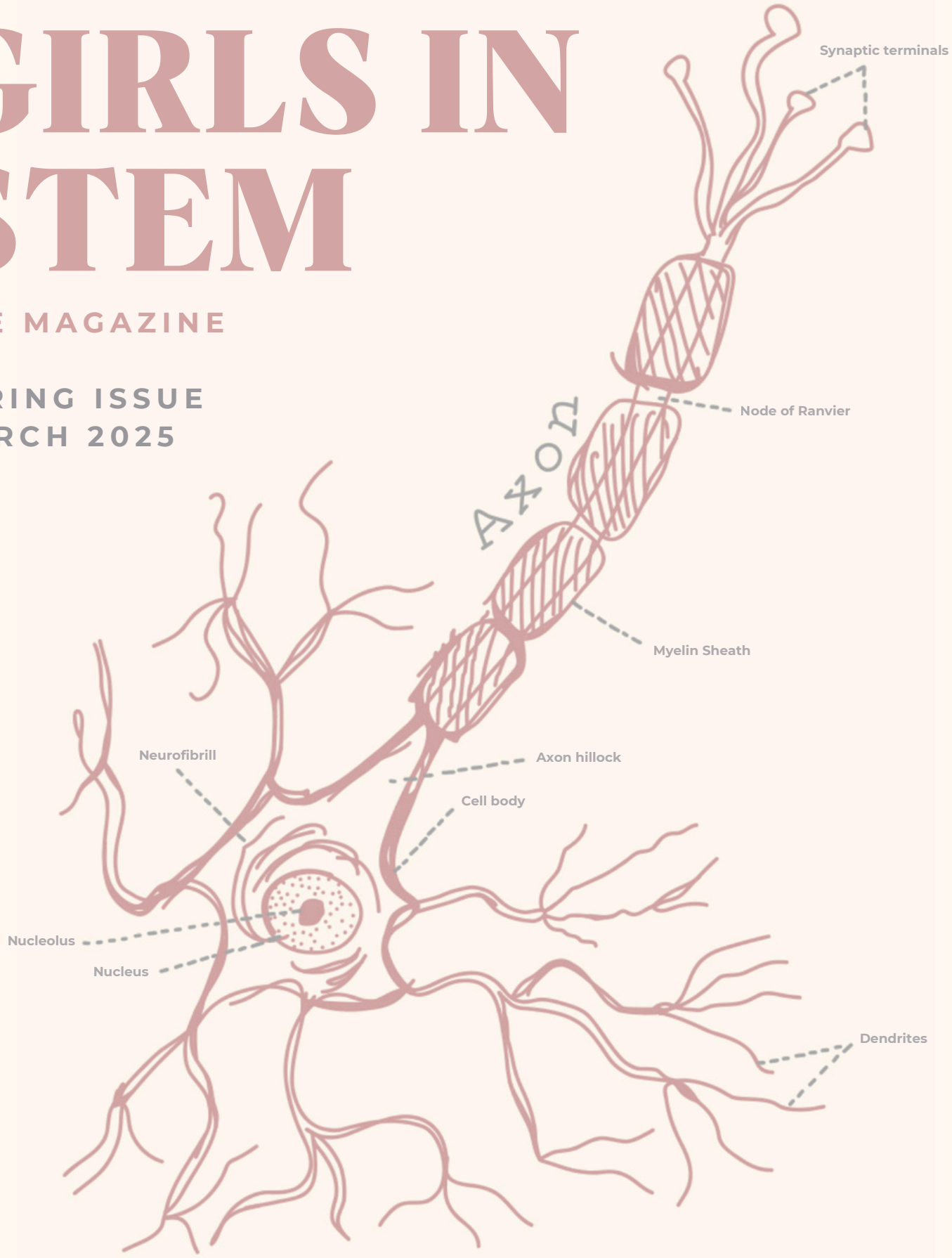
GIRLS IN STEM

THE MAGAZINE

SPRING ISSUE
MARCH 2025



Structure of a Neuron

TABLE OF CONTENTS

GIRLS IN STEM, the *magazine*

Launched in September 2024, Girls in STEM is a passion project born from a moment of self-reflection, a time when I felt torn between the path I had chosen in university and the realization that I was drawn to the world of STEM which had never been presented to me in the right way. I wanted to do something meaningful, but I didn't see how I could make that transition. That's when the idea for this magazine took shape: a place where young girls, who may feel the same way, can find motivation, inspiration and role models to encourage them to pursue STEM with confidence and passion. Through stories of real women in STEM fields, insightful interviews and informative content, this magazine is dedicated to sparking curiosity, breaking down barriers and inspiring future innovators. With every issue, we hope to bring a little more confidence, a little more curiosity and a whole lot of inspiration to the next generation of girls in STEM.

