



Just like most materials that bring great ease to our life but have bad side effects or disadvantages, nanoparticles also create concern regarding the human health and the environment when used. The minuscule size of these make it quite easy for them to enter the human body or the structures of other life forms in ways like inhalation, direct contact or ingestion. Researches to hopefully find a safe way of use for them are naturally are being conducted all around the world.

In short, nanoparticles are tiny particles with enormous potential. Their unique properties make them invaluable in a wide range of applications, from medicine to electronics to environmental remediation. As research into nanoparticles continues, it is essential to balance their benefits with potential risks to ensure their safe and responsible use in the future.

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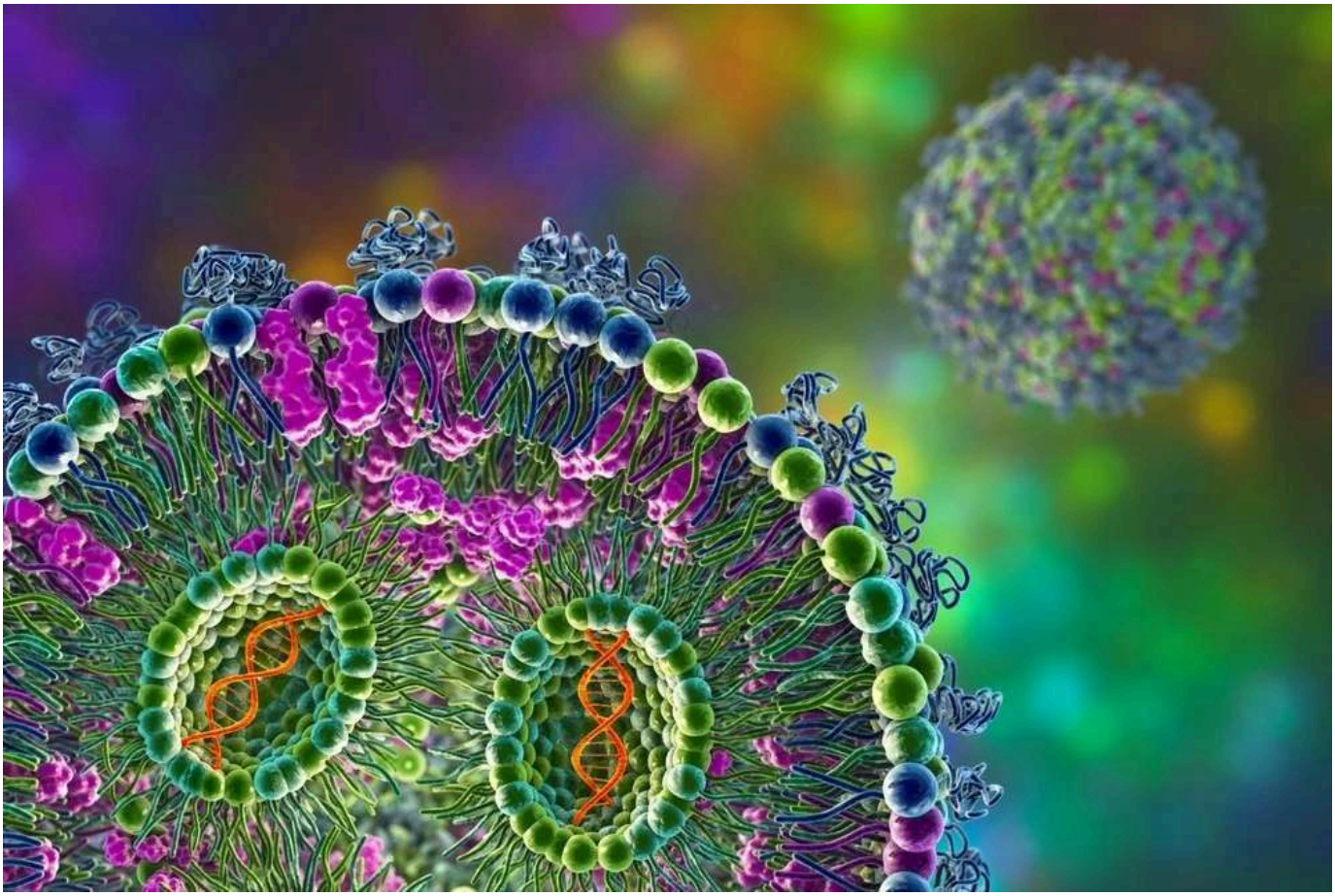

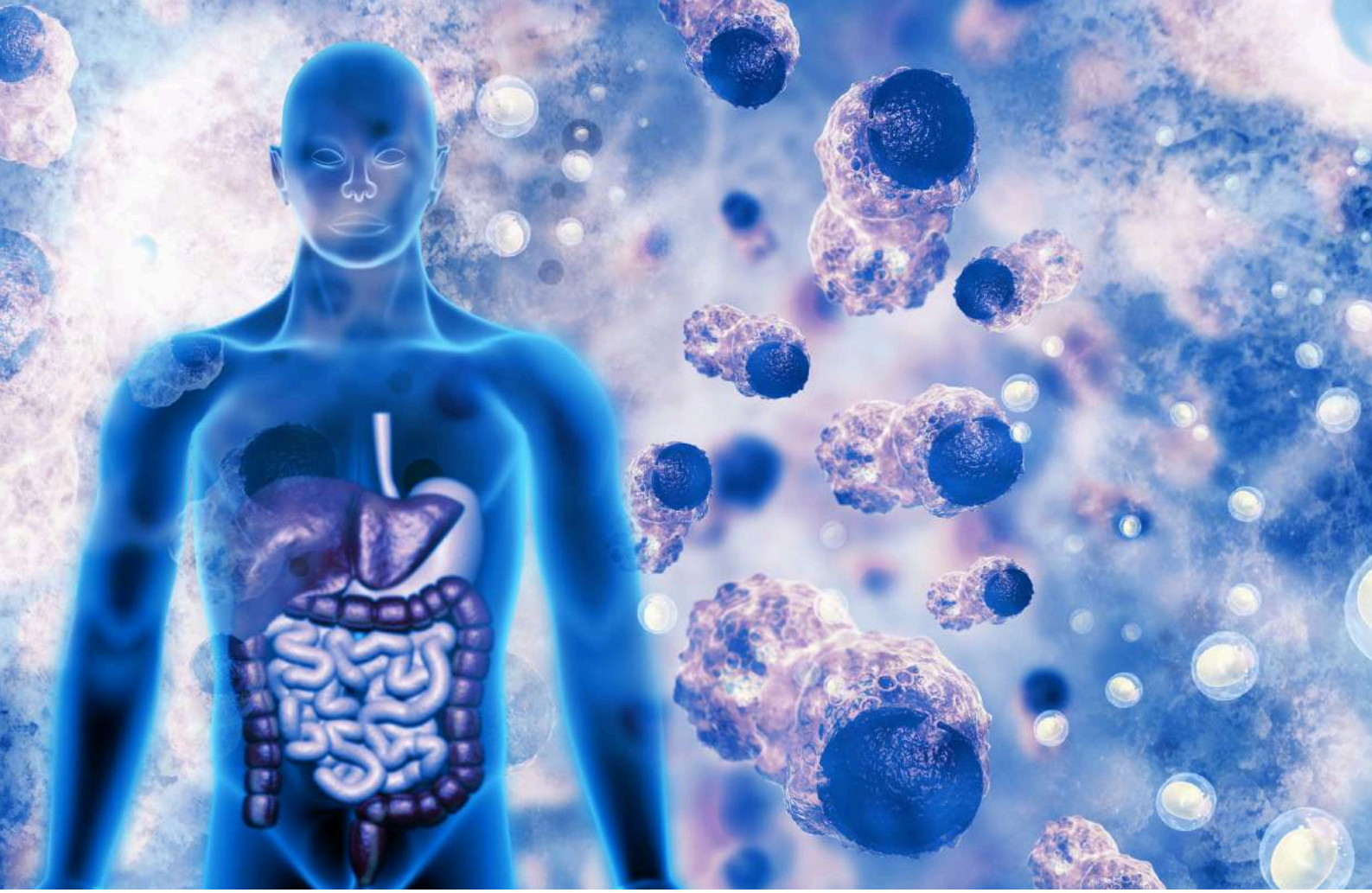

EXPLORING THE TREATMENT METHODS IN CANCER

Naz Tural
10/I

Cancer is the most death-causing disease globally. According to WHO every 1 in 5 women and every 1 in 12 men get diagnosed with cancer. Despite the advancements in medical treatments and inventions, it has protected its complex structure and continues to pose a challenge to modern medicine. Understanding the treatment methods of cancer plays a crucial role in today's world.

The main objectives of cancer treatment are to either significantly extend the patient's life or cure the cancer by eliminating it entirely. When the cancer is considered terminal and the prognosis is bad, palliative care becomes necessary. Cancer comes in a variety of forms, and if caught in time, many of them may be effectively treated.

Cancer, an adversary of formidable nature, has been presenting challenges to medical science spanning decades up until now. Yet, strides of a significant nature have been accomplished in the realm of understanding its multifaceted intricacies and the development of effective treatment methodologies. From traditional approaches inclusive of surgery, chemotherapy, and radiation therapy to innovations that could be termed groundbreaking like immunotherapy and therapy that is targeted, the landscape within which cancer treatment exists has undergone an evolution of dramatic proportions. There exists a multitude of diverse treatment methodologies for cancer, highlighting mechanisms, benefits, and potential patient implications in varied manners.

Surgery stays fundamental in treatment cancers, presenting an opportunity for curative results by excising tumors and affected tissues. Advancements in surgical techniques, including minimally invasive operations and robotic-aided surgery, improved patient outcomes and minimized post-operative complications. Not withstanding, surgery is not always be doable, notably in times where tumors be inoperable or metastasized to far-off locales.

A very well known type of treatment is called Adjuvant Treatment this treatment is what most people choose to it's relyability. Adjuvant treatment concludes; Hormone therapy,RadiationTherapy and Chemothereapy. In order to lessen the likelihood that the cancer may recur, adjuvant therapy aims to eradicate any cancer cells that might still be present following initial treatment. Adjuvant therapy can be used to any cancer treatment. Similar therapies are performed before the primary treatment to make it simpler or more successful; this is known as neoadjuvant therapy.

Also, Local Hyperthermia is used to heat a tiny region, such as a tumor, one uses localized hyperthermia. The cancer cells are destroyed and surrounding blood vessels are destroyed by extremely high temperatures. This effectively cooks the surface that is in contact with the heat. Additionally, much like in cooking, the impact found within tissues increases with exposure time and temperature. While moderate hyperthermia is caused by minor temperature increases, thermal ablation refers to therapies in which extremely high temperatures cause irreparable damage to cells. The space can be heated using microwaves, ultrasonic waves,

radio waves, and other energy sources. When ultrasound is employed, the method is known as high intensity focused ultrasound, or HIFU. Focused ultrasound is another name for this technique.

Strong medications used in chemotherapy have long been a standard practice in the treatment of cancer to destroy quickly proliferating cells, especially those that are malignant. Chemotherapy, although therapeutically beneficial, is frequently associated with significant side effects, such as nausea, baldness, and immunosuppressive effects. Furthermore, due to its non-selective nature, chemotherapy can cause harm to healthy cell structures, hence greatly increasing the likelihood of systemic toxicity. Chemotherapy, although therapeutically beneficial, is frequently associated with significant side effects, such as nausea, baldness, and immunosuppressive effects. Furthermore, due to its non-selective nature, chemotherapy has the capacity to cause harm to healthy cell structures, hence greatly increasing the likelihood of systemic toxicity.

The treatment landscape in cancer is characterized by a diverse array of modalities, ranging from conventional therapies to innovative approaches tailored to individual patients. While challenges persist, recent advancements in immunotherapy, targeted therapy, and combination regimens offer new hope in the fight against this complex disease. By embracing a multidisciplinary and personalized approach, we can continue to improve treatment outcomes and enhance the quality of life for cancer patients worldwide.

The core of every malignant neoplasm's therapy is quality of life concerns. As treatment grows increasingly successful, the quality of survival will become a crucial factor. Oncologists and fundamental scientists both view this worry as important information. The study of quality of life in oncology practice should be viewed as a process, and rather than creating a single, "ideal" quality of life instrument, it makes sense to develop multiple distinct lines of questionnaires as part of this process.

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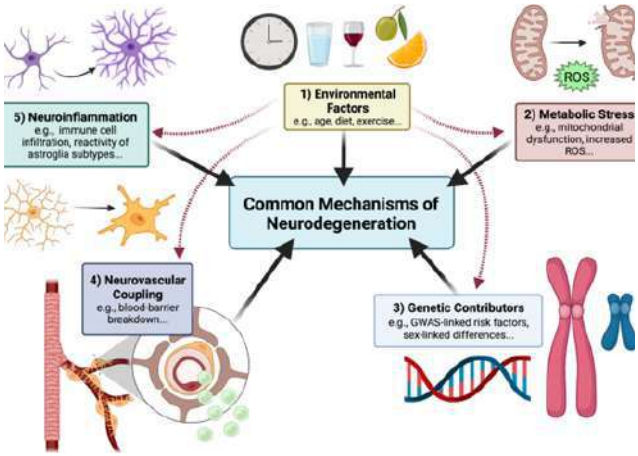
NEUROGENETICS AND NEURODEGENERATIVE DISEASES

Naz Erdem
10/R

Neuroscience is about the nervous system and its activities, while genetics is the study of heredity. It could be said that neurogenetics is the combination of these two fields since it focuses on the neurological aspects of genetics. It can be considered as a relatively new field because it emerged in the 20th century. It started expanding in the 1960s due to the work of Seymour Benzer. Seymour Benzer was an American molecular biologist who is known for his studies on various topics such as DNA, mutations, genes, and viruses. He is considered as one of the giants of twentieth-century biology and has made many discoveries concerning the field. To sum it up, neurogenetics covers a wide range of topics and they are all important for the improvement of humanity's understanding of genetics and heredity.

Behavioral Neurogenetics

Over time, science has improved significantly, making it possible for scientists to map out individuals' genetic arrangements. The potential behavioral and psychological effects of genetic factors have also been investigated and beneficial results have been reached. These factors can be seen in an individual in multiple different forms. Examples are personality traits, cognitive abilities, or major psychological disorders such as depression or schizophrenia. Even traits that are considered to be determined by cultural differences such as religion and political views have appeared to be controlled by genetics. It is also genes that push someone to be more aggressive than others, sometimes leading them to perform violent acts. This is also where the cycle of abuse theory is proven to be true. The abused becomes the abuser, leading to a cycle of abusive relationships in families or among peers in schools.



Neurodegenerative Diseases

Neurodegenerative disorders are chronic conditions that damage and destroy someone's nervous system over time, mainly affecting the brain. These conditions develop slowly and are generally incurable. Even though they are uncommonly seen, they currently affect 50 million people worldwide, most of them being people of age since these diseases are majorly seen in people over the age of 65. There are many types of neurodegenerative disorders such as dementia-type diseases, demyelinating diseases, parkinsonism-type diseases, and motor neuron diseases. Dementia-type diseases cause confusion, memory loss, and other troubles related to these. The most common form of this disease is schizophrenia. Demyelinating diseases have symptoms related to muscles such as tingling or numbness, spasms, and coordination issues. Multiple Sclerosis (MS) is an example of this type of disease. A commonly seen type of neurodegenerative disease is parkinsonism-type. These diseases mostly affect movements. An affected person could move slower, lose balance, or suffer from uncontrollable shaking. There are three main types of PD which are idiopathic, early-onset, and familial. As stated in its name, motor neuron diseases kill neurons that control motor functions, leading to loss of muscle control and weakness. An example of MND is Lou Gehrig's disease.

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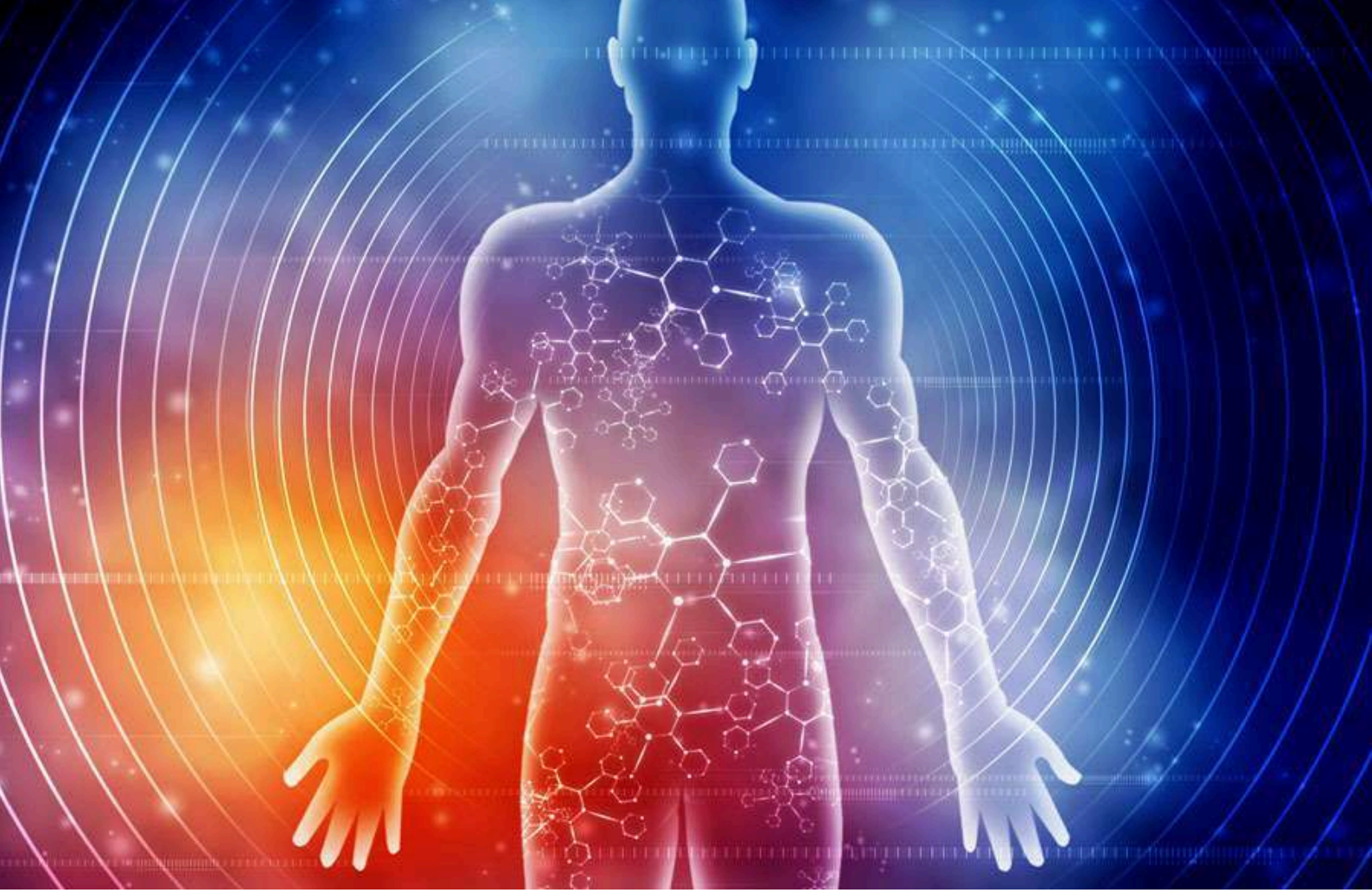


BIOENERGETICS: THE MYSTERY SOURCE OF LIFE

Bennu Sönmez
10/C

Bioenergetics is an intriguing scientific field that focuses on the study of energy flow and transformation in living organisms. It looks at how life sustains itself by obtaining and using energy from various sources. Bioenergetics offers a thorough understanding of how living beings acquire, regulate, and utilize energy from cellular respiration at the microscopic level to the interactions within ecosystems. This article aims to provide an informative overview of bioenergetics, exploring its core principles, importance, and practical applications.