Contributors

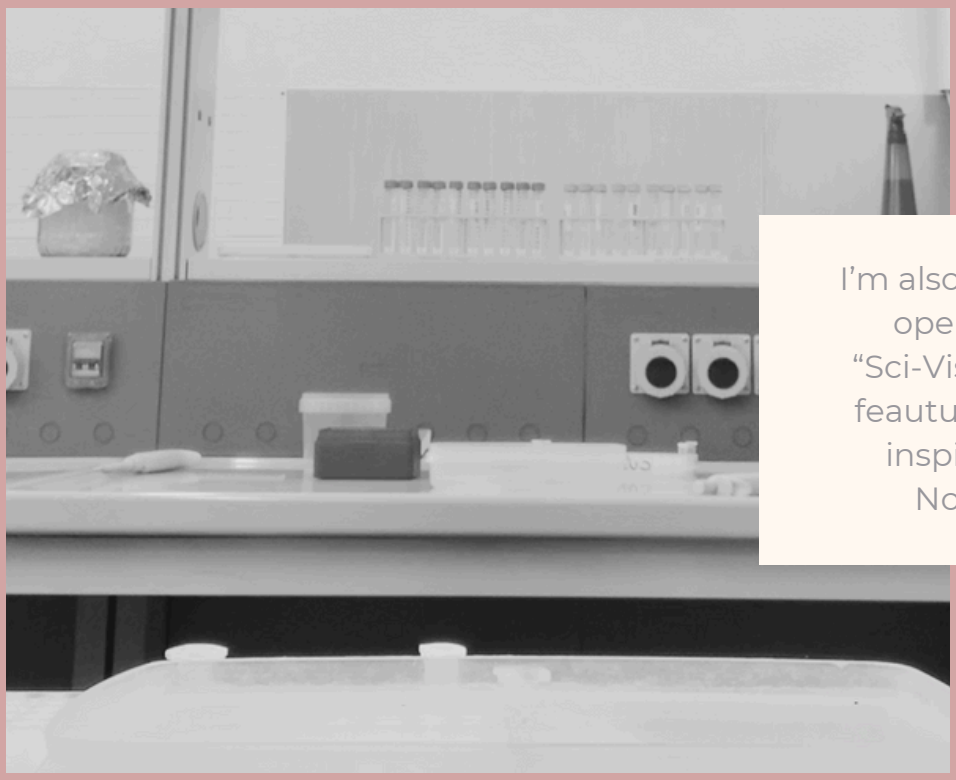
ARTICLE WRITERS
Marissa Mowers
Alyssa Chitolie
Viviana Farese
Ha Anh Vu
Aria
Isabella Cass
Molly Abbott
Andrea Maji
Stefania-Florentina Radu
Havin Uluyol

ART
Irina Tall Novikova

INTERVIEWS
Marissa Mowers
Anne Schauer
Mia Soviero

about our *Staff*

Editor in Chief: Arianna Moreo
Co-Editor: Yaiza Fernández García
Logo Designer: Aria



I'm also thrilled to announce the opening of a new section "Sci-Visions: the Art of Science" feauturing the fascinating and inspiring works of Irina Tall Novikova (see page 43)

Letter from the *Editor*

Hi everyone, I hope you are all doing well! I won't lie to you, these past months have been hard between my university exams and the beginning of the new semester, which has not started as chill as I hoped it would. I have been drowned in school material and because all my courses are very theoretical, my 500+ pages long books have been summoning me to my desk. I know how rough and draining life can be, especially when we're navigating through adulthood, whether we are in school or we are already working (let alone who works and studies). Which is why, with this new spring issue I want you to take a deep breath, a step back, sit somewhere nice, let it be a cafè or a bench at the park, relax, drink a coffee and read these super interesting articles our lovely girls wrote for us. With that being said, I hope you will find these topics as fascinating as I did when I read it for the first time! I am very thankful for everyone who dedicated time to this and for you, who are now reading my words.

Arianna Moreo

Editor-in-Chief

Stable *Isotope Analysis* in BIOLOGICAL ANTHROPOLOGY

MARISSA MOWERS

Introduction

Stable isotope analysis is a practice of biological anthropology that uses analytical chemistry techniques to reconstruct life histories and diets. Isotopes are versions of an element that differ in mass due to a differing number of neutrons. For example, ^{13}C is an isotope of carbon with 13 neutrons while ^{14}C is an isotope of carbon with 14 neutrons. Note that "$\delta^{13}C$" indicates the isotope signature of ^{13}C in per thousands. The analysis of life histories and diets using these isotopes are relevant to the analysis of recovered remains in human and non-human primates, and are therefore relevant to the research of bioarchaeologists and primatologists. The determination of migration patterns can also be applied to identify the geographic origin of recovered human remains, relevant to the work of forensic anthropologists. We will uncover the methods of stable isotope analysis, its application to various disciplines of biological anthropology, and the contribution of women in isotope research.

Methods of Analysis

Stable isotope analysis is based on the assumption that the isotopic composition of tissue is a direct reflection of the isotopic composition of the organism's diet, with bone collagen being the most common tissue used in this analysis. Isotopes of elements such as nitrogen and carbon vary between food sources, including in both plants and animals. Carbon isotopes vary between C_3 and C_4 plants based on the relative usage of $\delta^{13}C$ and $\delta^{14}C$ in their photosynthetic pathways. In terrestrial plants, C_3 plants fix approximately -26.5‰ $\delta^{13}C$ while C_4 plants fix approximately -12.5 ‰ of the $\delta^{13}C$ isotope in its photosynthetic pathway.

Furthermore, this same analysis of $\delta^{13}C$ and $\delta^{14}C$ can discriminate between terrestrial, marine, and intermediate coastal and estuarine plants. While the relative abundance of $\delta^{13}C$ isotopes in terrestrial plants has been stated above, marine plants are primarily plants following the C_3 pathway. The relative abundance of the $\delta^{13}C$ isotope is thus in between that of terrestrial plants at approximately -19.0‰. For coastal and

estuarine plants, their ecosystem is composed mainly of C_4 plants, with the C_4 plants of estuarine environments displaying a relative abundance of -12.0‰ $\delta^{13}C$ and the C_4 plants of coastal aquatic environments displaying a relative abundance of -6.0‰ $\delta^{13}C$.

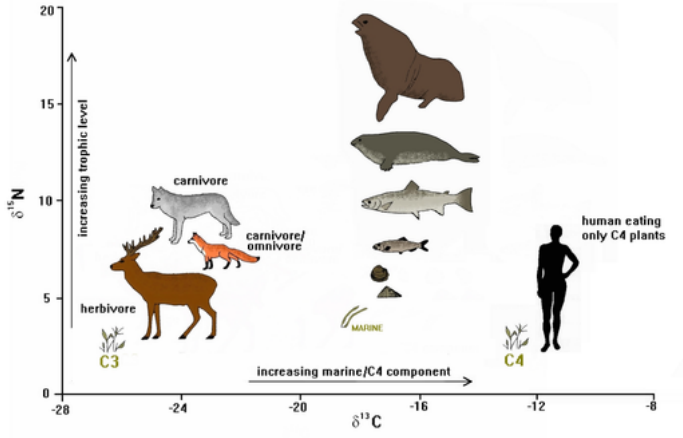
While carbon isotopes are used to determine the types of plants composing an organism's diet, nitrogen isotopes determine the types of animals eaten by the individual. Marine fish tend to contain 14.3‰ $\delta^{15}N$ while freshwater fish contain 11.5‰ $\delta^{15}N$[5].

The aforementioned relative abundance of carbon and nitrogen isotopes in each respective food source is ultimately meaningless if we do not know how to measure the isotopic composition of our tissues. Luckily, a type of instrumental analysis called mass spectroscopy exists which takes the sample of bone collagen and separates the isotopes within it depending on their mass. As we have already learned, each isotope of a given element such as nitrogen and carbon will have different masses. Mass spectroscopy makes measuring the abundance of each isotope easy as the relative abundance of each is separated and measured for us.

The isotope signature of each measured isotope can be determined by the following equation:

$$\delta^{13}C = \left[\frac{\left(\frac{^{13}C_{sample}}{^{12}C_{sample}} \right)}{\left(\frac{^{13}C_{standard}}{^{12}C_{standard}} \right)} - 1 \right] \times 1000$$

Plotting the obtained isotope signature of nitrogen against the obtained isotope signature of carbon allows biological anthropologists to finally conclude the diet of the individual according to this figure:



Estimation of trophic level and proportion of marine C_4 component of diet based on carbon and nitrogen isotope signatures

Similarly, the geographic region in which we grow up has its own unique isotope signatures of strontium due to the varying rocks and other natural elements of the region. These isotopes are introduced to our bodies through features such as our source of drinking water in the region. Following the same procedure as above to determine the isotope signature of strontium in an individual, we can compare with known isotope signatures around the world to determine their region of origin.