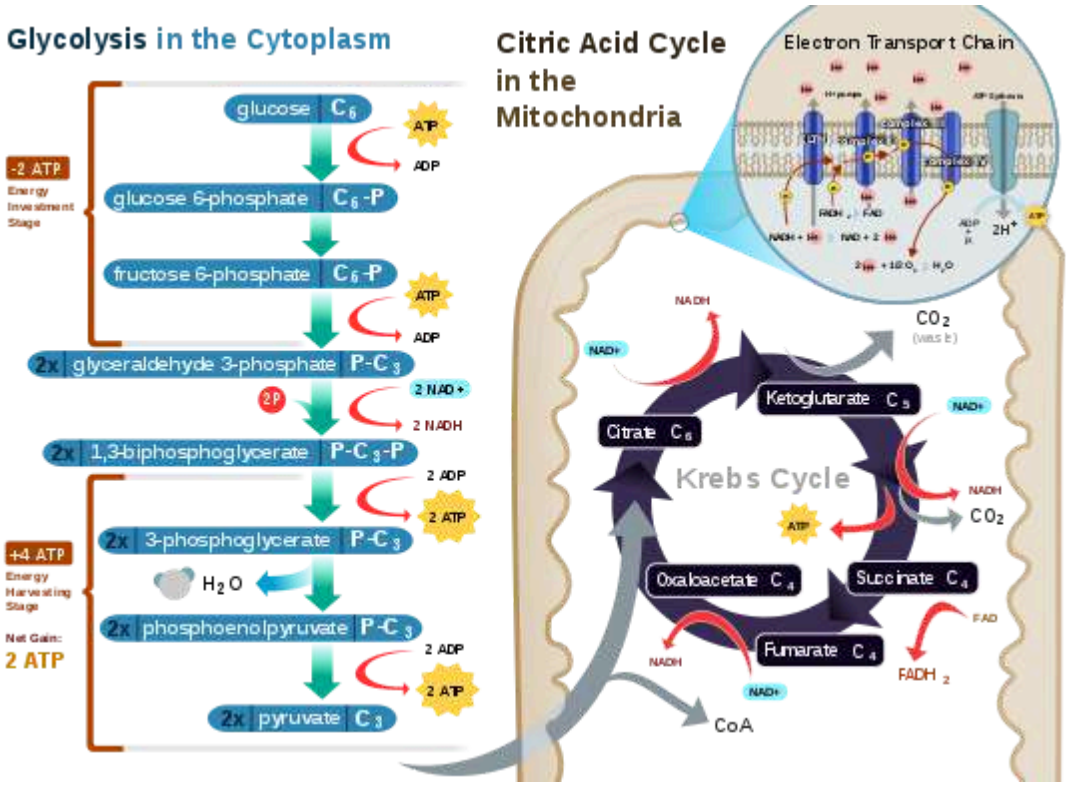
Energy is the driving force behind all living forms, necessary for basic functions such as growth, reproduction, and movement. Bioenergetics investigates how organisms obtain, store, and utilize energy to maintain their essential processes. The primary energy source in biological systems is the sun, which is converted into chemical energy through photosynthesis by plants and other photosynthetic organisms.

The production of energy within cells involves breaking down glucose through a metabolic pathway in a process known as "cellular respiration" to form ATP—adenosine triphosphate—a molecule that serves as the primary source of energy for cellular functions. It consists of three main steps: glycolysis, the Krebs cycle — or the citric acid cycle — and oxidative phosphorylation. These interconnected processes release energy by breaking down glucose and other organic molecules.

In more complex organisms, energy is transferred and transported through integrated systems. The circulatory system supplies oxygen and nutrients to cells and removes waste. Glucose and fatty acids are distributed to tissues and organs with the help of the circulatory system. The respiratory system provides gas exchange to ensure a sufficient supply of oxygen for cellular respiration.

Bioenergetics explains how energy flows in through ecosystems. The energy process starts with primary producers, like plants, that use the energy from sunlight to produce chemical energy through photosynthesis. Primary consumers, herbivores, receive this energy through plants. Carnivores, the secondary consumers, get it by consuming the herbivores, and so on up the food chain. Energy gets wasted at each level. The recycling of energy usually depends on decomposers, organisms that break down waste material such as animal carcasses, thus providing nutrients to the ecosystem.

Bioenergetics also feeds other branches of biochemistry, such as biotechnology and medicine. It has greatly contributed to the development of renewable energy sources, such as biofuels, by using energy-producing pathways in microorganisms. In medicine, research in bioenergetics discovered metabolic disorders and age-related diseases, including those caused by mitochondrial dysfunctions, such as neurodegenerative and cardiovascular diseases.



Bioenergetics is an interesting branch of science that provides information on energy flow and transformation between living organisms.

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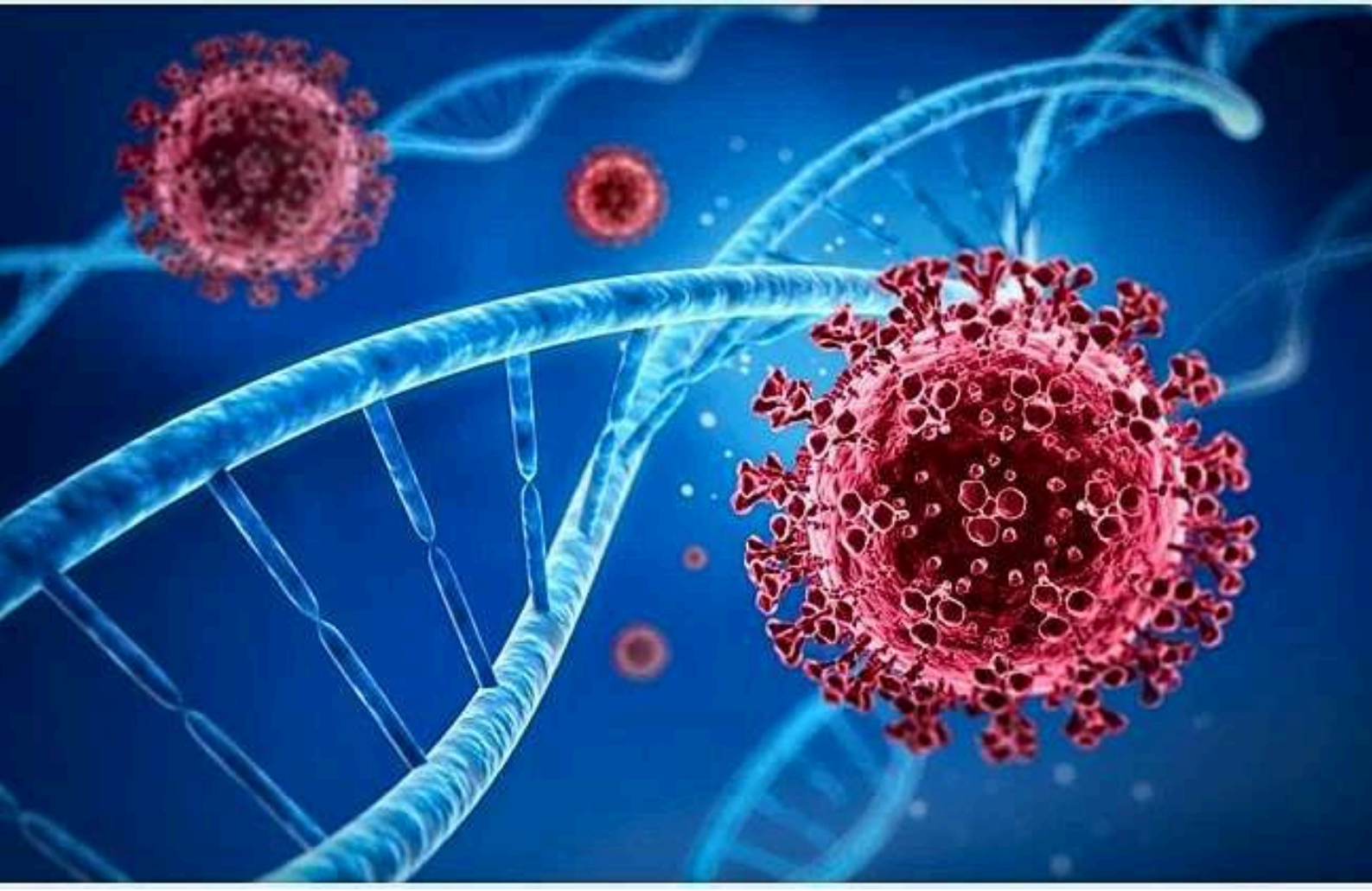


UNRAVELING THE MYSTERIES OF MOLECULAR VIROLOGY

Alya Gürses
10/C

Molecular virology is an interesting subject in biology. It is of not much use, given the great ability of viruses to have a hand in all spheres of life. From diseases to evolution, viruses are a significant factor in the world. This is about learning more about molecular virology-beginning with what viruses are made up of; their design; how they multiply what they can do to human health and more. Essentially, this means studying them at the molecular level – hence molecular virology. But first things first what exactly is a virus?

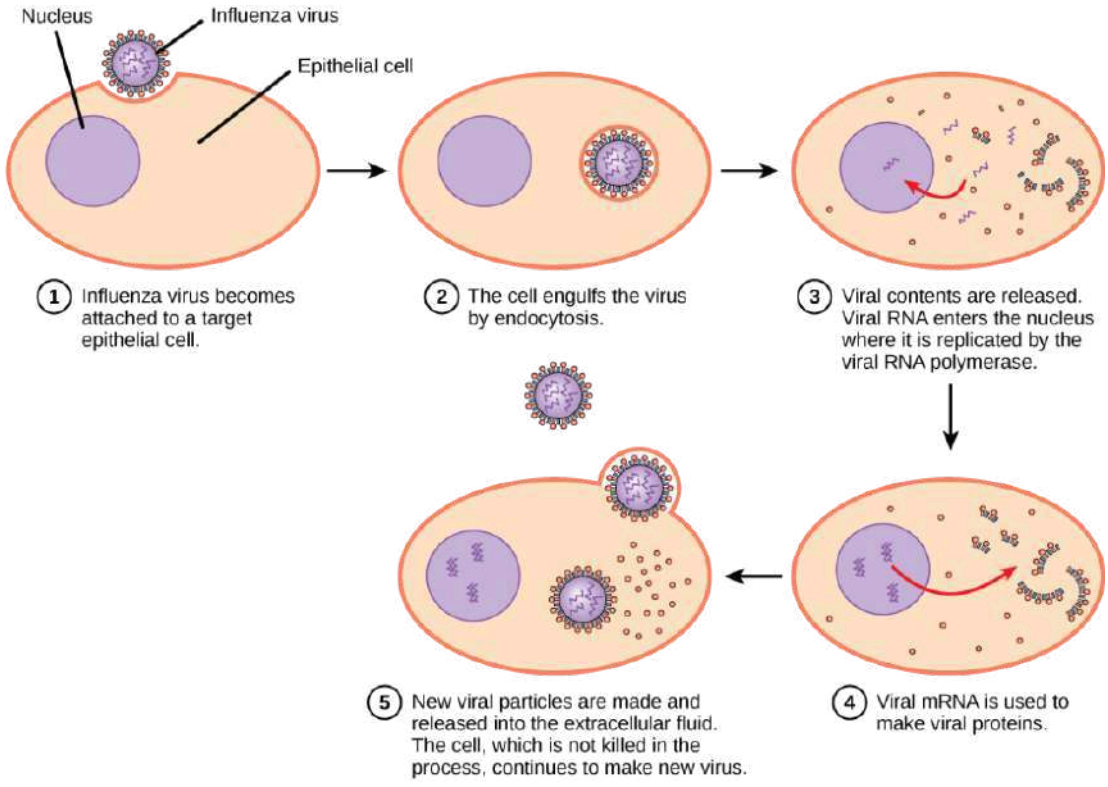
Viruses are very small living things (organisms) that cause infectious diseases in animals, plants, or bacteria; these organisms need other living cells in order to grow and multiply since they cannot do so by themselves. They come in different shapes and sizes. Viruses are infectious agents that are much smaller than bacteria and lack the capacity to survive and reproduce outside of a living organism. They differ greatly in appearance; while some bacteriophages are relatively large and complex, others like picornaviruses have a very simple geometric structure. However, despite this great variety in shape and size among viruses, they all share several common features: their genetic material — either DNA or RNA — is enclosed in a protein coat known as a capsid; some of them also have an outer covering made up of lipids taken from the host cell membrane.

How a virus is built directly affects how it functions and its relationship with the host cell. The capsid shields the viral genome while attaching to host cells, and consists of protein subunits called capsomeres in case of most of them. Besides, there are other kinds of viruses (for instance, the flu virus). The capsid, made from proteins and called capsomeres, is what protects the viral genome and allows it to attach to host cells. More complex viruses like influenza have additional structures on their surfaces such as spikes or glycoproteins which may help them enter host cells. Understanding the way that viruses reproduce is vital when trying to understand the lifecycle of a virus.

A typical replication cycle includes viral attachment and penetration into host cells, genome replication, assembly of new viral particles within the host, and their release back into the environment. Every virus' proteins interact with different parts of cellular machinery regulating each of these steps very closely.

Virus infection is the entry and multiplication of a harmful virus within a host organism. It is important to note that not all viruses are harmful, and in fact, many are extremely helpful. It is the immune system's job to destroy harmful viruses. It is caused by a virus which is a small infectious agent that replicates only inside the living cells of other organisms. Any form of life can be infected by a virus. Viruses are perhaps the most abundant type of biological entity on Earth. They have been found in almost every ecosystem. The study of viruses is known as virology.

New types of viral diseases have affected the globe and posing as pandemics. The coronavirus SARS-CoV-2 manifestation, the COVID-19 pandemic vividly displays the reality that infectious diseases are always around. Thus, it is necessary to determine the origin, transmission dynamics, and pathogenesis of these new emerging viruses for molecular virology to be able to apply quick response strategies in containing outbreaks and for developing effective countermeasures.



To sum up, molecular virology gives us fascinating information about the world of viruses and their relationship with host organisms. Additionally, understanding how viruses replicate and cause diseases at a molecular level continues to be useful in the fight against current viral infections while also preparing us for challenges that may be brought about by new pathogens that might arise in the future. We learn about viruses and their effects on human health and more from molecular virology which uses a variety of research methods and innovation across different areas of study to investigate how viruses work.

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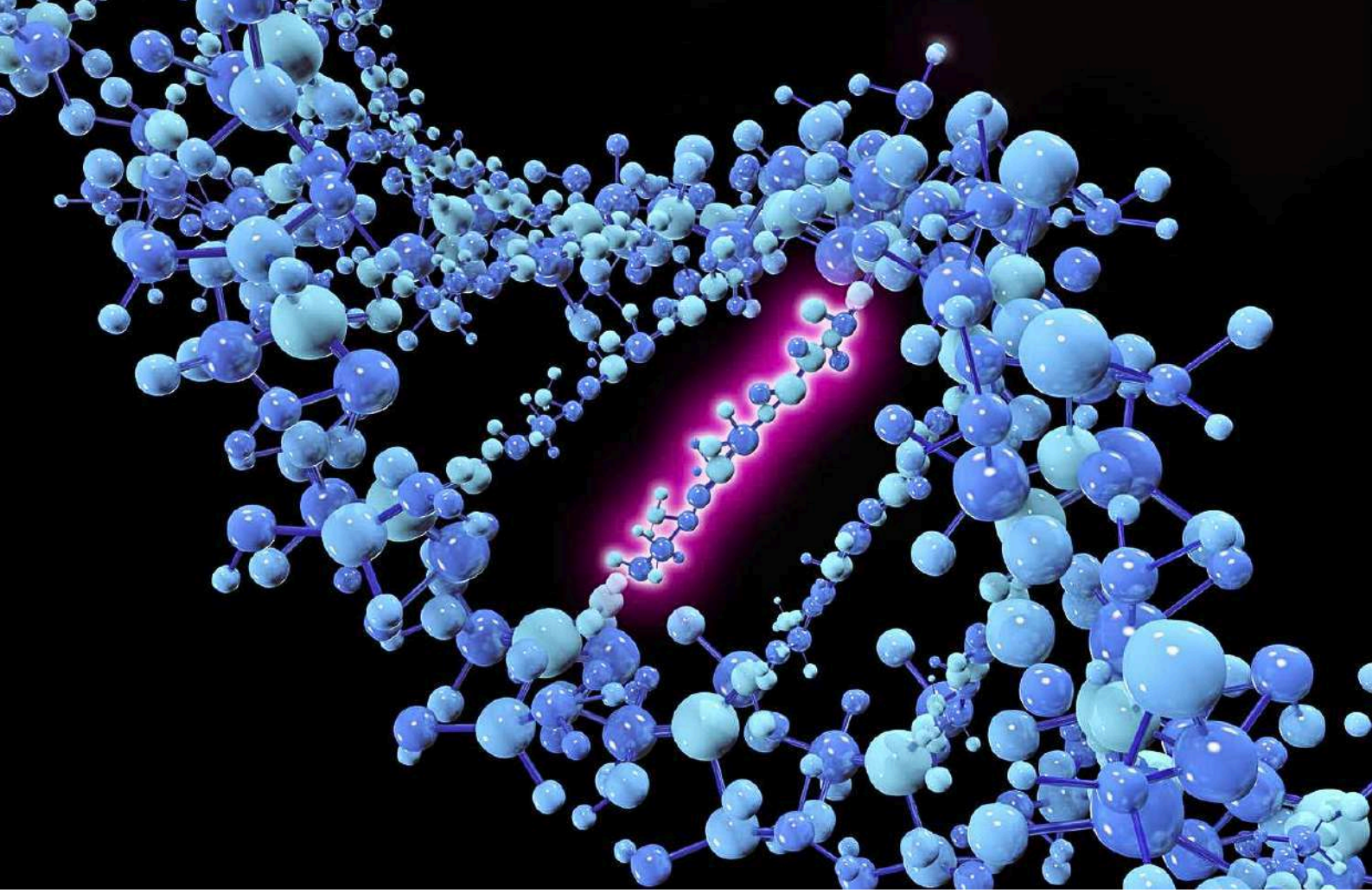


MUTATION TYPES AND EFFECTS: THE FUNDAMENTAL BLOCK OF MEDICINAL SCIENCE

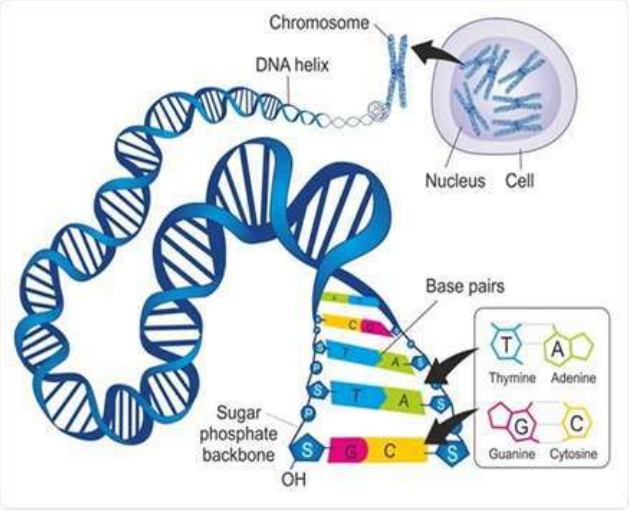
Peri Ertuğ
12/F

Introduction

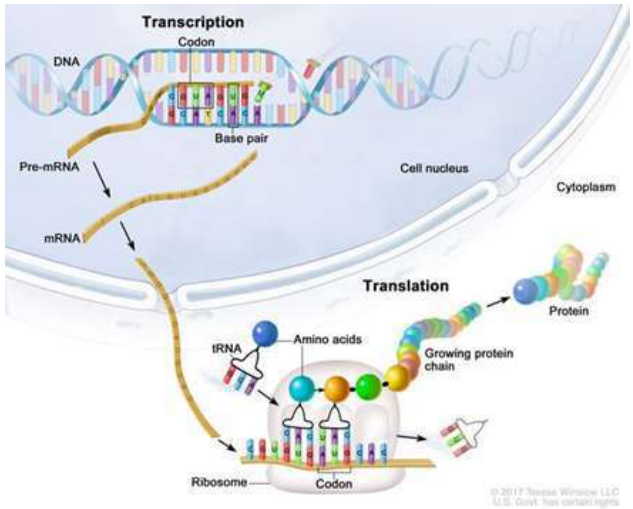
Anyone who has seen science-fiction movies would be familiar with the term “mutation” but most probably wouldn’t know the basis of mutation enough to address its types and their exact effect on the molecular level which the knowledge with enhanced technological methods have paved the way for the study of genetic diseases thus evaluation of mutagenic risks. So, how do mutations arise, and operate, and do they all result in mutants that movie lovers all associate with? Mutations, permanent changes in the genetic information carried in the deoxyribonucleic acid (DNA), occur in different forms whose variation come from the way they alter the mechanism of DNA which encompasses biological instructions that determine the conduct of constituent units of an organism from the smallest building blocks. This variety of changes in DNA can either be attributed to external influences or natural occurrences. However either way cause severe diseases and disabilities, few of which can be treated effectively despite the advances in medical technology in terms of diagnosis and treatment.