Applications to Archaeology

Stable isotope analysis allows for the reconstruction of how human populations lived in the past, providing insight into both migration and diet. We now know how this is done, but now we will investigate why.

Studies have shown that adaptations to diet lead to adaptations in our genes, which is the driving force for evolution. Understanding the diet of our ancestors as well as the historical context of the time (ex. poor food security) allows us to understand why adaptations to a new diet were essential, and thus why we have evolved to be the species we are today.

This poses another question however; why do biological archaeologists want to study human evolution? Understanding human evolution means understanding the natural processes that have posed a threat to our survival in the past and even today. The study of human evolution allows for the understanding of genetic diseases to further advancements in medicine, predict environmental changes that will threaten species survival, and understand how we have physiologically adapted to tackle poor health. In other words, understanding why humans have survived for billions of years despite environmental changes threatening our species' survival enables us with the knowledge to ensure our species can continue to resist potentially catastrophic environmental stressors.

Applications to Primatology

Stable isotope analysis of diet in non-human primates shows more promise than other methods as it allows for the diet reconstruction and feeding behaviour analysis of extinct taxa, as all that is needed is their bones. Carbon isotope analysis to identify the types of plants making up a primate's diet can also give insight into what sort of habitat the primate lived in.

Studying the feeding behaviours and habitats of non-human primates of the past allows for reconstruction of primate evolution when coupled with the research conducted on non-human primates today. Identifying why and how we diverged as a species from our primate ancestors helps us to better understand our unique survival needs. For example, an obvious difference in humans and non-human primates is our bipedalism. This divergence from other primates arises because our species best survives in open grasslands (the savanna hypothesis) as opposed to our closely related species who live in heavily wooded jungles.

Applications to Forensic Anthropology

Stable isotope analysis of recovered remains is especially important when the remains are of forensic interest. In the recovery and analysis of these remains, identification of the individual is the primary goal. A typical forensic anthropological analysis would study the bones to estimate the age-at-death, probable sex, and race of the individual (although the reliability of race estimation from bones is currently a topic of debate). Stature estimations from the femur (assuming the femur is present) is also an important piece of information. However, even still, only a vague

description of the individual can be provided based on the biological aspects of the skeleton. Stable isotope analysis can provide the individual's birth region, long-term adult residence, recent travel history, and diet choices. This additional analysis narrows down the potential identities of the recovered individual and is therefore a very valuable analysis to aid in forensic investigations.

Women in Stable Isotope Analysis

The University of Cambridge in England, UK, is home to the Dorothy Garrod Lab, specializing in stable isotope analysis. Work within the lab focuses on carbon, nitrogen, and strontium isotopes as discussed above, along with oxygen and sulfur isotopes. Dorothy Garrod (1892-1968) was an English archaeologist specializing in the Paleolithic period; the period of which the earliest known tool use occurred in hominins. Garrod was one of only a few women studying at Newham College, Cambridge, eventually returning to the University as the Disney Professor of Archaeology as the first woman to hold a chair in either Cambridge or Oxford. Her excavations in Gibraltar, Bulgaria, and across the Middle East were especially notable in her career, subsequently leading to the naming of the Dorothy Garrod Lab at the University of Cambridge in her honour.

Conclusion

Stable isotope analysis is where analytical chemistry meets biological anthropology to answer questions regarding the history of human evolution, the ways and reasons for which our evolution diverged from non-human primates, and provide crucial descriptive elements in a forensic investigation to aid in human identification. This is done by the analysis of carbon isotopes to reconstruct the plant components of diet, nitrogen isotopes to reconstruct the animal components of diet, and strontium isotopes to discriminate the geographic origin of the individual. This practice is made possible by an instrument known as a mass spectrometer, separating these isotopes by their mass so that we can determine the relative quantities of each. As research is continuously done to further develop stable isotope analysis, there is potential for isotopes to be applied to other subdisciplines of biological anthropology, helping biological anthropologists to answer the questions that our curiosity continues to ask.

Portrait of English Archaeologist Dorothy Garrod

the use and ETHICS of CRISPR in *healthcare*

ALYSSA CHITOLIE

From the smallest single celled organisms to the largest creatures on Earth every living thing is defined by its genes. Genes are strands of DNA that contain the biological instructions for life. They make up and define who we are as individuals. So what if we could edit these genes and what are the consequences if we do ?