A Not Very Brief Look Into Operation of DNA

Without DNA, no organism is more alive than a robot that is not coded. DNA is an operator manuel in which all the necessary information and instructions regarding proteins are included thus the proteins, that DNA instructs to create, are enabled to determine the structure and function of all the cells within the body allowing the organism to function from the cellular level onwards self-dependently and develop over processes. This most significant and common feature of living things, DNA, has a double helix shape with two strands of alternating sugar and phosphate backbone to which bases; adenine, cytosine, guanine or thymine, are attached. The sequence of the bases along the DNA encodes directives for making a protein or RNA molecule which are necessary formations for the essential process of protein synthesis, composed of two steps called transcription and translation (1).



According to central dogma in molecular biology, during transcription genetic informations from DNA that are in the form of genes composed of mainly promoter, coding sequence, and terminator are transferred to a type of RNA called mRNA, which is responsible from transporting information, in the form of complementary genes. In the last part of central dogma called translation, sequence of codons in mRNA is read by the ribosome and tRNA, which assists in protein synthesis, brings amino acids to the ribosome by having anticodons and binding to complementary codons in mRNA (2). When amino acids bind to each other over each step of translation, a polypeptide chain forms creating a protein overall (3). While protein synthesis is noteworthy, as it concerns all the functioning of a body, DNA replication should not be forgotten as processes described in protein synthesis can most probably occur smoothly only if all the necessary information is successfully replicated from the parent DNA at the very start. So, it seems crucial to take a look at how things can go wrong even when there is a very detailed, 3-meter-long operator manual in possession (4).



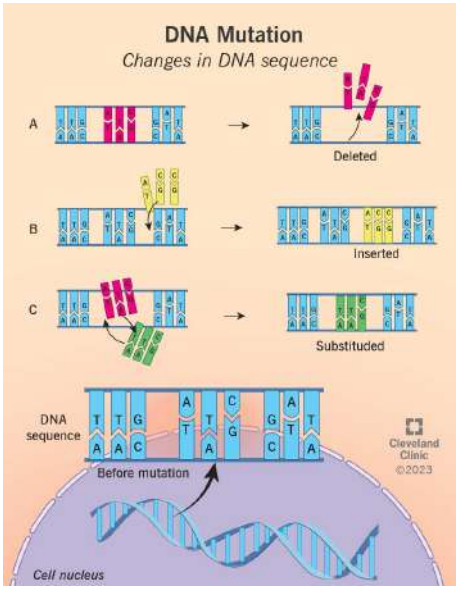
Ways In Which Mutations Can Occur and Their Outcomes

Although it sounds unbeliavable for mankind to be estimating all the ways in which DNA can vary from its supposed self, mutations can currently be gathered under a total of 6 types. These types can be listed in order as following: substitution, deletion, insertion, and frameshift. When, along a DNA strand, one base is exchanged for another, substitution mutation occurs and it can lead to a change in the codon that encodes a different amino acid where only substitution has occurred, causing

a small change in the protein produced. An example of substitution mutation is sickle cell anemia which is the result of a substitution in the beta-hemoglobin gene, which alters a single amino acid in the protein (5). Luckily, some amino acids can answer to multiple codons, therefore if the codon is changed into another codon that the same amino acid answers to, no change in the protein synthesized will be seen. This type of substitution mutation is known as “silent”. However, a change in the termination codon can cause the protein to not function at all due to being incomplete which has more serious effects. When a section of DNA is lost or deleted, then deletion mutation occurs. The deletion can vary from a single base to an entire chromosome. Examples of deletion mutations usually include intellectual disabilities, development delays, and physical abnormalities. For instance, Wolf-Hirschorn Syndrome is caused by to deletion of a portion of chromosome 4, showing characteristics of intellectual disability, seizures, having a small head, and facial abnormalities. As for insertion mutations, one or more nucleotides are inserted into the DNA which can involve the addition of varying magnitudes just as deletion mutation. An example of insertion is “fragile X syndrome”, where an excess of 200 CGG nucleotide repeats are inserted into a gene, making it non-functional (6). As seen in the example, addition and deletion that alter the DNA to an extent that no longer large proportions of amino acids are correct, are frameshift mutations. When mutation such as addition or deletion which affects the rest of the DNA sequence takes place, if the mutation is located closer to the end of the gene, it may not cause a big change in protein however, if it is located at the start, frameshift may make the product protein unidentifiable or even non-functional as in example. Now the question is, whether they are small or big, what causes these changes?

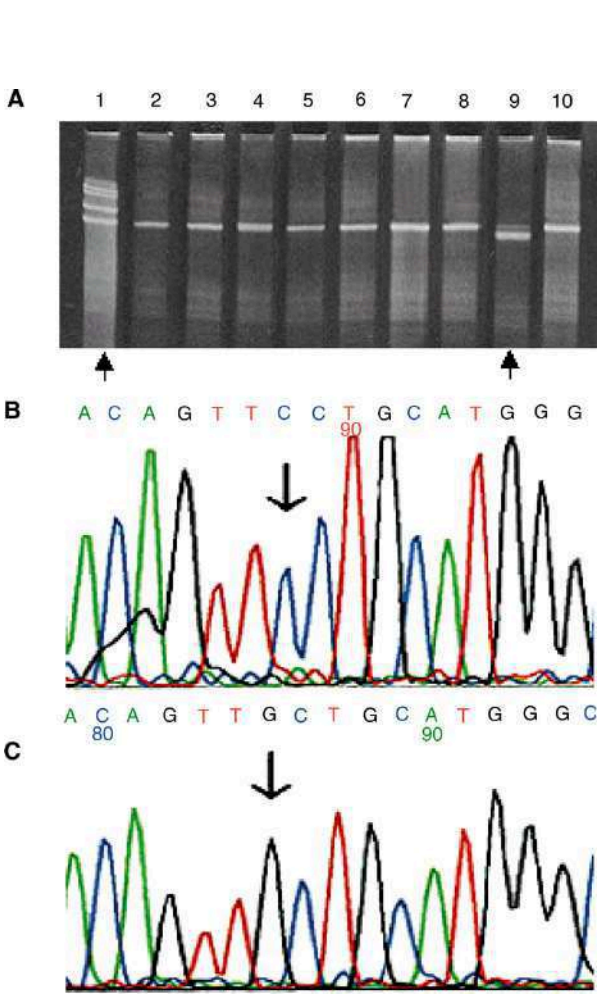
Causes of Mutations

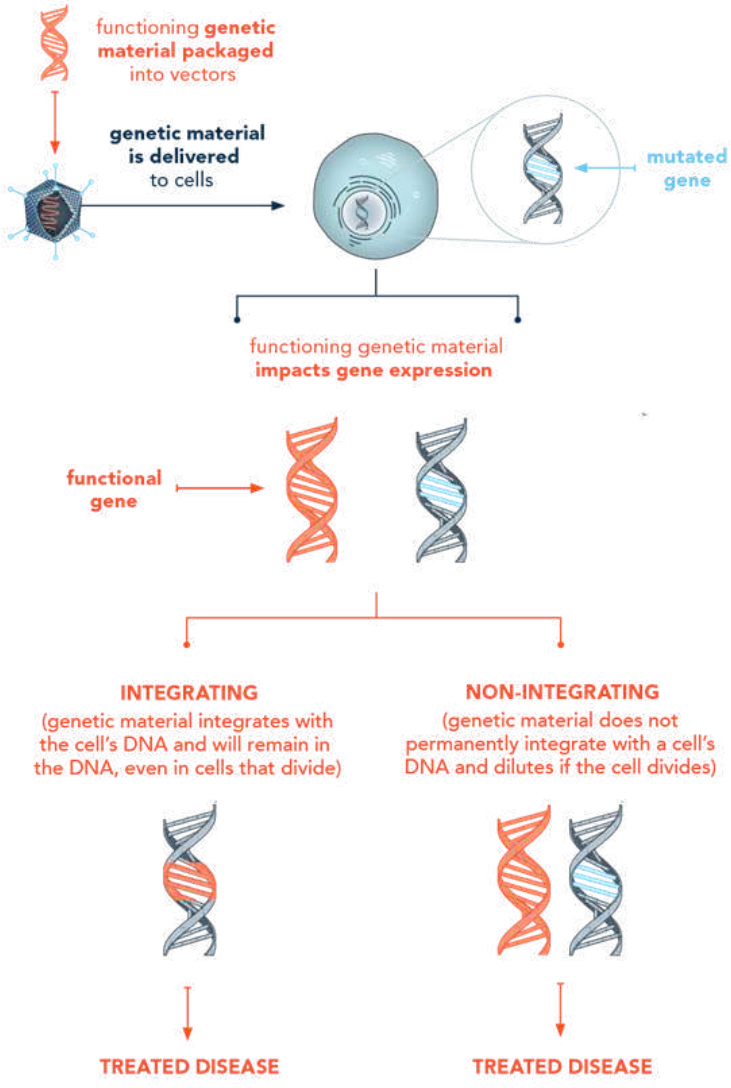
Mutations can occur either due to internal malfunction or external influences. Naturally occurring mutations may be because of errors during DNA replication which refers to the process by which genetic material is copied from parent DNA to the offspring in the production of new cells. The DNA polymerase enzyme that reads the DNA template and synthesizes a new strand of DNA by adding nucleotides to the growing strand, may skip over a nucleotide or add the wrong nucleotide, causing mutation (7). If not internally caused, then exposure to certain chemicals, radiations, or oxidation caused by stress may be the cause. Chemicals like alkylating agents generally used in cancer treatment have the potential to cause deletions via the addition of alkyl groups to DNA. As for ionizing radiations such as x-rays or ultraviolet radiations can result in mutations. A reason that is not so often heard may be, cells producing too much reactive oxygen due to the occurrence of oxidative stress which can damage DNA, cellular components, and proteins. It is important to mention that it hasn’t always been easy to detect the problem let alone the cause due to not having necessary technological advancements. However, there is a more hopeful story nowadays.



Technologies for Diagnosis And Treatment

In the past few decades new technologies that paved the way for the further analysis of mutations have been developed and alternative solutions to mutagenic diseases have been found. Denaturing gradient gel electrophoresis (DGGE), constant denaturing gel electrophoresis (CDGE), temporal temperature gradient gel electrophoresis (TTGE), single-strand conformation polymorphism (SSCP), and protein truncation test (PTT), have been helpful over the past decades in terms of assisting with the analysis of mutations (8). For mutation detection a more recent technique: high resolution melt (HRM) analysis have also been preferred. What all these techniques have in common is the utilization of DNA amplification via PCR prior to the specified technique used. Following the techniques, DNA sequencing can be used to verify the mutation (8). As a treatment to mutations that can now be detected in a wider range and early on, owing to the technolog; gene therapy can be a hopeful answer. Gene therapy is said to restore the normal function of a protein that is faulty. The treatment can be taken in a few options depending on the mutation types: introduction of a new or modified copy of a gene, turning on or off of genes to avoid diseases, replacement of the disease causing sequence of gene with the healthy copy of the sequence, gene editing, or base editing (9). Thus, in order to reach the goal of changing the course of mutation-caused-diseases by targeting genetic cause, treatment like gene therapy have been made available with assistance of newly developed medical technologies mostly used in analyzing.





Conclusion

Mutations, which can be attributed to dysfunction of an element during the DNA replication or external factors varying from chemicals, radiation, stress-inducing elements, etc., can occur in 6 types which have the proteins produced during protein synthesis differentiate from the original at different extents. Whether a mutation causes a mutant and has the person live in fantasy or leads to a simple Wolf-Hirschorn Syndrome and has the individual go through difficulties in a society where no mutations are appreciated, unlike what might happen to mutants, all depends on whether a tiny base happens to be mistakenly inserted into the DNA sequence or a couple of nucleotides making up to a chromosome are forced to leave its place. Either way, today, there are techniques that have been developed to enable mutations, small or big, to be detected and treatments that offer a way back to no-mutation life that might be life-changing for some people.

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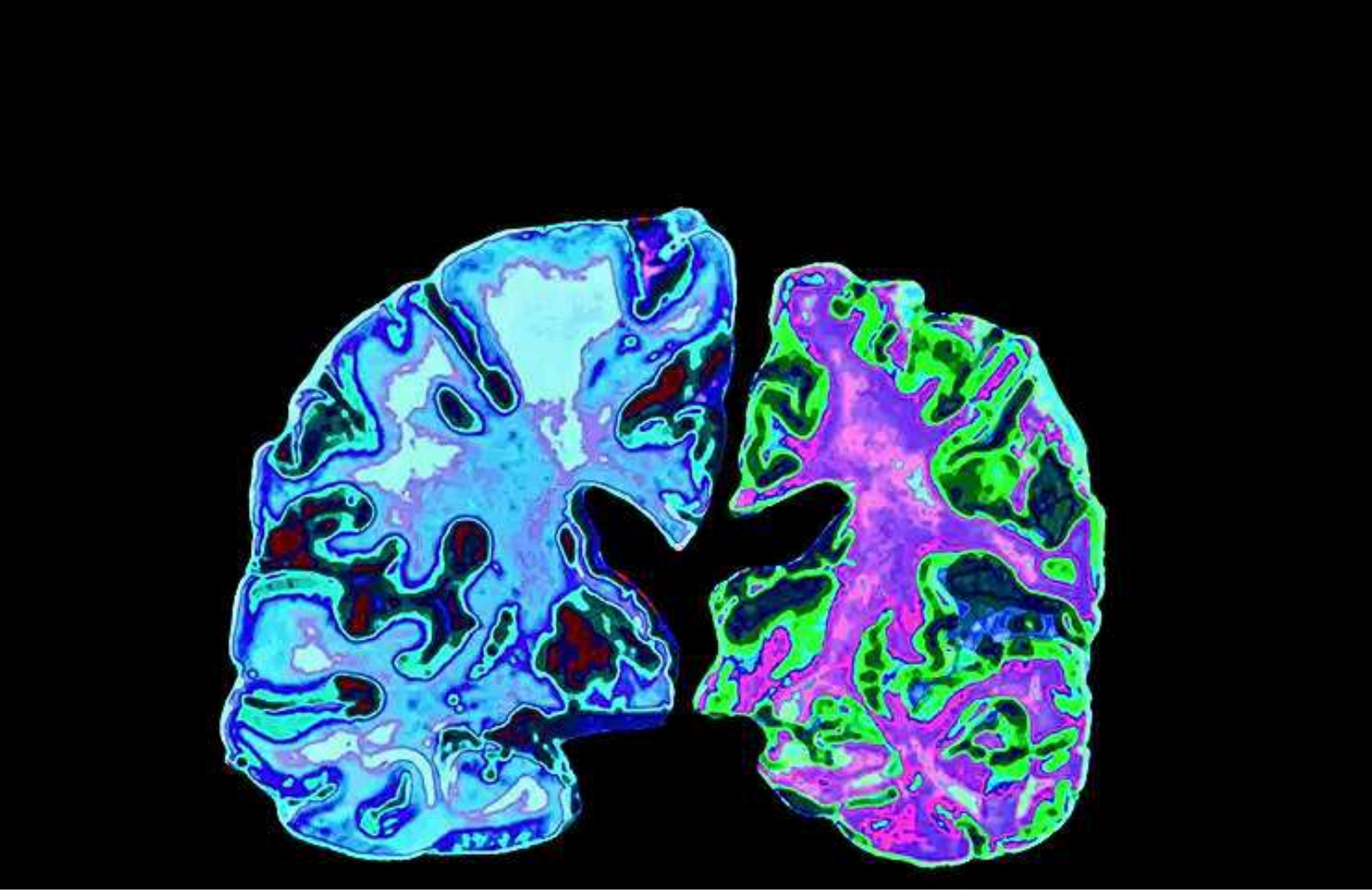


UNDERSTANDING THE DEVELOPMENT OF ALZHEIMER'S DİSEASE

Arda Kabal
12/B

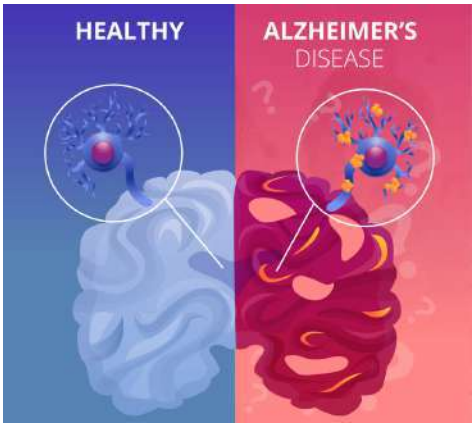
Over the last few decades, worldwide modern medicine has been flourishing exponentially. With this rapid advancement, many mysteries about formerly unknown diseases are unraveled and their causes are unearthed. One of those diseases is Alzheimer's Disease (AD). This article aims to explain the development of Alzheimer's Disease, its causes, and current research on it.

To start, what is the notorious Alzheimer's Disease and what is its history? AD is the most common cause of dementia, which is a term to indicate memory loss and diminishing cognitive functions. AD is a progressive disease, which means it generally gets worse and worse as time passes. From its early stages to its later stages, it can cause mild to complete memory loss, loss of communication skills, changes in physical abilities, and vulnerability to certain illnesses like pneumonia (1) AD has been known for over a century.

The first diagnosis of AD that was ever recorded was in 1906 by psychiatrist and neuroanatomist, Alois Alzheimer-whom the illness takes its name. He reported his case- a 50-year-old woman who experienced paranoia, progressive sleep and memory disturbance, aggression, and confusion, until her death 5 years later- as "A peculiar severe disease process of the cerebral cortex" to the 37th Meeting of South-West German Psychiatrists in Tubingen. He also reported the distinctive plaques and neurofibrillary tangles that were seen to be accumulated in the brain histology. In the conference, despite getting enthusiastic responses from some of his colleagues, this case did not incite much interest. However, with his later publications on this same "plaque" disease, he engraved his name in the scientific medium as the founder of Alzheimer's Disease (2).