CRISPR, which stands for Clustered Regularly Interspaced Short Palindromic Repeats, is a revolutionary technology used for genome editing and it was originally discovered as part of the immune defense mechanisms in bacteria. It works by scientists designing a short RNA sequence that matches the target DNA sequence. A Cas9 enzyme is guided by the RNA to the target DNA. Cas9 cuts the DNA at the specified location and the cell's repair mechanisms either knock out a gene by introducing errors during repair or insert a new gene by providing a DNA template for repair. This allows scientists to edit DNA, study gene functions and develop therapies.

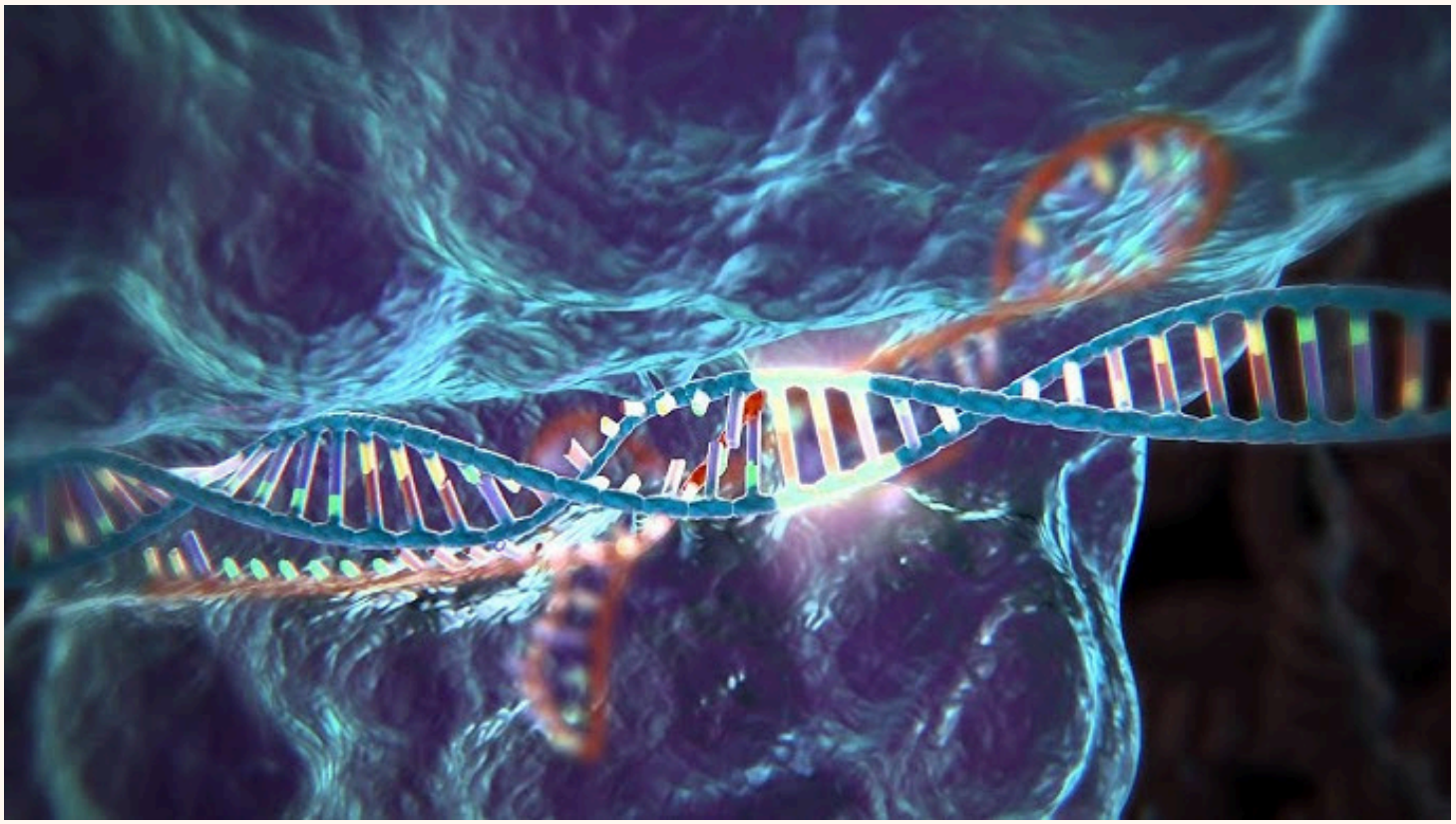
Some treatments involve genome editing to prevent and treat diseases in

The Dark side of CRISPR, Scientific American

humans. Genome editing tools have the potential to help treat genetic-based diseases such as cystic fibrosis, diabetes and some cancers. CRISPR can also revolutionize acne treatment and skincare products by targeting the root causes of acne at a genetic or microbiological level. For example, CRISPR could modify genes regulating sebum production to reduce outputs as overactive sebaceous glands produce excess sebum, which contributes to clogged pores and acne.

Although this use of technology in healthcare is groundbreaking there are some drawbacks. For example, sometimes genome editing tools cut in the wrong spot and scientists are not yet sure how these errors might affect patients. Assessing the safety of gene therapies is critical in ensuring the patient's safety and that the technology

is ready for patient use. There are some ethical barriers in the fact that germline therapies (change DNA in reproductive cells) create an issue of informed consent as the patients affected by the edits are the embryo and future generation and many people have moral and religious objections to the use of human embryos for research. Therefore whilst it's important to acknowledge the value of technological advancements in healthcare, CRISPR use must be modified to ensure the best treatment outcome for patients.



CRISPR-Cas9 method for genome editing, McGovern Institute

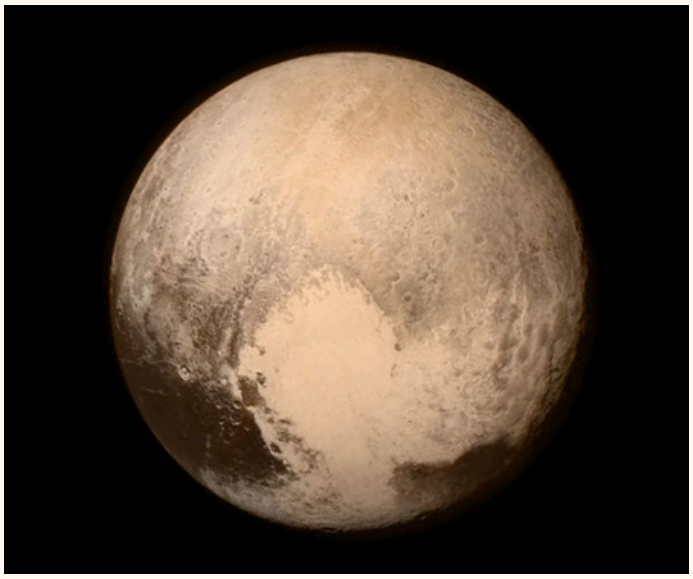
VIVIANA FARESE

Pluto's Heart ♡

Pluto was discovered back in 1930 by astronomer Clyde Tombaugh. Astronomers knew it existed before then but no one had ever observed it and it didn't even have a name: it was known as "Planet X". However, Pluto's distance from Earth (~ 5.4 billion km) made its study quite difficult, so much so that, until July 2015, the most detailed maps of Pluto in our possessions were products of complex computer analysis of images that had been captured by the Hubble Space Telescope back in 2002, which were made of only a few pixels. Hence, astronomers didn't really know what to expect from the, soon to be demoted to dwarf, planet: was it rocky? Cold? Virtually dead?

Which is why, when the New Horizons spacecraft sent back to Earth its first images of Pluto, scientists were amazed! New Horizons is an interplanetary space probe and it was launched in 2006 as a part of NASA's New Frontiers program, with the mission of exploring the planets at the edge of the solar system. It reached Pluto well over 9 years later and on July 14, 2015 it sent back the first picture of Pluto to the John Hopkins University Applied Physics Laboratory. Data collected thanks to New Horizons revealed a (dwarf) planet much more complex than imagined: Pluto's surface shows a dynamic planet with a montainous terrain and active surface.

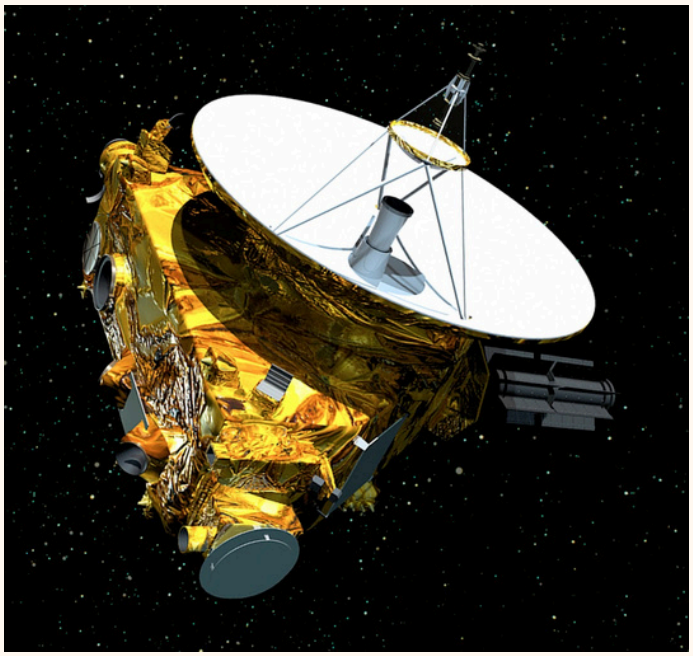
But at first sight, what really hit people, when those images started to circulate, was the presence of a giant nitrogen glacier in the shape of a heart! This led to the nickname "Pluto's heart", although the valley is formally named Sputnik Planitia, after Sputnik 1, Earth's first artificial satellite. The crate was left by the impact with some massive body and then filled up with nitrogen ice.