After its first record, the formation of senile plaques (SP) and neurofibrillary tangles (NFT) have been seen as the main cause of AD. Over the years, studies of the molecular composition of SP and NFT have been conducted in order to better understand how they play their role in the development of AD and its pathogenesis. The discovery of ß-amyloid (Aß), which is the most important molecule for the formation of SP, gave scientists a better understanding of how these degenerative plaques and tangles were able to form in patients' brains. Research showed that these senile plaques could form in the tissue between the nerve cells, cause abnormal clumps of proteins (Aß) along with degenerating the central nervous system. On the other hand, neurofibrillary tangles, which are bundles of twisted filaments containing a protein called tau, were seen to be forming within neurons. Normally, tau protein helps the transportation in a nervous cell. However, in AD, tau proteins are changed in a way that causes them to take a helical shape, which then leads to tangles. This abnormality disrupts the transport system of the nervous cells and disintegrates them, putting a halt to the communication between nerve cells and eventually making them die. Both degenerative abnormalities contribute to the lessening of the patient's ability to communicate, decrease of their cognitive skills, and memory loss- Alzheimer's disease (3)(4).

Even though scientists know how Alzheimer's is caused, they do not fully understand why it occurs. Many scientists believe AD is caused by genetical reasons along with harmful mutations. Genes that one inherits from their parents can affect how likely one can develop AD. On the other hand, it is also generally accepted that aging, lifestyle, and environmental factors are also an important risk factor that causes AD. Even though age does not directly cause AD, it is the most important risk factor for it. For every 5 years beyond the age of 65, the number of AD patients doubles. Research show that aging leads to the degeneration of nervous cells, shrinking of the brain, inflammation, vascular damage, and hindering of the energy production within cells. Lastly, environmental factors and lifestyle are also solid causes of the disease. Factors like diet, physical activities, social engagement, and sleep time all contribute to vascular and mental health, which are proven to affect one's risk of getting AD (5).



To conclude, Alzheimer's Disease- even though there is much active research- is still a greatly unknown matter for humankind. As the world's population increases geometrically, the mortality rate of Alzheimer's also increases despite the development of modern medicine. Currently, the mortality rate of AD patients is around 35% (6) having an annual death count of around 100,000 to 120,000 (7)(8) per year and there is still no known cure for it. Therefore, it is safe to assume that Alzheimer's Disease is an urgent and deadly matter for our world. However, it must also be noted that, with the rapid advancement of modern medicine, there is still hope for the millions of patients who suffer from Alzheimer's Disease worldwide.

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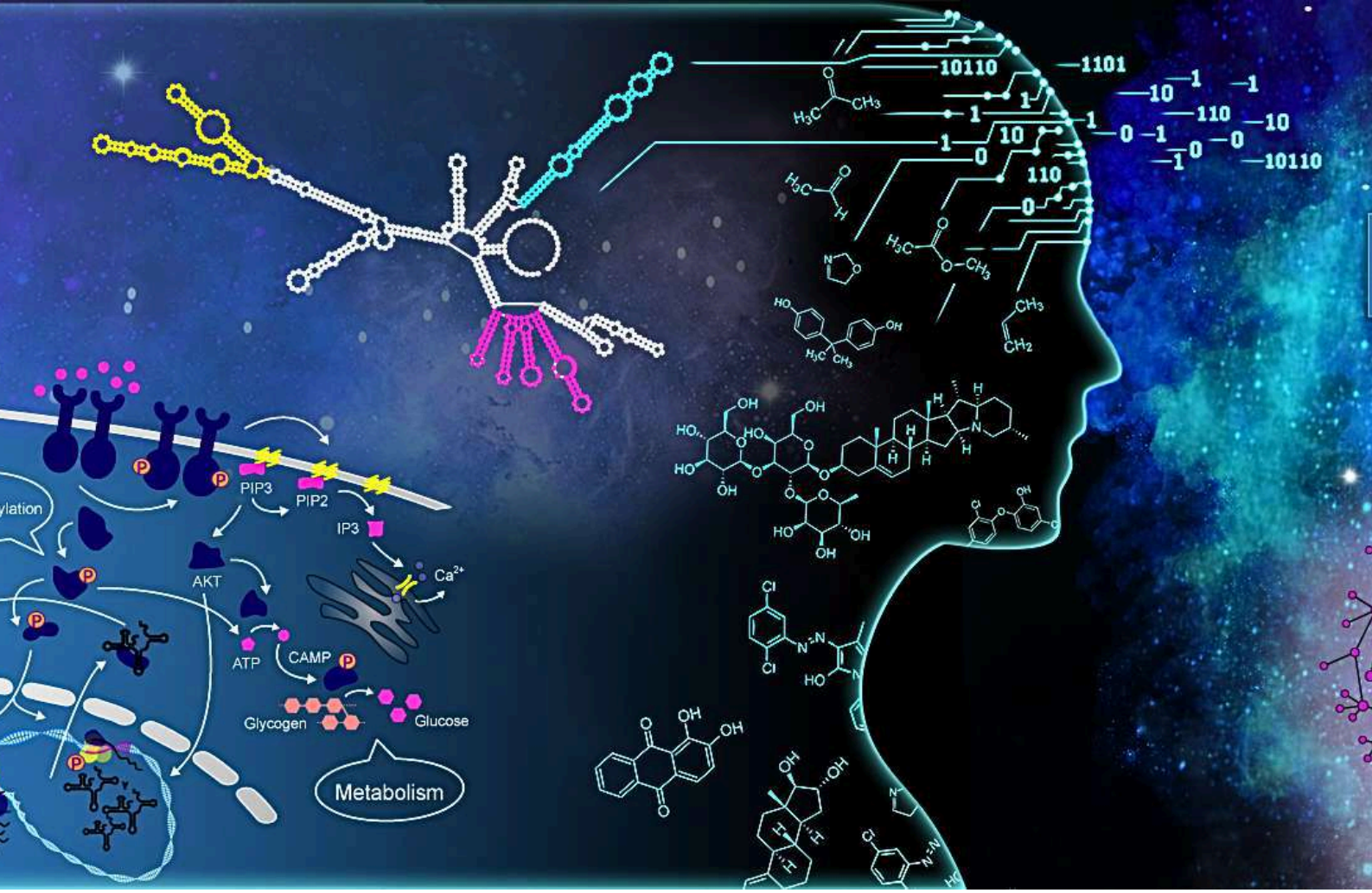

BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

Beril Ekin Gürhan
12/G

The study of sizable biodata sets, biological statistics, and research findings is referred to as bioinformatics. The analysis and integration of genetic and genomic data, cheminformatic comparisons of proteins to enhance personalized treatment, and the prediction of protein function based on data sequence and structure information are a few instances of bioinformatics investigations. In contrast, computational biology focuses on finding answers to problems brought up by research in bioinformatics. Generally speaking, these topics are seen as aspects of the quickly developing data science and biotechnology industries. Through the simulation of protein folding, mobility, and interaction, computational biology is helpful in scientific study, particularly the investigation of how proteins interact with one another.

The transformation of vast amounts of data in the "big data" era into insightful knowledge has grown in importance in diverse fields, and bioinformatics is no different. Significant amounts of biological data, such as omics, picture and signal data, which have been gathered, and the potential uses that result for biological and medical research has drawn interest from academics and industry alike. Because for instance, IBM developed Watson for Oncology, a software that analyses patient data and helps medical professionals with options for medical treatment. Computational biology and bioinformatics offer the methods and instruments needed to make sense of this flood of data. By comparing genomic sequences, they allow scientists to analyze genomic data and find genes, regulatory regions, and mutations linked to various diseases. Recognize protein structures because computer programs can forecast how proteins will fold and interact, which is necessary for developing new drugs and comprehending how cells work. Examine evolutionary links because phylogenetic research sheds light on biodiversity and conservation by tracing the evolutionary history of species. Model biological systems: Research and medical applications can benefit from the ability to predict system responses under a variety of scenarios through simulations of metabolic pathways and cellular processes.

Figure 1: Advice, A. (2023, July 21). AI-Powered Platform from IBM Watson Health to Personalize Cancer Treatment. Medium.

Computational biology and bioinformatics integration has had a significant impact on research and medicine. These fields allow, for example, the study of a person's genetic information to customise therapies according to that person's genetic composition. This strategy is essential for creating cancer and genetic condition focused medicines.Bioinformatics techniques are used in drug development to analyse protein interactions and structures to find possible therapeutic targets. Drug interactions within biological systems can be simulated by computational biology models, which expedites the creation and testing of new treatments.Furthermore, these fields are essential to comprehending complicated illnesses including diabetes, cancer, and neurodegenerative diseases. Researchers can find biomarkers for early diagnosis and create preventative and treatment plans by evaluating massive datasets from clinical trials and lab experiments.

The areas of computational biology and bioinformatics present a number of difficulties in spite of significant improvements. Modern biological research generates tremendous amounts of data, which require complex algorithms and a strong computational infrastructure to handle and analyse.

Bioinformatics and computational biology are important for treatment and analysing data. They help scientists to explore the combination of data science and biology will surely produce even more significant discoveries and advances in our comprehension of living systems as technology develops.

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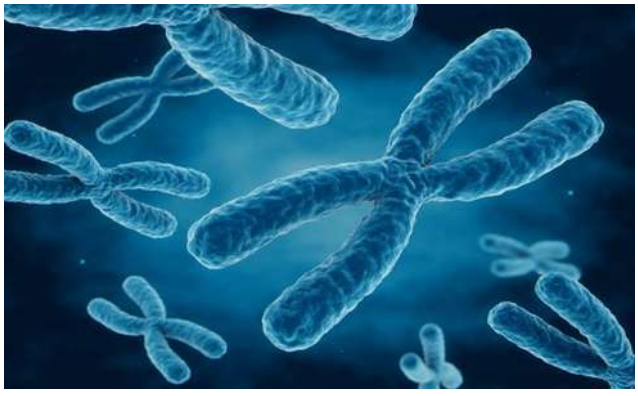
GENOME ORGANIZATION AND DYNAMICS

İsmet Doruk Göklü
12/Z

The genome, which is the entire DNA of an organism, is a highly dynamic blueprint for all aspects of biology, from the development to routine cellular functions of the organism. Determining the genome's dynamics and order is the most important aspect of understanding life's complexities and development, disease, and evolution. Chromatin, a mixture of histone proteins and DNA, is the basic unit of genome organization. Nucleosomes, which are like beads on a string, nucleosomes are created when DNA is wrapped around histone proteins. These are then further folded and condensed to form higher-order structures, which are then arranged into chromosomes. This hierarchical packaging is required not only to put the long DNA string in the nucleus but also to regulate gene accessibility and expression.

Chromosomes are found in various areas of the nucleus referred to as chromosomal regions. The genome can only functionally be called this considering this non-random spatial arrangement. The genome is sorted by the cell into compartments that may be accessed for transcription, replication, and repair of particular DNA regions. Scientists were able to map these three-dimensional structures using technological advances like Hi-C; these innovations reveal that three distant genome regions may be physically linked through folds and loops. Enhancers are regulatory DNA sequences introduced into proximity to a target gene by interaction and do affect that gene's expression. They may also act in the intervening regions. Enhancers are regulatory DNA sequences that are brought into proximity to their target gene through interactions, thereby affecting the expression of that gene. Epigenetic modifications, which are chemical changes in DNA or histones that alter gene activity but do not alter the DNA sequence, have a significant impact on genome dynamics. The best-known epigenetic markers are histone modifications and DNA methylation. The ability of the transcription machinery to bind to DNA can be stimulated or inhibited by these changes, which in turn controls gene expression. The ability of cells to "remember" their identity and function overtime is made possible by the remarkable stability of epigenetic modifications required for processes such as differentiation and development.



Maintaining genome integrity is important due to the ongoing threat of DNA damage from both exogenous causes such as UV radiation and endogenous sources such as metabolic wastes. To repair this damage, cells have created complex DNA repair systems. For example, homologous recombination corrects double-strand breaks, while base excision repair corrects small, strand-intrusive base lesions. Many malignancies are characterized by genomic instability, which can result from defects in various repair processes. at the ends of chromosomes are repetitive DNA sequences that protect chromosomes from damage and prevent them from joining. Polymerase has the property of shortening with each division of cells and forms a kind of biological clock, limiting the life of any individual. This type of arrangement is called senescence and occurs when the telomeres become alarmingly short, resulting in immobility of the cells. This process is necessary to stop uncontrolled cell division, a defining feature of cancer. Non-coding DNA makes up approximately 98% of the human genome, and its role in genome organization is fascinating. These sections, previously thought to be "junk DNA", are now understood to be essential for controlling gene expression. Enhancers, silencers, and non-coding RNAs are components of regulatory networks that modulate the expression of genes. With the discovery of these components that reveal the complexity of the genome, our understanding of genetic regulation has completely changed. The development of CRISPR-Cas9 technology has revolutionized the study of genome dynamics by enabling precise DNA sequence editing. By correcting mutations at their source, this method holds great promise in the treatment of genetic diseases. CRISPR's capacity to alter specific DNA sequences opens new opportunities for research and therapeutic uses, providing hope for the treatment of

inherited diseases thought to be incurable. Studies of the structure and dynamics of the genome revealed the careful control of underlying biological functions. These systems, ranging from tightly packed DNA molecules to dynamic control of gene expression and maintenance of genomic integrity, ensure the proper functioning of the genetic code. Our understanding of these processes will increase with further research, opening the door to advances in biotechnology, medicine, and other fields.

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PERSONALIZED MEDICINE AND PHARMACOGENOMICS

Emir Küçükbarak
12/İ

The world has experienced tens of thousands of diseases since the formation of organisms, many of whom which affected human life. These diseases affect certain parts of the body and make them function slower or lose their function completely. In most diseases, the microorganisms that cause the disease get into the body often through the respiratory or circulatory systems. They then bind to a structure in the body – such as receptors or enzymes – and disrupt their activities. However, technological advancements allow most diseases to be treated either by drugs or by certain therapies. The drugs used to treat diseases are prescribed usually in certain doses, as being subjected to too much of a drug will result in a much worse situation than the disease itself. The amount of medication per dose a patient should take differs from person to person since everyone has different genetic traits that affect their response to treatment. Pharmacogenomics is the study of how a patient's genetic structure affects their response to drugs (5). Any difference from an expected response can be determined before the prescription of drugs by analyzing genetic variations that affect certain traits like drug metabolism, which determines the rate at which a drug is broken down in the body, compatibility of drugs with the patient's genetic lineup, and any adverse reactions that the patient's body may show against the drug.

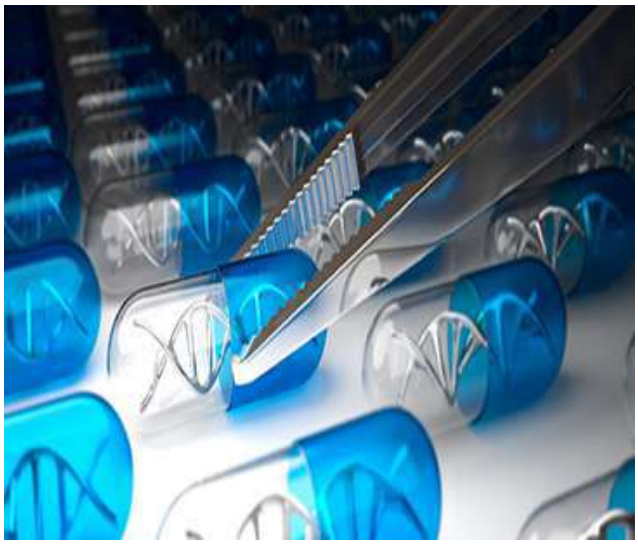

Figure 1: Picture of drugs (2)

Drug metabolism efficiency determines how fast the body breaks down drugs and puts them into use. This affects the period of time which the drug stays active. If a medication is broken down too fast, it will stay active for a much shorter time than normal, as it would be quickly excreted out. The Cytochromes P450, which are a superfamily of enzymes maintaining drug metabolism, may show a different amount of activity in individuals (3). This is caused by the enzyme's genetic polymorphism which suggests different forms of specific DNA sequences in the structure of the enzymes (4). Those varying DNA sequences cause the enzymes to respond differently in every human. Other genetic variations may cause some patients to develop adverse reactions, reactions like negative side effects, to certain drugs. Pharmacogenomics is used to identify any of these genetic variations and aid in personalized medicine. Personalized medicine is the adjustment of drugs – may be for doses, how frequently a medicine should be used, and determination of alternative treatments if the patient cannot tolerate a drug – according to the genetic variations of patients.

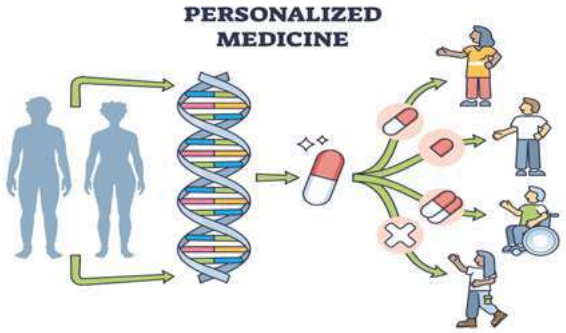

Figure 3: Personalized Doses of Drugs (6)

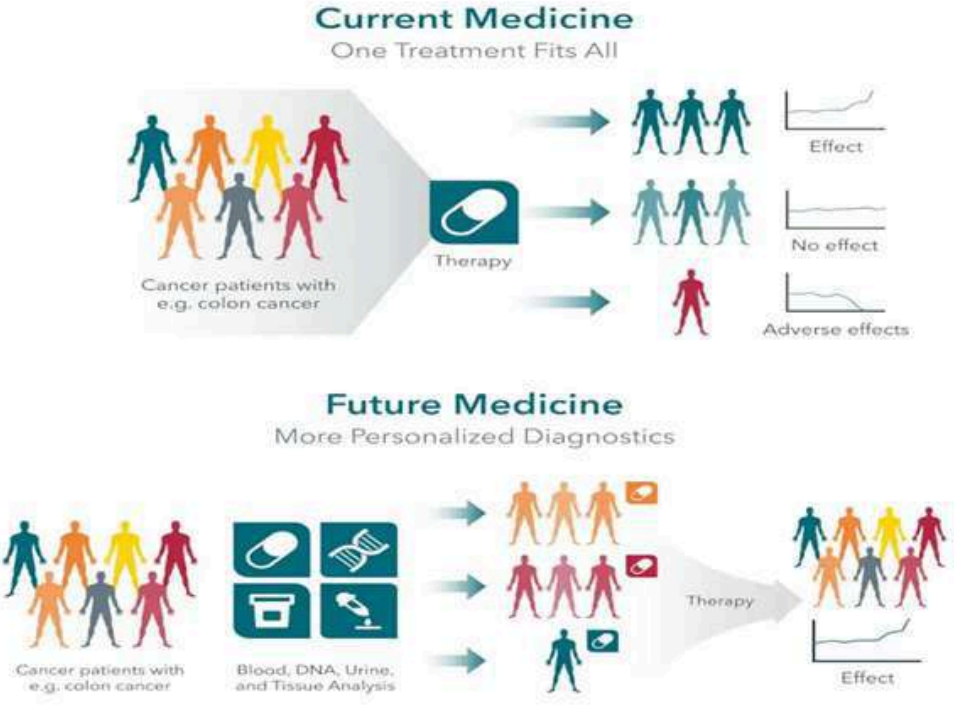

Figure 2: Personalized medicine and its effects (1)

Personalized medicine is a thriving field in the modern-day world. It is used in various areas including oncology, cardiovascular diseases, neurology, psychiatry, infectious diseases, and pediatrics. In addition to drug metabolism, tolerance, and selection, it can also be used to develop targeted therapies for cancer cells, identification of high-risk patients for several diseases, and many more areas of health. With technological advancements paving the way, personalized medicine and pharmacogenomics will likely become expectation-exceeding studies for human health.

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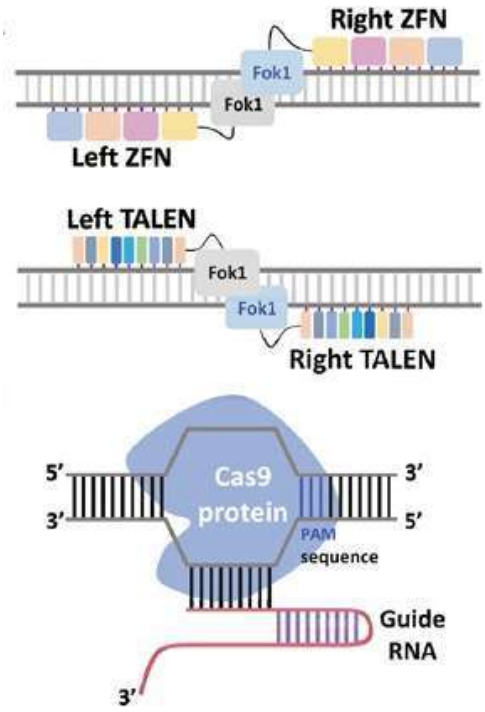
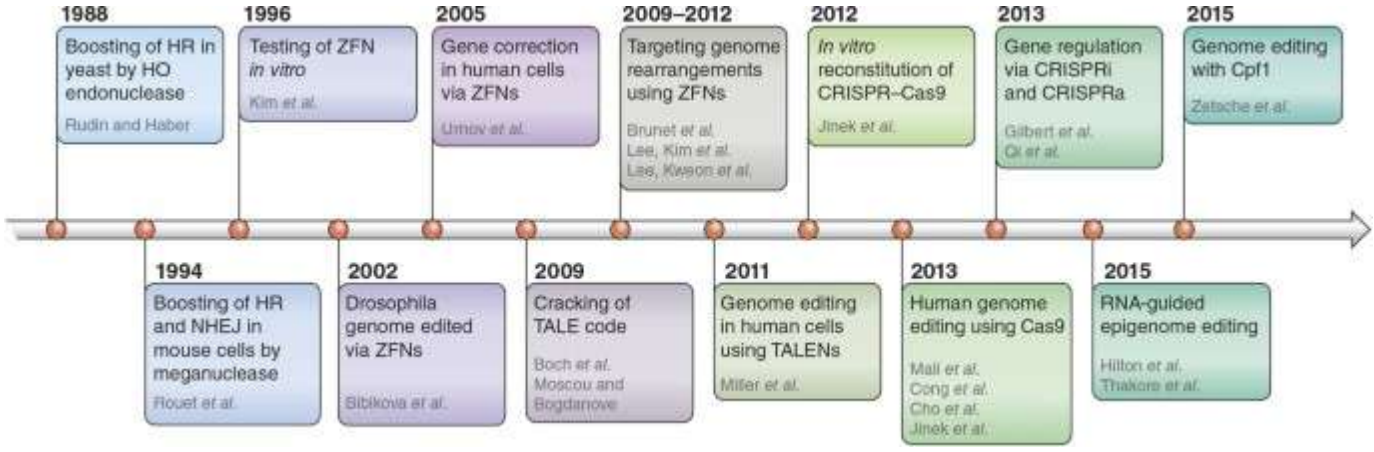
HISTORY OF GENE EDITING METHODS

Nehir Gülseren
12/İ

Gene editing involves making precise changes to a living organism's DNA sequence, thereby changing its genetic makeup. Nucleases, especially enzymes, are employed for gene editing by creating incisions in DNA strands, enabling the elimination of existing DNA and the introduction of new DNA. This is a thrilling period for genetics, primarily due to advancements in genetic research and manipulation. Advancements in high-speed DNA sequencing and genome editing have made a significant impact on various fields such as model organism research, evolutionary studies, food organism enhancement, and medical applications. The new gene-editing tools have reinvigorated ongoing discussions about the ethical and social impact of human genetic engineering. For years, people have been questioning whether genetic engineering should be utilized for curing illnesses in humans or for changing characteristics such as beauty or intelligence.

The idea of using gene editing for medical treatment or changing characteristics can be traced back to the 1950s, following the discovery of DNA's double-helix structure. During the genetic discoveries of the mid-twentieth century, scientists discovered that the sequence of DNA bases is typically passed down from parent to child and that minor changes in this sequence can impact whether an individual is healthy or sick. Identifying these "molecular mistakes" related to hereditary disorders will eventually lead to correcting them, which can prevent or reverse diseases. The idea was considered the ultimate goal of molecular genetics in the 1980s and served as the basis for gene therapy. The ability to create a specific DNA double-strand break (DSB) in the chosen chromosomal area is essential for effective genome editing. The understanding that a break could cause gene targeting and local mutagenesis did not happen on its own, but through research on DNA damage and repair. Intentional double-strand breaks encourage recombination between similar sequences in meiosis, while breaks due to ionizing radiation lead to crossovers between sister chromatids. Studies using specific enzymes showed an increase in homologous repair in both yeast and mammalian cells, opening the way for precise genome editing. Nonhomologous end joining (NHEJ) serves as an alternative technique to reconnect severed ends. The INDELS caused by the NHEJ mechanism provide a great method for studying how a gene works. RNA interference has been previously employed for the examination of gene function. Nevertheless, it only decreases the activity of the desired gene, never fully halting its expression. Gene editing via NHEJ completely abolishes the expression of the specified gene and effectively deactivates all alleles. Despite being a helpful method for studying gene function, RNAi may not entirely exhibit symptoms caused by the absence of a gene due to the continued expression of the target gene. Zinc-finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and meganucleases represent some of the innovative protein-based genome editing technologies.





An alternate method, named CRISPR/Cas9, is widely used as a genome editor and a powerful tool for studying gene function. Due to its RNA-based nature, CRISPR/Cas9 is simpler and more effective for genetic modification compared to protein-based methods, and it enables the targeting of multiple sites. The discovery of CRISPR came from basic research funded by NIH on bacteria's defense mechanisms against viruses.CRISPR/Cas9 operates by cutting a DNA sequence at a specified genetic position and deleting or inserting DNA sequences, which can alter a single base pair of DNA, vast chunks of chromosomes, or regulate gene expression levels. CRISPR/Cas9 works by slicing a DNA sequence at a designated genetic location and removing or adding DNA sequences, causing changes in a single DNA base pair, large sections of chromosomes, or controlling gene expression amounts.

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MOLECULAR TECHNIQUES USED IN BIOTECHNOLOGY

Evren Demirkaya
12/İ

Biotechnology started as natural processes like fermentation and has been improving over the years. This improvement is done by the power of molecular techniques, tools that allow scientists to analyze the core of life which are DNA, RNA, and proteins. These have improved the understanding of living organisms and also influenced the development of products that change our lives, from medicine to environmental sustainability. In this essay, I explore the molecular techniques used in biotechnology and their applications and the impact they have had on the future of this field.

Molecular techniques in biotechnology is a lot, but some stand out as basic and most common. Here, I explain them in a few chapters.

Polymerase Chain Reaction (PCR): Often seen as the base of molecular biology, PCR allows scientists to boost a specific DNA sequence millions of times. This creates enough material for further analysis, making it important for tasks like detecting genetic diseases and identifying pathogens. Imagine having a whisper and turning it into a roar, that's the power of PCR.

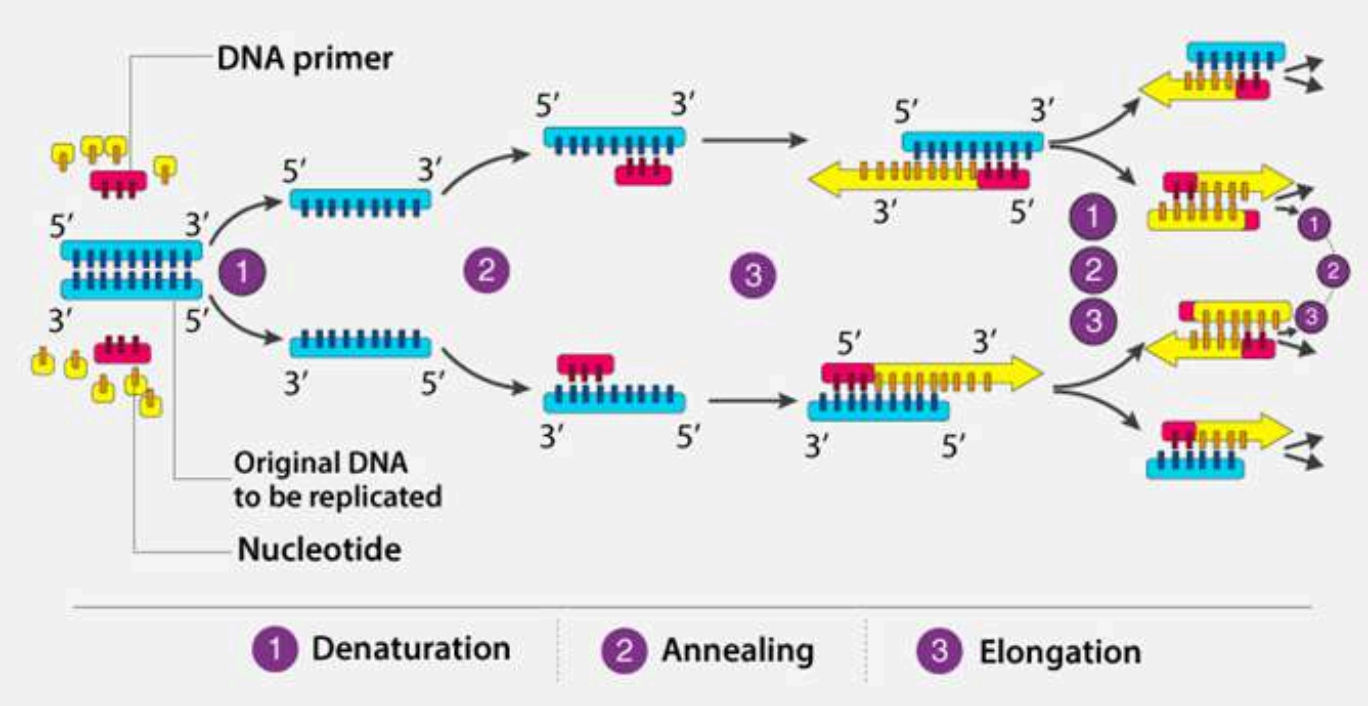

Figure 1: Admin. (2022, June 7). PCR -principle, steps, types, components, and applications of PCR. BYJUS. https://byjus.com/biology/pcr/

Gel Electrophoresis: This technique acts as a molecular sorting system. By applying an electric current through a gel, DNA, RNA, or protein molecules are separated based on their size and charge. This lets scientists analyze the components of a biological sample.

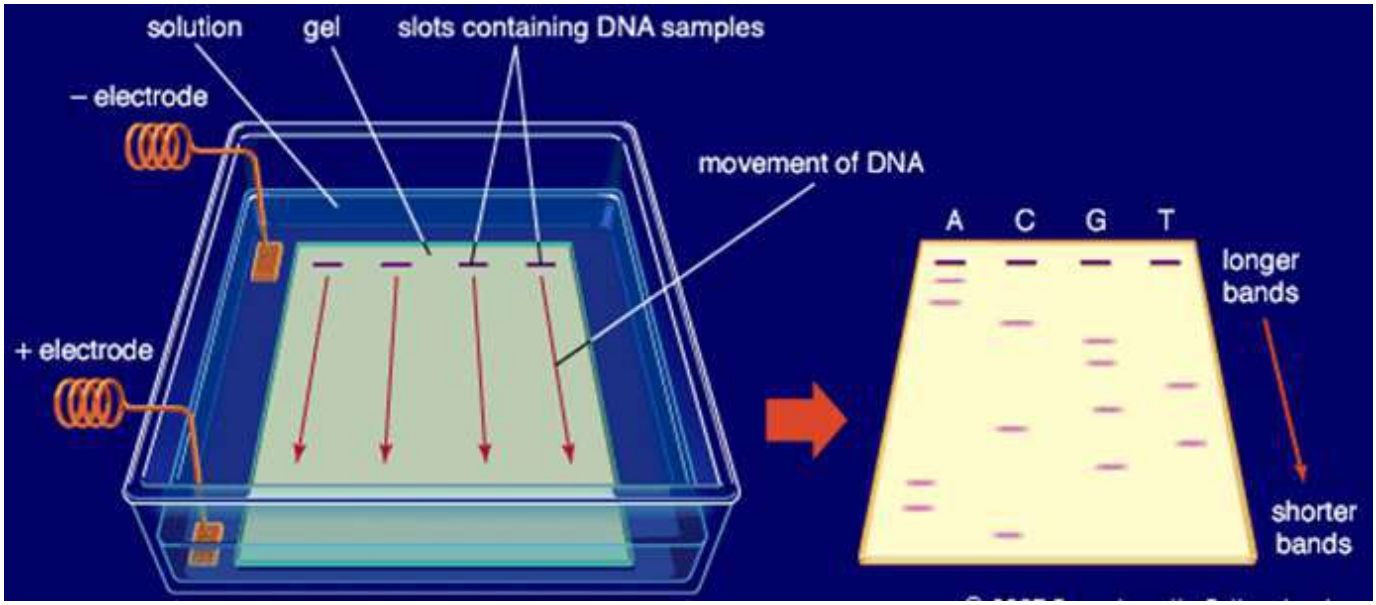

Figure 2: Encyclopædia Britannica, inc. (2024, March 21). Gel electrophoresis. Encyclopædia Britannica. https://www.britannica.com/science/gel-electrophoresis

·**Blotting Techniques:** These methods, like Southern blotting for DNA and Western blotting for proteins, involve transferring separated molecules from a gel onto a membrane for further analysis. This lets scientists to identify specific molecules using molecular tags that bind only to the target of choice. It's like having a police dog sniff out a specific suspect in a lineup of DNA or protein molecules.

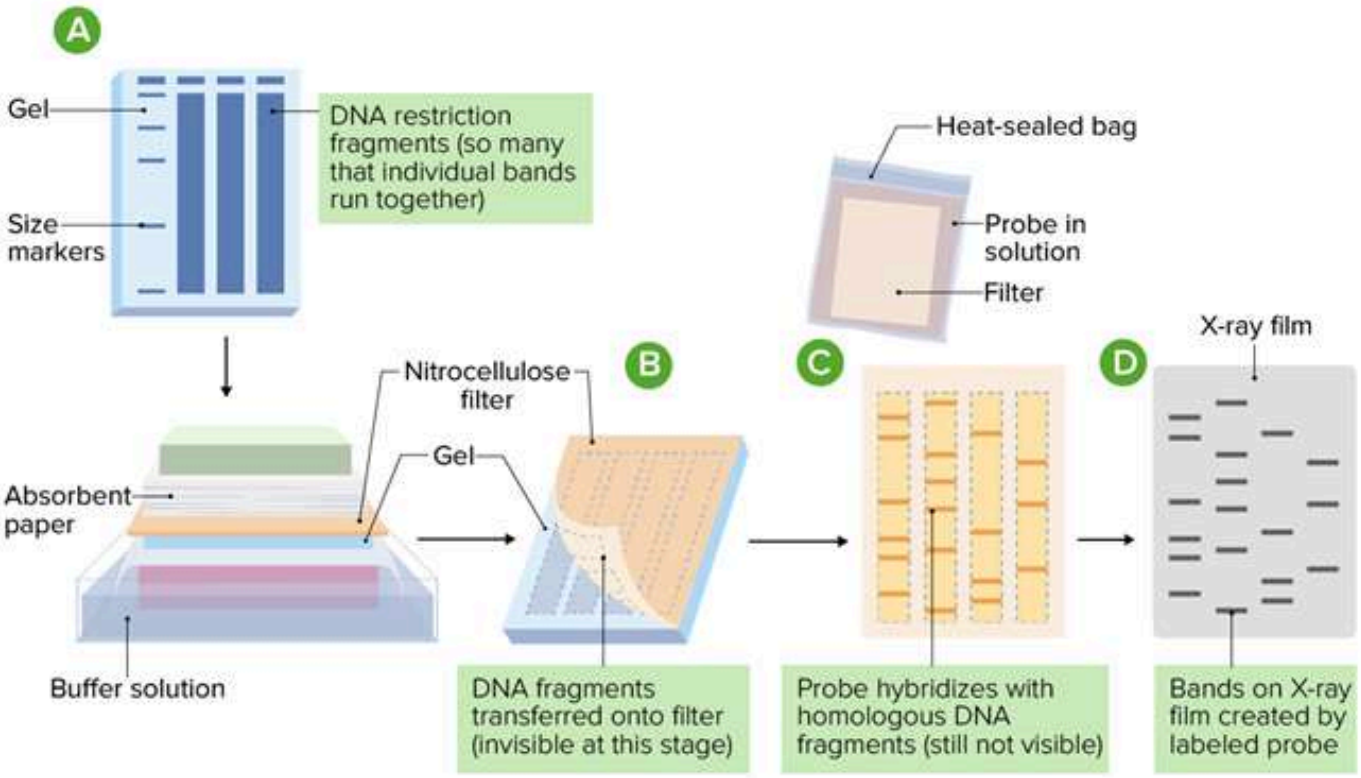

Figure 3: Blotting techniques: Concise medical knowledge. Lecturio. (2024, March 21). https://www.lecturio.com/concepts/blotting-techniques/

·**Recombinant DNA Technology:** This powerful technique allows scientists to cut, paste, and manipulate DNA to create new combinations. This has allowed the development of genetically modified organisms with improved resistance for animal cells and improved nutrition for plant cells, similar to taking parts from different Lego sets to build something entirely new.

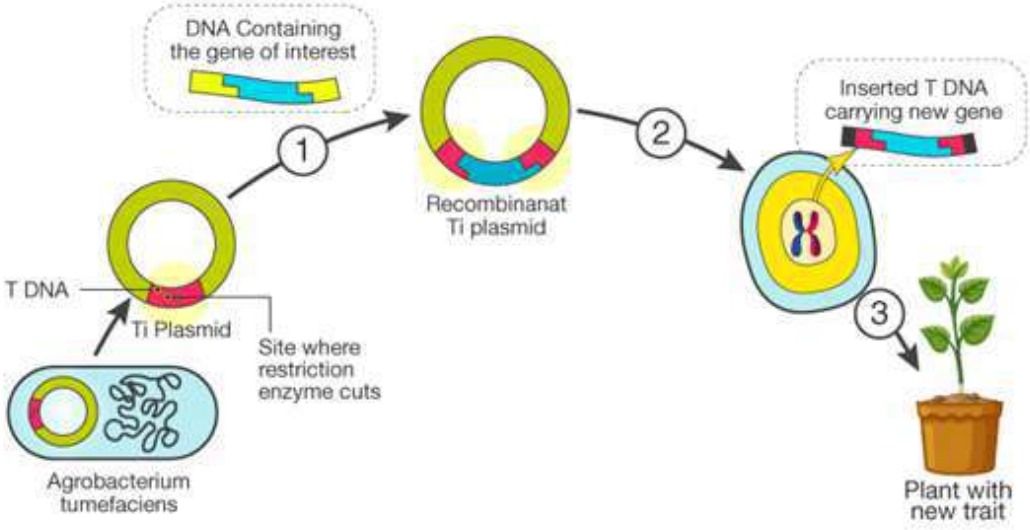

Figure 4: Admin. (2022b, June 8). Recombinant DNA technology- tools, process, and applications. BYJUS. https://byjus.com/biology/recombinant-dna-technology/

These are just a few examples as there are many other examples that can be mentioned. As scientists develop new techniques, the applications in biotechnology become more exciting. The world of molecular techniques has changed biotechnology. From disease diagnosis and treatment to the development of sustainable food sources, these tools are changing our lives. As research continues, we can expect even more applications to be done. However, it is important to also acknowledge the ethical considerations and potential risks associated with this. Open discussions and responsible development are important to make sure that molecular techniques continue to be ethical in the future of biotechnology. The future holds a lot of power, with the potential to get rid of diseases, engineer new materials, and even personalize medicine based on individual genetic profiles. The power of molecular techniques is far from over, and it is going to shape a brighter future for future generations.