Pluto's heart, NASA/APL/SwRI, July 14, 2015

Why is Pluto's heart so interesting to us though? Some of planetary exploration's main goals are finding somewhere we can live when we are done burning our own planet or discovering evidence of extraterrestrial life. This is where it gets interesting because data from New Horizons revealed something scientists always look for on other planets: water! There are massive boulders of water ice floating on the crater's glacial field which means Pluto might be hiding one of the

basic requirements for life, liquid water, although that would probably be many kilometers under the surface. Some have speculated that deep under its surface, Pluto might even be harbouring some sort of life, but that remains purely hypothetical.



New Horizons, Madrid Deep Space Communications Complex

Some scientists even raised the possibility of using Pluto as a base for astronauts who will be travelling to deep space, although this looks unlikely in the near future, as with the state of technology nowadays it would take us 30 years to reach Pluto. Moreover, due to its distance from the sun, the surface temperature probably is around -230 °C. However, all bets are off when science is involved. Research today is definitely focused on sending humans to Mars and once we reach the red planet, who knows what will come next?

And a little curiosity for those who, like me, get somehow attached to space probes and such and are wondering whatever became of New Horizons: it is very much still on mission and thriving! It's travelling with a few trinkets, such as 30 grams of Clyde Tombaugh's ashes to commemorate his discovery of Pluto. As of October 1, 2024 it passed 60 times as far from the Sun as Earth is, meaning the spacecraft is twice as far out as Pluto was when New Horizons flew by on July 14, 2015! In August 1992, scientist Robert Staehle had called Tombaugh, requesting permission to visit his planet. "I told him he was welcome to it", Tombaugh remembered, "though he's got to go one long, cold trip".

Antimicrobial Resistance
a modern day CRISIS

HA ANH VU

Abstract
The World Health Organization has named antimicrobial resistance (AMR) a healthcare crisis, affecting millions of patients worldwide. Yet public knowledge about the subject and its causes is still limited. In this article, I will discuss the specific mechanisms of antibiotic resistance, how resistance naturally arises, and what other factors in our modern world contribute to this deadly crisis. These include the misuse of medication in many countries and a failure to adequately fund the pharmaceutical industry and researchers to improve and discover new therapeutic options.

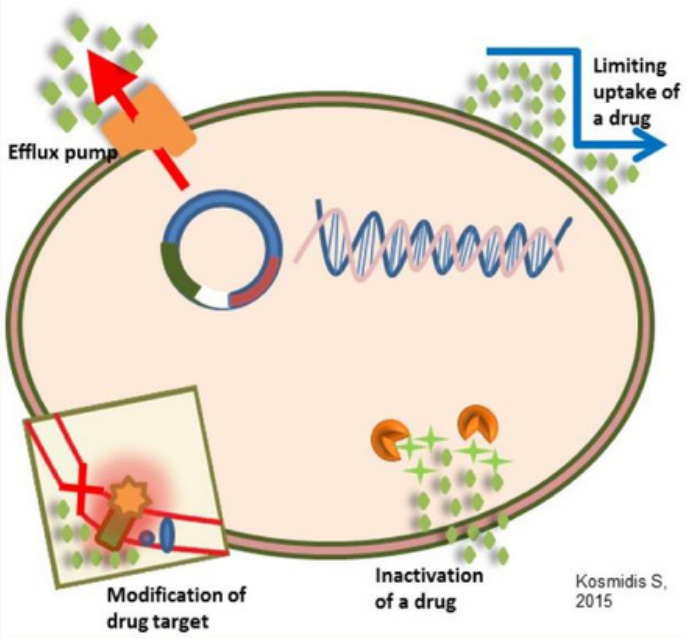
8.2 Million
That is the number of deaths associated with antimicrobial resistance (AMR) estimated in 2050 in a paper published in 2024. The situation is even more severe in war zones and developing countries. When 27-year-old Pte Oleksander Bezverkhny was in hospital, it was discovered that his infection was resistant to multiple common antibiotics, the only antibiotics that were available in the scarcity of war-ridden Kyiv. It took an international effort to source expensive medicine and more than 100 operations for his condition to stabilise, but that is not the case for millions of other patients who suffer complications from AMR each year across the globe. Nearly 100 years after Alexander Fleming discovered penicillin, humanity now faces the threat of all available antimicrobials becoming useless.