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GENE EXPRESSION DYNAMICS

Demir Ertuğrul
9/B

Introduction:

In the complicated maze of life, gene expression dynamics become the composers, the ones that arrange the symphony of biological processes. The whole process of the lifespan of an organism, from its birth to its function and inevitable death, is controlled by the gene expression dynamics which determines the rhythms and melodies of life. The aim of this research is to get to know as much as possible about the complicated relationship between the two and to find out what its benefits are to health, disease, evolution, and life itself.

The Essence of Gene Expression:

The basis of gene expression dynamics is the basic process of the translation of the information contained in DNA into functional molecules, like proteins or non-coding RNAs. This process is strictly controlled, with genes being activated or deactivated, as well as their expression levels, fine-tuned, in response to a variety of internal and external cues.

Dynamic Regulation:

Gene expression is not static; it changes, it is reactionary, to the environment, to the developmental stages, and to the cellular needs. Cells have a complex regulatory system, which includes transcription factors, epigenetic modifiers, and signaling pathways, to control the gene expression patterns in such a way that it is precise as a clock. This transfer of the regulation of cellular homeostasis, adaptation to stress, and the specialization of cell types within multicellular organisms makes the life of the cell dynamic.

Temporal Dynamics:

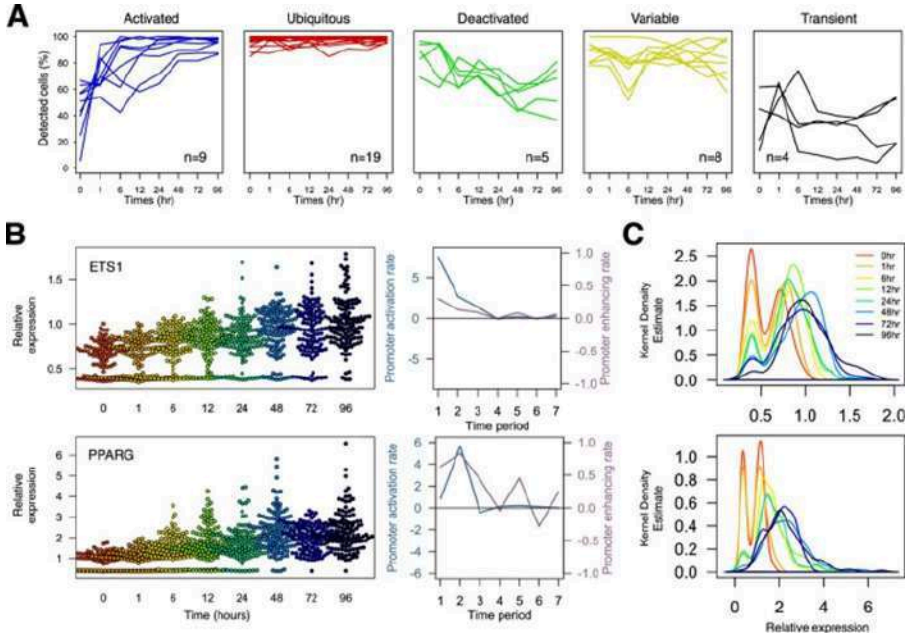
Temporal dynamics of gene expression are the key elements for the acceleration of the developmental processes like embryogenesis, tissue patterning, and metamorphosis. Genes are activated or repressed in a coordinated manner and this together with the formation of the regulatory networks results in the temporal transitions of development. In addition, the expression of genes is rhythmic, and has a circadian oscillation, which is in sync with the 24-hour day-night cycle, thereby affecting many physiological processes, like metabolism, behaviour and more.

Spatial Dynamics:

In multicellular organisms, gene expression is spatially controlled, hence, a distinct pattern of gene expression is seen in every tissue, organ, and cell type. This spatial diversity is the basis of the cellular identities, tissue architecture, and organ function which is necessary for the establishment and maintenance of these cells or tissues. The spatial gene expression dynamics are driven by the interactions of the internal factors like cell lineage and positional information as well as the external signals from the adjacent cells and the microenvironment

Pathophysiological Implications:

The uncontrolled gene expression dynamics is a major cause of various diseases such as cancer, neurodegenerative disorders, and autoimmune conditions. Mutations, epigenetic modifications, and changes in cell signaling pathways can throw off the system of gene expression, thus leading to diseases. The knowledge of the molecular processes that cause these dysfunctions is a great opportunity for the creation of new diagnostic methods and the treatment of diseases.



Technological Advances:

In the past few years, high-throughput sequencing, single-cell transcriptomics, and genome editing technologies have revolutionized the way we study gene expression dynamics with a resolution and scale that were not possible before. These technologies lend hands to the researchers to crack the enigma of the regulatory networks, uncover the rare cell populations, and investigate the gene expression heterogeneity in tissues and organisms.

Conclusion:

Genes are the biology, expression of the genes is at the intersection of biology and genetics, they play the role of the conductor, controlling the life flows from the molecular to the organismal levels. Through the complex, yet still reasonable, regulation, the temporal coordination, and the spatial patterning, genes shape the diversity and the complexity of living systems. The dissection of the mechanics of gene expression can not only increase our knowledge of life, but also help us to create new things in medicine, biotechnology, and other fields.

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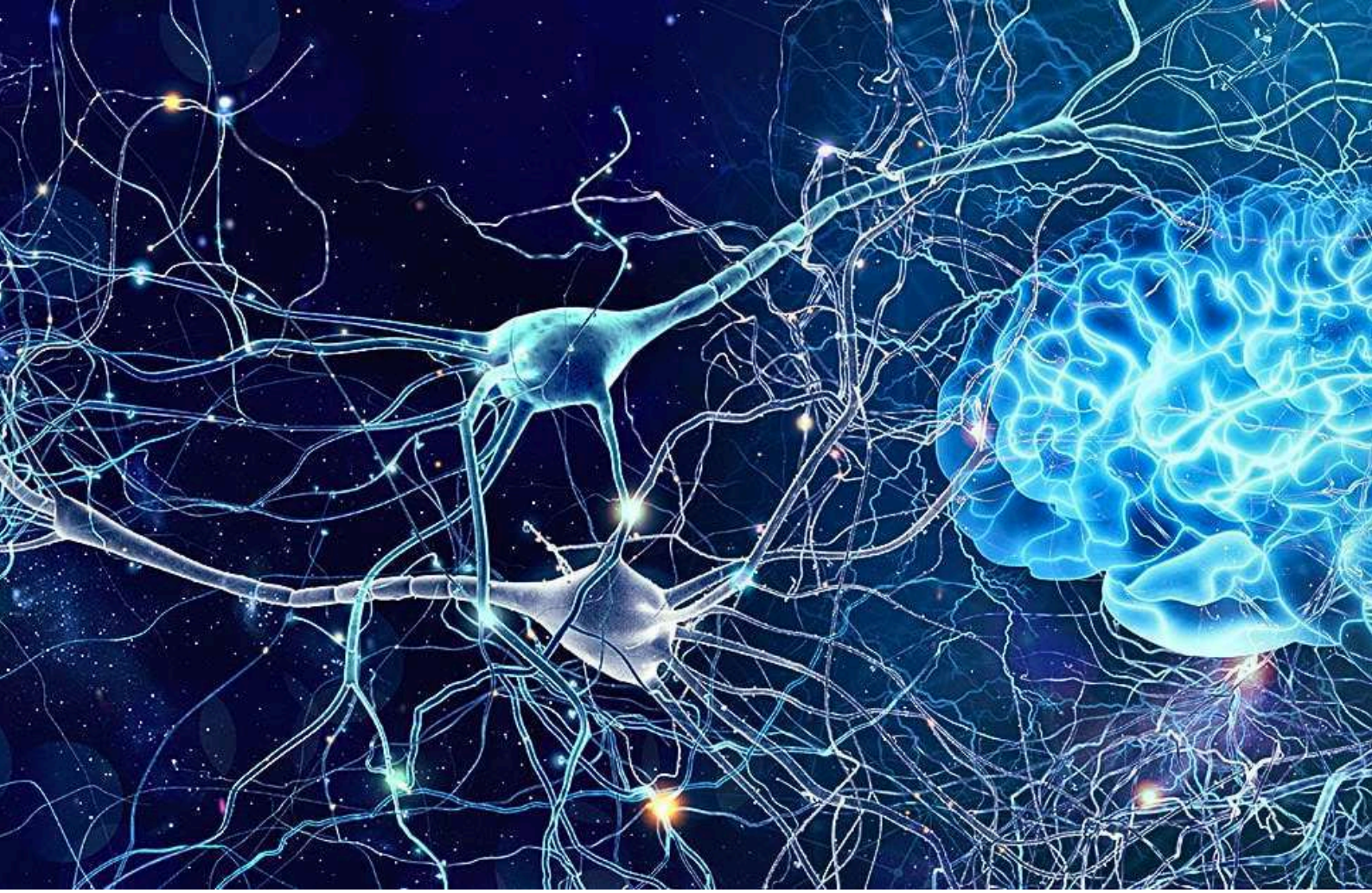


NEUROPLASTICITY AND BRAIN DEVELOPMENT

Rüzgar Papila
9/K

The brain is a special type of organ that plays a key role in humans' lives, for instance being able to adapt to environmental changes and situations, having a consciousness, and many more. The term neuroplasticity refers to how the brain adjusts and improves over time. Neuroplasticity allows humans to adapt to changing circumstances by reconfiguring brain structure and function to accomplish new patterns of thought and behavior. The human brain can get influenced easily, especially when it's in its early stages of development. To make you better understand this, quitting or acquiring new habits is much easier as a child compared to being an adult. However, this may also hurt children due to environmental influences.

Most people believe that after a short time creation of new neurons stops. However, today, it's understood that the brain's neuroplasticity allows it to reorganize pathways, create new connections, and, in some cases, even create new neurons. Although brain neuroplasticity is malleable it also has its limitations such as there are areas of the brain that play critical roles in movement, language, speech, and cognition.

There are two main types of neuroplasticity:

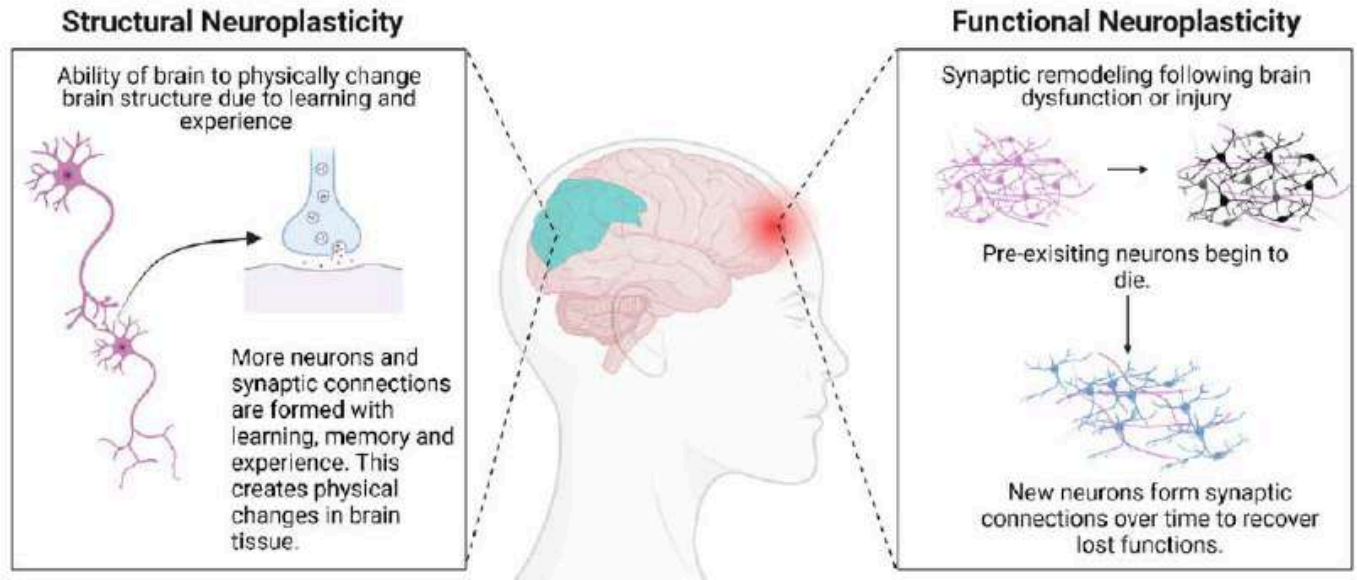
- **Structural plasticity**
- **Functional plasticity**

Structural neuroplasticity is the brain's ability to alter its neuronal connections. Also, many new neurons are being constantly produced and integrated into the central nervous system throughout one's life span.

Meanwhile, structural neuroplasticity is being investigated more within the field of neuroscience in the current academia.

In functional plasticity, there are four main types of functional neuroplasticity in humans: homologous area adaptation, cross-modal reassignment, map expansion, and compensatory masquerade.

- **Homologous Area Adaptation:** This happens when a brain function changes to a similar area on the opposite side of the brain.
- **Cross-Modal Reassignment:** This happens when a brain area originally used for one sense starts processing information from a different sense.
- **Map Expansion:** This involves a part of the brain getting bigger as a result of constant use or practice
- **Compensatory Masquerade:** This process is when the brain finds a new method to perform a cognitive task through different processes.



Conclusion:

To sum up, the brain is a malleable organ that can adapt to any kind of situation, this is also called neuroplasticity. Due to the adaptability of the brain, it can easily adjust in every situation. This can have a positive impact or negative, it changes the situation. In addition, the brain's neuroplasticity can create new pathways or produce neurons.

There are two types of neuroplasticity: functional and structural plasticity. Functional plasticity has four main types and structural plasticity which brain's ability to change neural connections.

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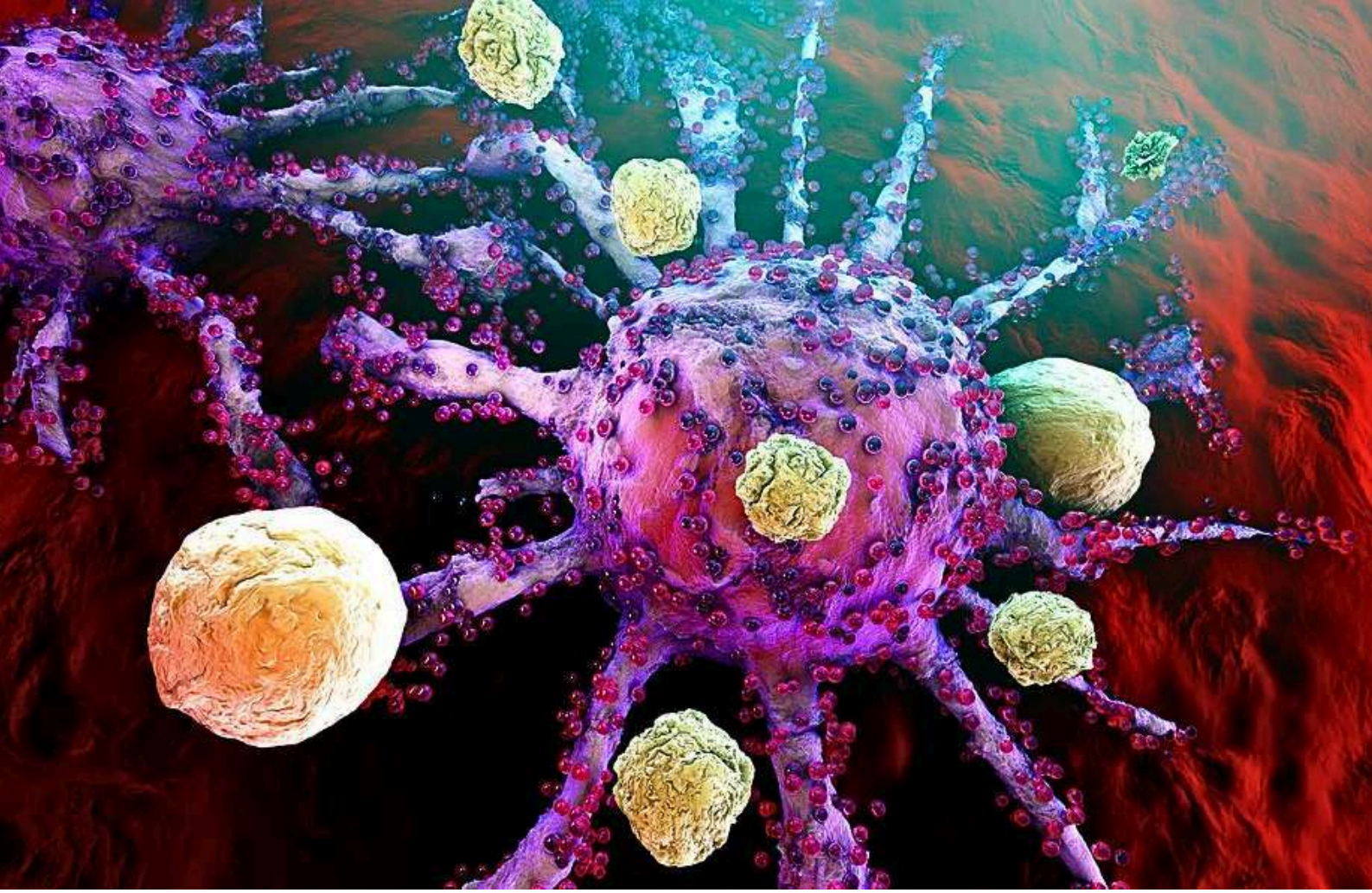


CANCER IMMUNOTHERAPY

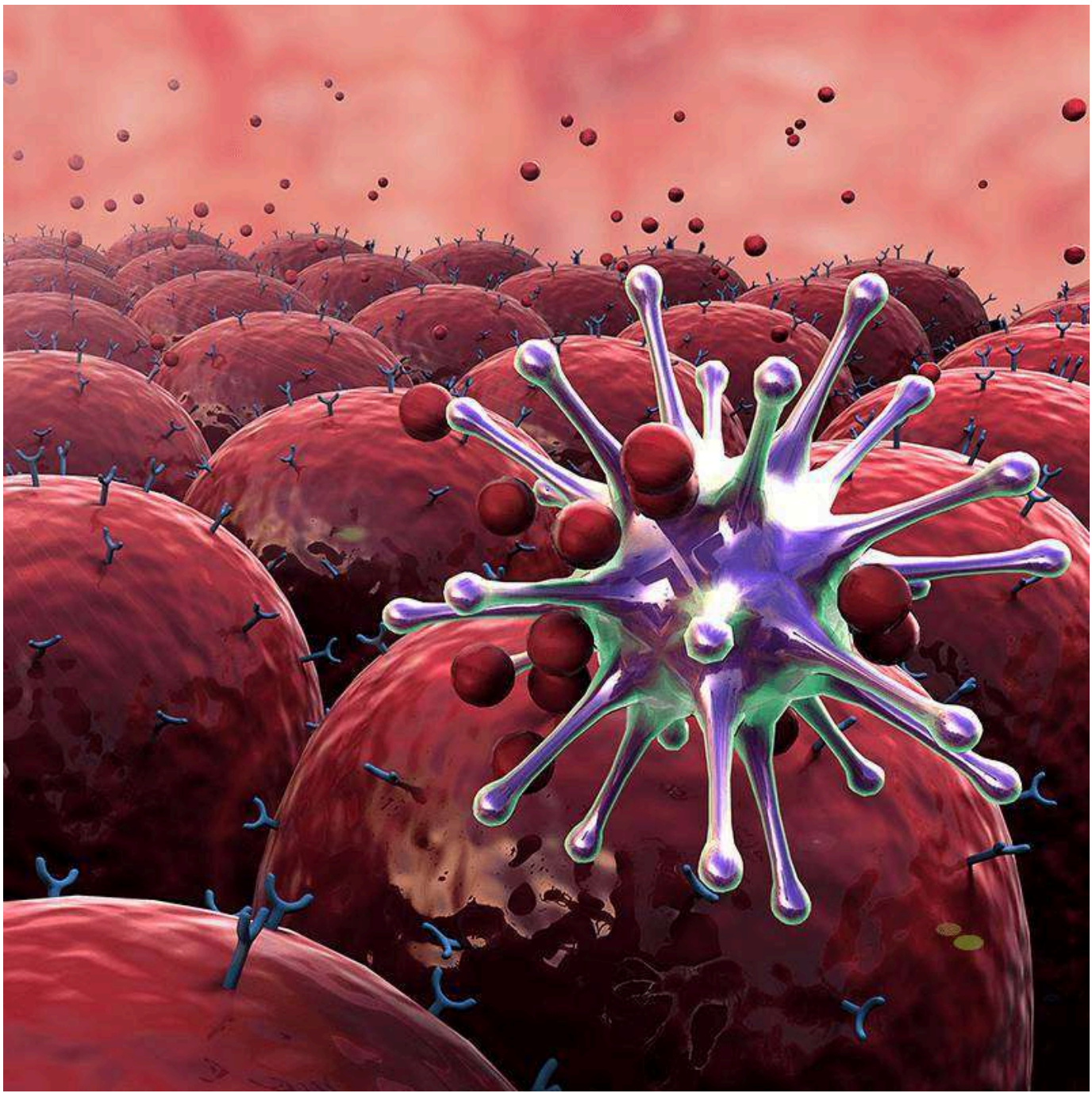
Can Özden
9/L

According to the Cleveland Clinic's definition of cancer immunotherapy, it's a type of cancer treatment that involves the use of one's own immune cells. Usually, doctors give patients chemical substances to stimulate the immune system to help fight against cancer.

Cancer immunotherapy first appeared in the late 1800s during an experiment carried out by William Bradley Coley. Then, many other experiments were carried out by other scientists which eventually led to the development of modern cancer immunotherapy. One of the most notable experiments concerning the field of cancer immunotherapy is the one that James P. Allison conducted. He began his experiment by isolating and observing T cells. T cells are the immune system's fighting white blood cells that also play a key role in eliminating cancer. He later figured out that they contain a specific protein called CTLA-4, which is found on the surface of T cells and prevents them from attacking everything they see. After a long time observing and trying to come up with a solution, James invented Ipilimumab, a drug that inhibits the mentioned protein. He was later given a Nobel Prize for his outstanding work in 2018.

We need immunotherapy to effectively fight against cancer because our body's immune system can't keep up with cancer's constant adaptations and mutations that make it really powerful. Therefore cancer immunotherapy plays a crucial role in ending cancer.

Cancer immunotherapy is one of many solutions for cancer that involves the active use of one's own immune cells as I've mentioned above. Cancer immunotherapy may function by stimulating or boosting the body's cells which makes the cells work harder and smarter to find cancer cells. Cancer immunotherapy has many advantages including being able to perform on various cancer cells, not being type-restricted. Also, it offers the possibility of long-term cancer remission. However, it also has its downsides which are fatigue, diarrhea, and constipation.



Despite the disadvantageous position our immune system is in, the development of immunotherapy has opened up a whole new world of opportunities for scientists to develop methods for the treatment of cancer, one of which I have already mentioned. In a nutshell, there are many types of cancer immunotherapy like Monoclonal Antibodies. Monoclonal Antibodies are immune system proteins created in labs and are designed to bind to specific targets on cancer cells. Other Monoclonal Antibodies mark cancer cells, making them more susceptible to the immune system. This will also reduce the cancer's overall rate of death.

To sum up, cancer immunotherapy is an intriguing topic for many young individuals as well as current scientists. According to the National Cancer Institute, cancer immunotherapy still has many undiscovered areas and will become more popular in the future. Many adolescents are considering pursuing a career in this field as it's a promising and thrilling job. Some experts also believe that cancer immunotherapy might be the key to curing cancer in the future.

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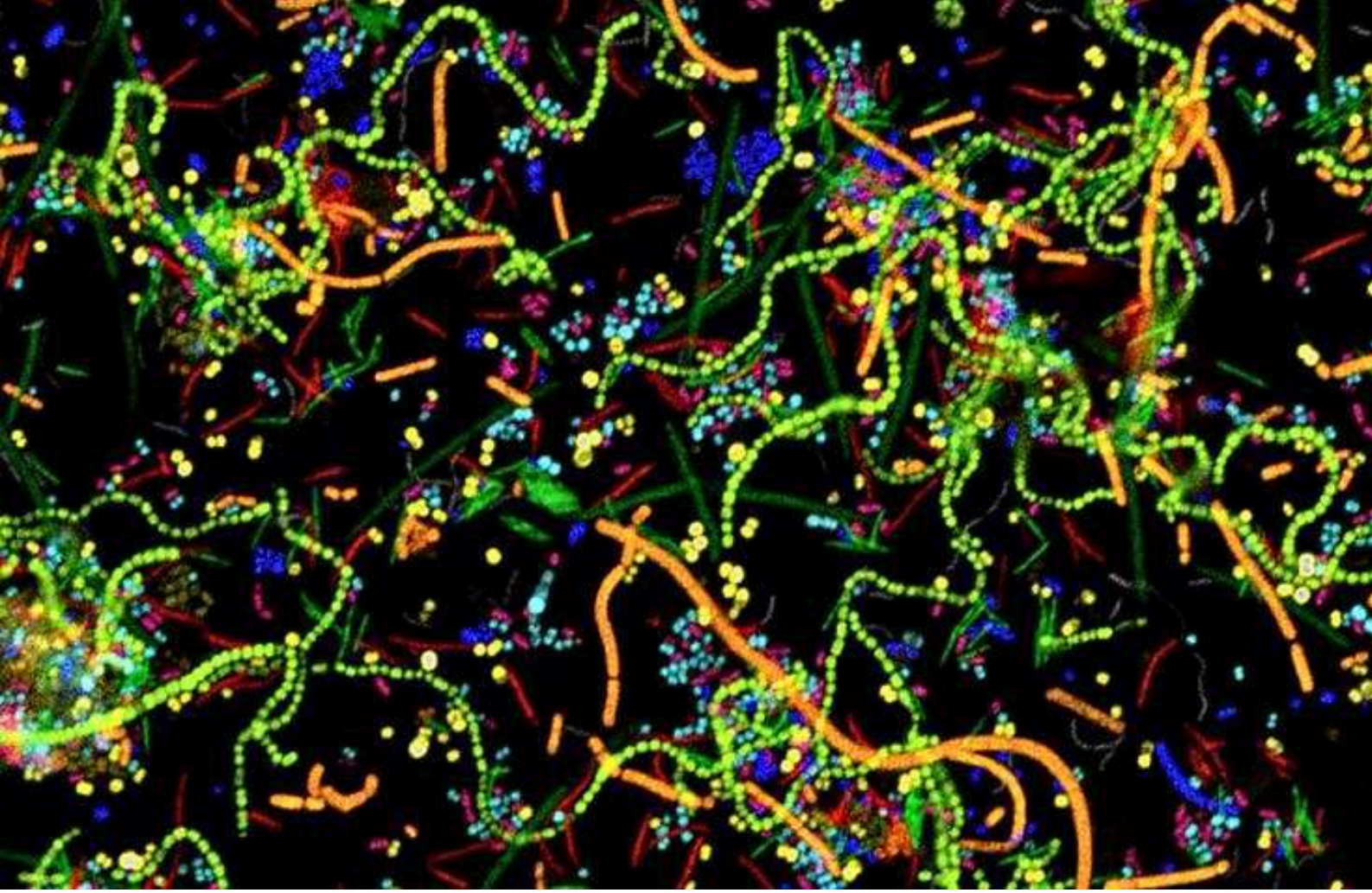


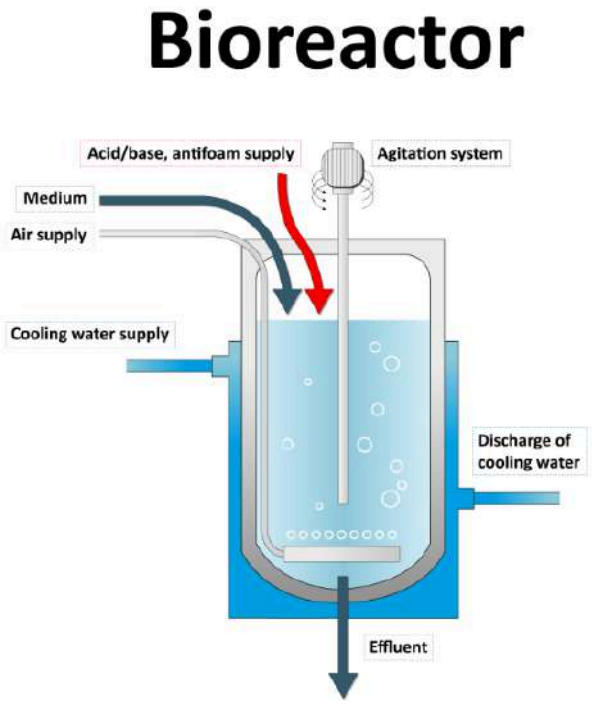
LABORATORY-GROWN CELLS

Neco Efe Özduran
9/R

Since the beginning of humanity, humans have made tools to improve their lives and to find cures for diseases. Medical research has advanced to a level where the cultivation of animal and plant cells is possible in laboratory settings. Today, growing cells in vitro (outside the living organism, artificial environment) has many applications, from drug development to the synthesis of bio-compatible materials to lab-grown organs and synthetic meat production.

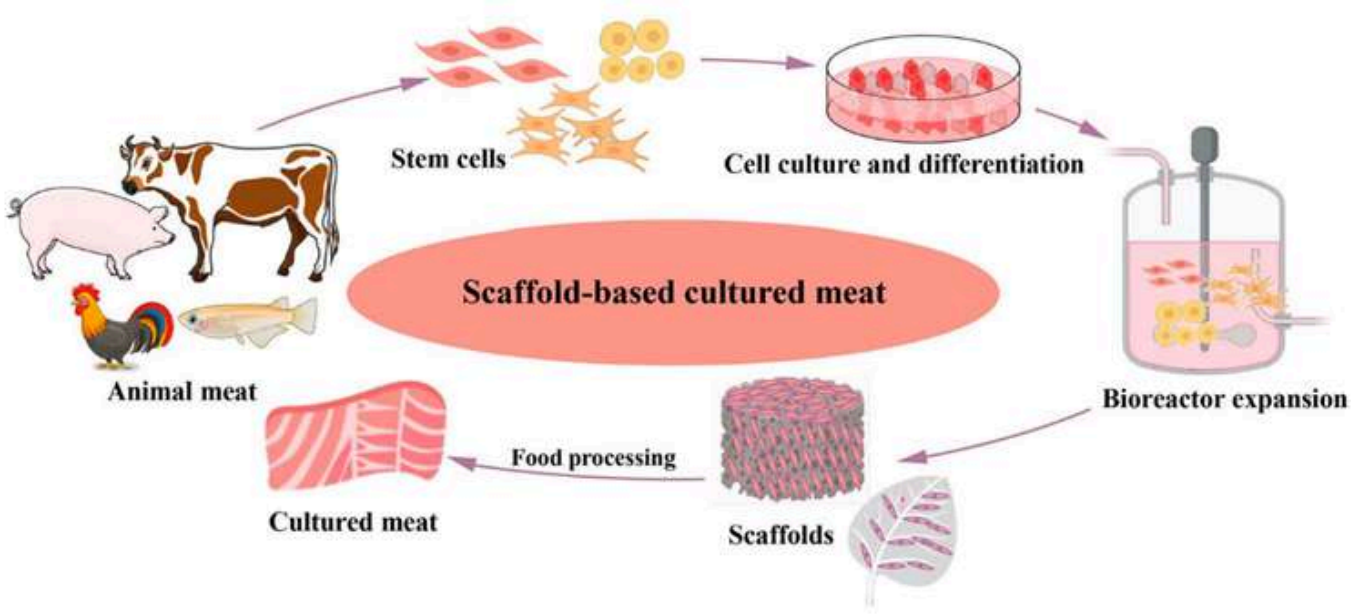
The initial step involves deciding on the cell type, which usually involves trial and error for many times. The environment necessary for the cells to replicate and differentiate must be tightly controlled with optimal temperature, nutrient supply, pH levels, vitamins and minerals, and any other compound the cells need for growth and differentiation. Depending on the desired differentiation, different transcription factors can be added to the cell culture. For example, a blood cell can be formed from a donor-delivered stem cell.

The equipment is also important. Bioreactors can provide a dynamic environment where cell can grow in three dimensions closely mimicking their natural habitat. This is especially important when creating functional tissues for medical purposes. Organoids (small organ-like structures) are an example to this. Organoids are generated mostly from stem cells and often closely simulate real organs in terms of development, cellular composition, organ-wide structure, and perhaps most importantly physiological processes. Organoids of the brain, intestine, lung, liver, and numerous other organs are routinely generated now and used for purposes ranging from basic research to drug screening.



Being able to grow the cells in lab environment not only allows the study of cell process and disease mechanisms but also opens the door for regenerative medicine where lab-grown cells can be used to repair or replace damaged tissues in patients. Tissue Engineering is a branch of regenerative medical technology that helps replace damaged tissue using appropriate scaffolding, living lab grown cells and growth factors. Using tissue engineering products can be a promising method for treating skin lesions such as wounds and deep burns.Lab-grown cells can also be used to grow meat from muscle and fat tissue without killing the organism.

In conclusion, the cultivation of lab-grown cells represents a remarkable achievement in medical research. From drug development to lab grown organs, the applications of in vitro cell growth are diverse and impactful. The process involves strict control of environmental factors to facilitate cell replication and differentiation. Bioreactors play a crucial role in creating environments that mimic natural habitats, allowing the generation of organoids. These advances not only enhance our understanding of cellular processes and disease mechanisms but also hold promise for regenerative medicine.



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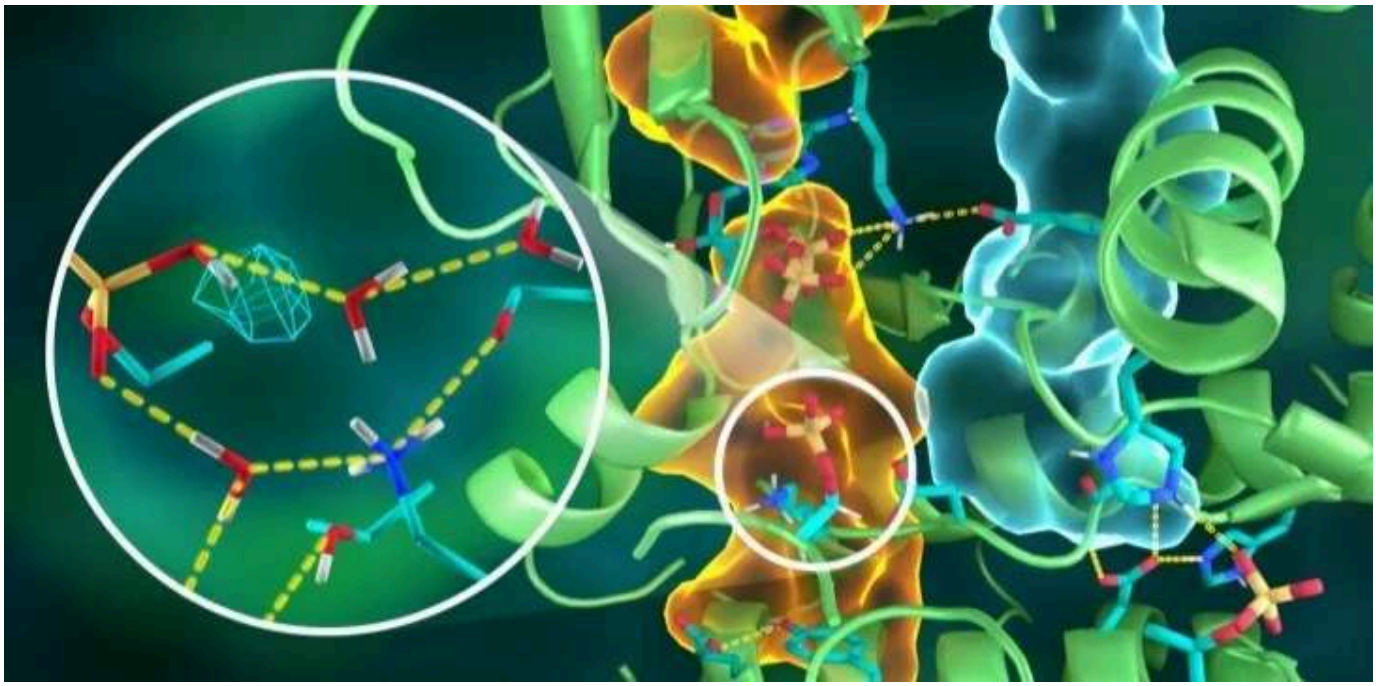
ENZYMES AND BIOCHEMICAL REACTIONS

Fizenaz Naycı
9/R

Have you ever wondered how our body works? People often ask themselves this question. While they are thinking about this the enzymes in their bodies have already started breaking down multiple substances and many biochemical reactions have occurred. Human bodies work in multiple ways: secretion, respiration, digestion, etc... In all of these reactions, enzymes are the star, without them none of these would happen. Suppose that you have gotten the flu after a few days you have completely recovered from the illness, but you can't help but question your recovery in such a short time. You ask your doctor about this and this is the response you get: “The answer is the enzymes.” The enzymes in the lysosome which are mostly found in your white blood cells break down and digest the virus. Biochemical reactions in living things are catalyzed by a series of enzymes and are tightly controlled by protein and non protein enzyme inhibitors. Enzyme inhibitors are necessary for the enzymes' catalytic actions. Without these inhibitors, the enzymes wouldn't be able to fulfill their role completely.

What is the relation between biochemical reactions and enzymes? The enzymes speed up the biochemical reaction. Cellular respiration, energy production and etc. All of these reactions would take more than what it takes right now without enzymes.

What are enzymes? Enzymes are catalysts. They break down substances to speed up the process. However, enzymes wont be able to do their job without their subparts. For that reason we have to understand the enzymes sub-parts. Let's start with the enzyme itself. Enzymes are made up of proteins. These proteins make up a unique shape in the site called "active site" these sites are necessary to match the substrates unique corresponding shape. When both of these have come together they form a “Enzyme-Substrate complex” which is also called the lock and key model. In some cases, the active site and the substrate won't attach perfectly. So the "inhibitor" shaped specially to fill the spot comes and makes this complex work. After this complicated process, the enzyme has already broken apart the substrate, which then proceeds to be called as "products", and has finished its job. Enzymes are found in a lot of places in our body. For example, our mouth. Our mouth has an enzyme called Amylase which can also be found in our pancreas breaks down carbohydrates. In conclusion, our body is full of enzymes and without enzymes biochemical reactions that are vital to a human being wouldn't be able to occur. Enzymes go through a lot of processes in our bodies for us to digest food and substances.



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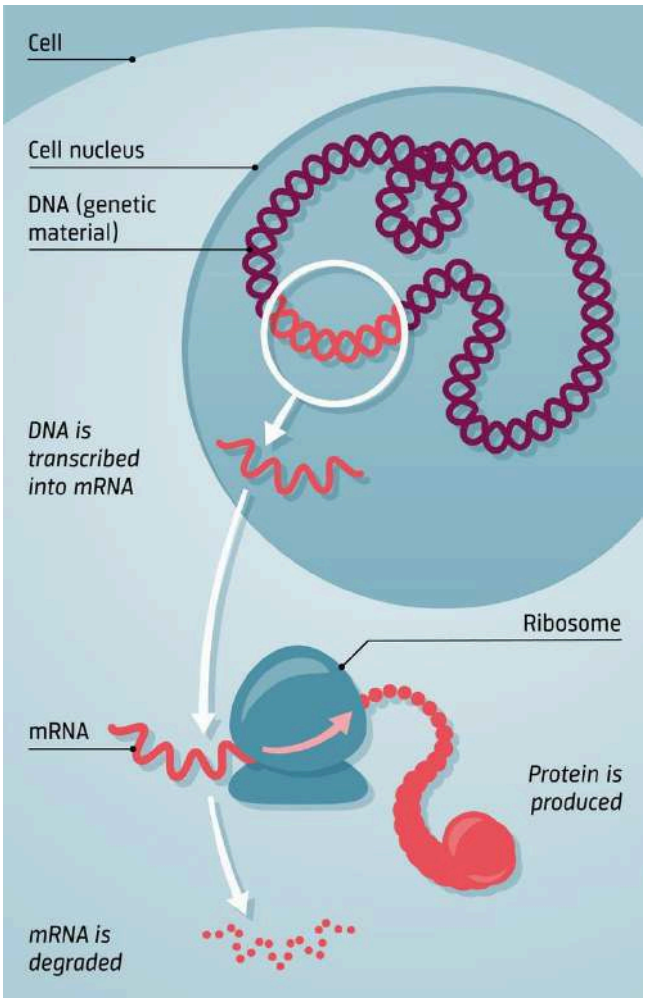
TYPES OF RNA AND THEIR FUNCTIONS

Gözde Bayrak
9/S

Rna, a shortened name for ribonucleic acid, is a nucleic acid present in all living cells that has structural similarities to DNA. However, unlike DNA, RNA is single-stranded. RNA has a backbone made of alternating phosphate groups and sugar ribose. There are four bases attached to each sugar; adenine (A), uracil (U), cytosine (C), or guanine (G). There are a total of 5 different types of RNA. 3 main RNA types and 2 that are more like sub-types. The main types include messenger RNA (mRNA), ribosomal RNA (rRNA), and transfer RNA (tRNA). The sub-types are microRNA (miRNA) and small interfering RNA (siRNA). These 2 sub-types are short RNA molecules that modulate gene expression by targeting specific mRNA molecules for degradation or by inhibiting their translation into proteins.

mRNA:

Messenger RNA also known as the mRNA is the type of RNA that is responsible for containing the genetic blueprint to make proteins and also carrying the blueprint from DNA in a cell's nucleus to the cell's cytoplasm. A mRNA is made from DNA through a process which is called transcription(1).

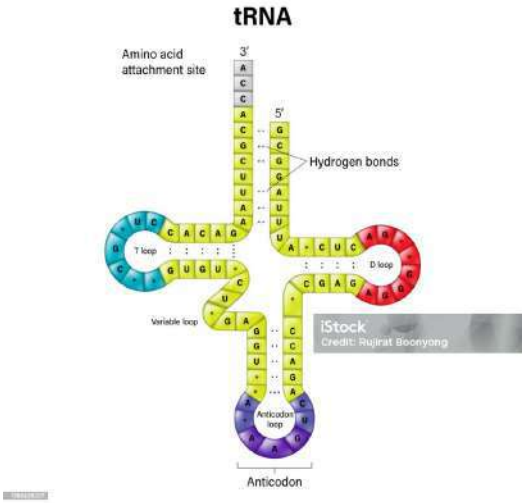


rRNA:

Ribosomal RNA also known as the rRNA is the type of RNA that's responsible for protein synthesis. rRNAs combine with proteins and enzymes in the cytoplasm to form ribosomes. rRNAs are composed of 2 subunits; 50S and 30S. Each of them are made up of their own specific rRNA molecules.

tRNA:

Transfer RNA also known as tRNA is the type of RNA that is responsible for serving as a link (or adaptor) between the messenger RNA (mRNA) molecule and the growing chain of amino acids that make up a protein.



miRNA:

MicroRNA also known as the miRNA is the type of RNA that is responsible for regulating gene expression. The majority of miRNAs are transcribed from DNA sequences into primary miRNAs and processed into precursor miRNAs and finally mature miRNAs.

siRNA:

Small interfering RNA also known as the siRNA is the type of RNA that is responsible for regulating the expression of genes, by a phenomenon known as RNAi (2). The siRNA delivery systems are categorized as non-viral and viral delivery systems. The non-viral delivery system includes polymers; Lipids; peptides etc. are the widely studied delivery systems for siRNA. Effective pharmacological use of siRNA requires 'carriers' that can deliver the siRNA to its intended site of action.

(1): In biology, the process by which a cell makes an RNA copy of a piece of DNA. This RNA copy, called messenger RNA (mRNA), carries the genetic information needed to make proteins in a cell. It carries the information from the DNA in the nucleus of the cell to the cytoplasm, where proteins are made. [taken from: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/transcription]

(2): RNA interference (RNAi) or Post-Transcriptional Gene Silencing (PTGS) is a conserved biological response to double-stranded RNA that mediates resistance to both endogenous parasitic and exogenous pathogenic nucleic acids, and regulates the expression of protein-coding genes. This natural mechanism for sequence-specific gene silencing promises to revolutionize experimental biology and may have important practical applications in functional genomics, therapeutic intervention, agriculture and other areas. [taken from: https://www.ncbi.nlm.nih.gov/probe/docs/techrnai/]

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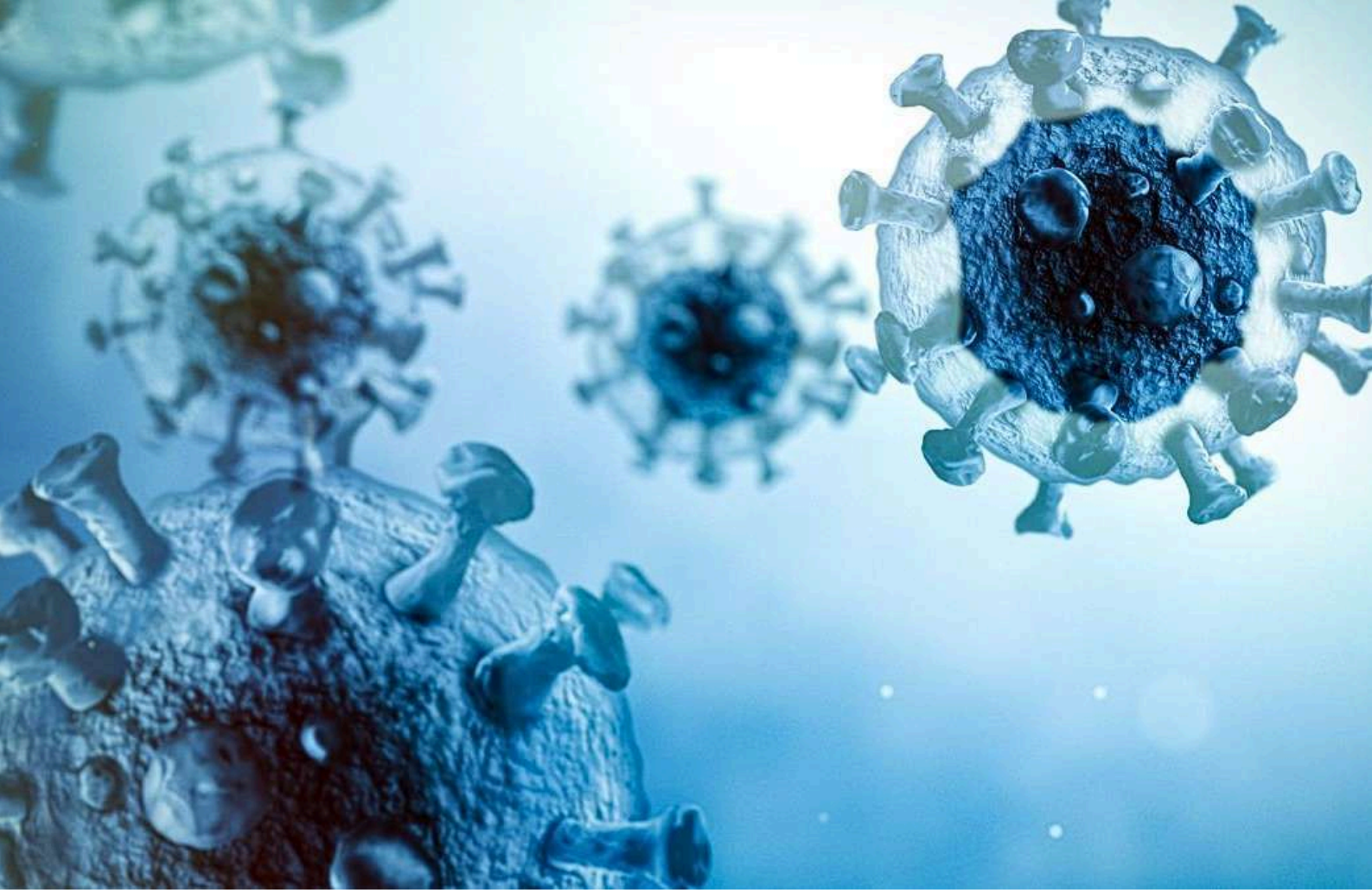


VIRUSES AND VIRAL PATHOGENESIS

Emirhan Gazyağcı
9/S

Viruses are small erm called pathogens that can infect you and make you sick. we can use flu, cold, COVID-19, AIDS, etc. They can also be called "virions". Viruses are around one hundred to a thousand times smaller than the cells in your body (viruses are around 20 to 400 nanometers). They have a segment of nucleic acid wich can be DNA or RNA surrounded by a protein coat. One thing that makes a virus different from cells is that it cannot reproduce on its own. It needs another organism for that. It infects it and uses it to make copies of itself which usually leads to the death of the cell. viruses do not only affect humans, they affect bacteria, fungi, animals, and also plants but each one only affects a specific type of organism. Viruses are basically a piece of genetic information surrounded by a protective coat called "capsid" but sometimes they also have an extra layer called an "envelope". Viruses without these are called naked viruses. They don't have the right equipment to make a new virus themselves, so they carry instructions with them and use the equipment of another cell. It is similar to parasites which also need a host to reproduce. It is like someone breaking into your house and using the kitchen it has the recipe but not the ingredients and tools but they also leave a big mess for you to clean. Viruses enter the body through the "mucous membrane", which includes the eye, genital organs, mouth, and anus. They can also enter through the skin with the help of a bite or tick.

Types of viruses

We group viruses into categories like family and genus based on their similar features like size, shape, and type of genetic material they carry. Here are some types of viruses.

Influenza viruses (Orthomyxoviriadae): This family of viruses has Influenza A and B which causes flu. Strains of influenza A can also cause Bird and Swine flu

Human herpesviruses (Herpesviridae): This family is a great family of viruses which also cause several illnesses like oral, genital herpes, shingles, etc.

Coronavirus: This is the subfamily of the viruses called SARS-CoV-2 but the virus that causes COVID-19 is the most known coronavirus and the other types of it cause illnesses like cold.

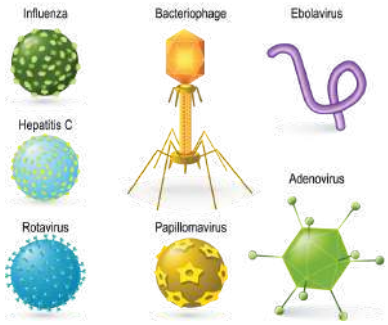
Human Papillomaviruses (HPV): These viruses cause warts and some types of them can lead to cancer.

Enteroviruses: Enterovirus is a genus that is a level smaller than the group called family, are virus infecting your intestinal tract. Some types of enteroviruses cause hand, foot and mouth disease and polio.

Flaviviruses: These viruses cause diseases like West Nile, yellow fever, and Zika. They are usually spread by mosquitoes

Orthopoxviruses: These viruses cause Blistering rashes like Mpox and smallpox.

Hepatitis viruses: These viruses do not belong to the same Family or genus but all of them affect your liver. Hepatitis A, B, and Care are the ones we come by most frequently.



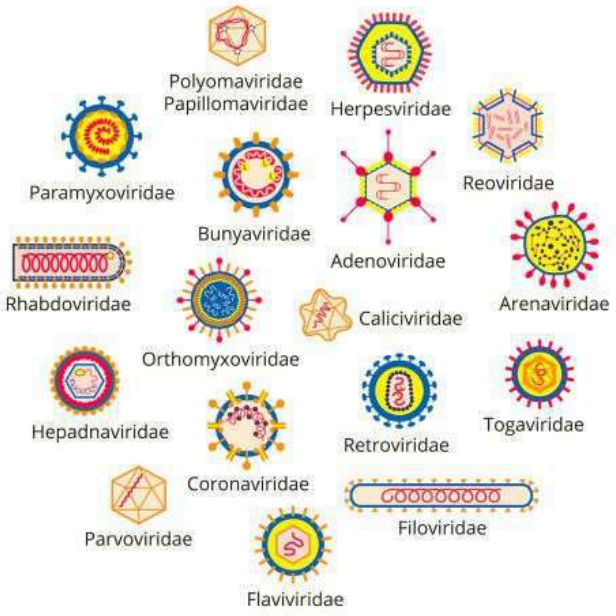
There are also some unique viruses that have special qualities like retro and oncoviruses.

Retroviruses: These viruses are viruses that have RNA and use special proteins to make DNA, which then inserts the DNA into yours. The cells think that this is your DNA as it is its own order. We can see HIV and human T-lymphotropic virus 1 (HTLV-1) as a retrovirus.

Oncoviruses: These are viruses that may cause cancer. viruses that have been linked to cancers include HPV, HIV, Hepatitis B and C, HTLV-1, etc.

Satellite viruses: These viruses cannot reproduce without other "helper" viruses(note: ı didn't really understand what the "helper" means so ı just wrote it as it says but it can mean they use it like cells but also viruses can't reproduce alone so ım not sure) most of these viruses are found in plants.

Bacteriophages: They are also called just phages. These types of viruses are found only in bacteria. Scientists are studying these viruses to potentially use them as antibiotics for bacteria immune to antibiotics.



How does the viruses work?
They have several steps of entering the body
1: attachment
2: entry
3: replication
4:assembly
5: release

Attachment and entry
Viruses have 3 ways of getting inside cells:
Receptor binding: cells have receptors on them that receive signals from proteins and viruses make them think that they should be allowed to get in the cell and cells let them enter.
Direct fusion: Some viruses attach to the host cells to get in. Bacteriophages inject their genetic substance into the bacterial cells they don't need to enter by themselves.

Replication, assembly, and release:
After the virus gets into the cell, it uses a lytic or a lysogenic cycle (some use both) to reproduce.
Lytic cycle: the virus uses the host cell's equipment to make copies of itself.
pieces of it assemble and the genetic code gets covered by by the capsid, they make so many copies that the cell eventually explodes out of the membrane and the viruses go away, spreading even more.
Lysogenic cycle: Some viruses don't spread immediately after they get into a cell, they have a silent phase. They put their receptors in the cells without them knowing it and the cells continue to reproduce each daughter cell having also another virus. certain things like stress, chemical signals, or temperature changes can trigger those cells to burst which spreads the viral particles.

Are Viruses Unalive or Alive?

Researchers have made 7 criteria to classify something as alive. One of which is homeostasis which is balance like our body temperature. As I said, viruses do not have internal organelles or nuclei to control these channels, and while some scientists argue that the capsid and the envelope help them do that, most disagree.

The second criterion is the level of organization. This means that viruses must have smaller building blocks like we do have organs or cells have organelles and viruses do pass this test. They have genes and a capsid made of smaller subunits.

The third criterion is reproduction, one of the basic urges in nature is to reproduce and pass on its genetic material. Viruses definitely multiply but they need another cell and scientists use the term replicate instead of reproduce to indicate that they need a host cell to multiply so we can say maybe on this one.

Living things grow. Living organisms use nutrients to get bigger but viruses are created fully in size in the cell and will not grow.

Living organisms use energy viruses to get their energy from the host cell. So even though they benefit from the usage of energy, they use the host to get it so maybe?

Living things respond to stimuli. This is a response to changes in the environment like sound, temperature, light, etc. But despite they do respond to these, we don't know if they respond to any other thing so this is uncertain

Finally, adaption.

Adaptation is the thing we use to stay alive like the poison in fungi or the resistance in bacteria to antibiotics. viruses definitely adapt. this is not an immediate action and takes place over time. Like I stated before, they have lytic and lysogenic cycles. They change to the lysogenic cycle from the lytic cycle when the conditions aren't right and the cell does not have the right conditions to make copies so they wait it out.

The conclusion is that we know that they are not dead. a dead thing cannot do these things but we either need a new way to determine whether something is alive or something else. They are like androids, like crazy killer robots, they rely on host materials.

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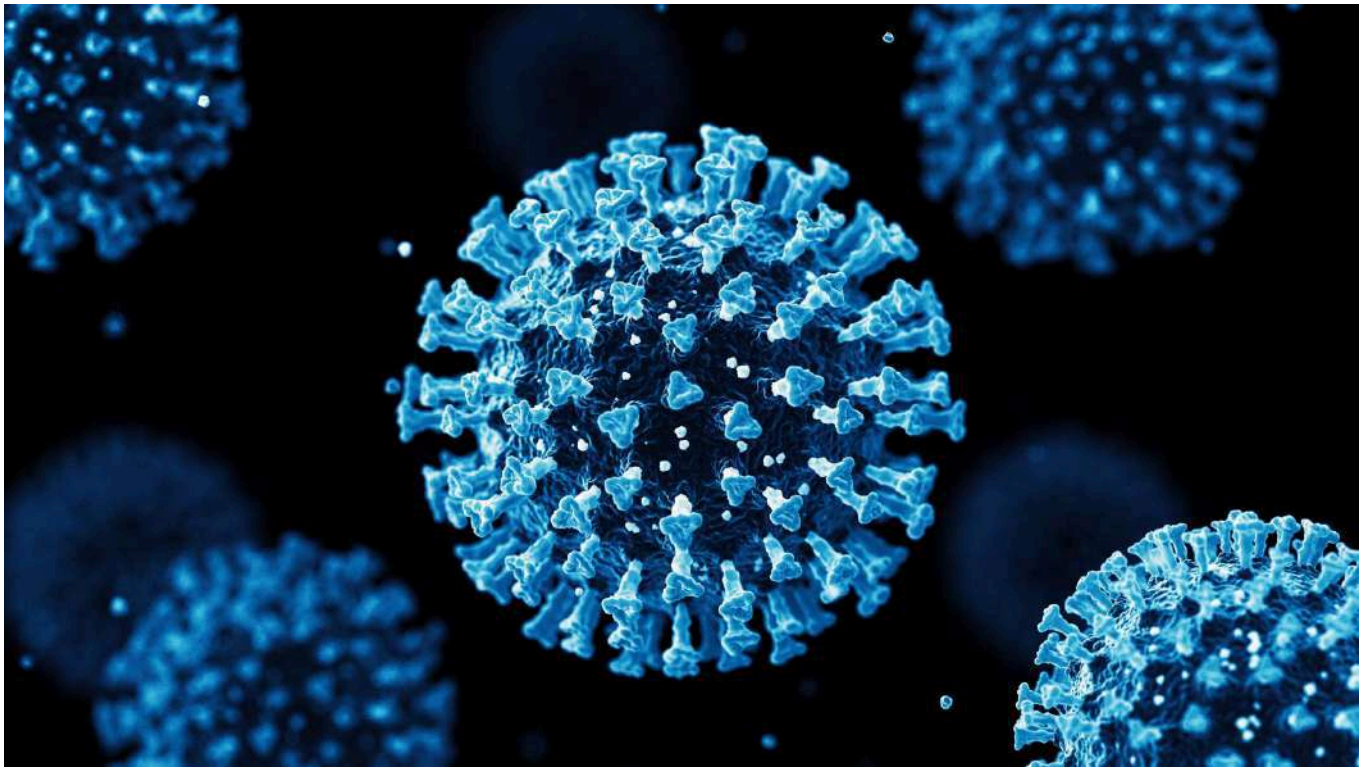

"Molecular biology has routinely taken problematic things under its wing without altering core ideas."

- Ian Hacking

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