What is AMR?
Antimicrobials are drugs used to treat a range of diseases, including bacterial, viral, fungal, and parasitic infections. Antimicrobial resistance (AMR) occurs when the target pathogen no longer responds to the medication designed to combat it. This results in ineffective treatment, prolonged illness, compromised surgeries and procedures, an increased mortality rate, and huge economic costs for healthcare systems worldwide.

Some pathogens can be intrinsically resistant to certain medicines, such as gram-positive and gram-negative bacteria. The name comes from the fact that different types of bacteria can be categorized based on the colour they turn when stained with crystal violet or methylene blue in a process known as Gram staining. Bacteria with thick peptidoglycan cell walls retain the dye, appearing blue or purple when viewed under a microscope. Gram-negative bacteria with thinner peptidoglycan cell

walls and an outer membrane can not hold the dye and thus appear red or pink. Thus, gram-positive bacteria can be treated with penicillin or other antibiotics with a similar mechanism of attacking the synthesis of a peptidoglycan cell wall, while gram-negative bacteria require different treatments.

Pathogens can also develop resistance, known as acquired resistance, to medication via 4 mechanisms: limiting drug uptake, modification of drug target, inactivating the drug or increasing drug efflux.



Antimicrobial resistance mechanism, ResearchGate

Limiting drug uptake is a strategy commonly observed in gram-negative bacteria with larger outer membranes. In those cases, the drug often enters the bacteria through porin channels on the membrane. Two mutations that often occur to limit the amount of drug being absorbed by the pathogen are either decreasing the amount of porin channels available, or mutations that change the selectivity of the porin channel, making it impossible for drug molecules to pass through. Many members of the Enterobacterales order, including Escherichia coli (E.Coli) or Klebsiella pneumoniae (K. pneumoniae), have been observed to reduce their porin expression and grow resistant to drugs such as carbapenems, a broad spectrum antibiotic often considered as a last resort drug due to its toxicity to the patient.

Many drugs work by binding to specific targets and disrupt its activity, inhibiting or killing the bacteria. When a mutation arises that changes the structure of the target, the drug can no longer bind to the target as it's no longer complementary. Instead, some bacteria develop mutations that release chemicals that bind to the drug and destroy it.

Additionally, some bacteria develop mutations that increase the amount of efflux pumps it has, actively pumping the drug out of the cell faster than it is being absorbed. In reality, a new strain of drug-resistant bacteria could utilize more than one of the mentioned mechanisms to counter antibiotics, and even more common is a strain growing to be multi-drug resistant, being able to defend itself against many different classes of medicine with different attacking mechanisms.

These resistant mutations can also be passed from pathogen to pathogen in

the case of bacteria via horizontal genetic transfer. Bacteria can exchange plasmid rings containing the resistant gene, as well as pick up genetic material from the surroundings. The concept of bacterial horizontal transfer of genetic material was first experimented on and reported in 1928 by Frederick Griffith, including transformation, in which the bacteria take up foreign genetic material, transduction, in which DNA is transported from one bacterium to another via a virus, also known as a bacteriophage, or conjugation, in which a plasmid of DNA is transferred during cell-to-cell contact. Horizontal transfer plays a critical role in the spread of antibiotic resistance as a mutation not only develops within a person but can also be spread from person to person.

Why is AMR such a problem?

In my GCSE biology class, my teacher used to always repeat this phrase: “Mutations are natural, and mutations create variations in a population”. Natural selection dictates that pathogens like bacteria or fungi will multiply and mutations will arise, which inevitably will result in certain resistant strands, then why are we so worried?

This problem can be analysed in 2 separate, yet equally significant core issues that contribute to this modern crisis: The inappropriate use of current medication and the lack of new classes of antimicrobials.

Misuse

In many countries, especially countries without strict regulations regarding pharmacies, antimicrobials are sold over the counter and are easily accessible to the public. This makes many people prefer to opt for self-medication instead of going to the doctor to be subjected to never-ending queues and eye-watering medical bills. Obviously, the issue with self-medication is that people will be consuming very broad-spectrum, non-specific medicines for their generic sore throats and skin itches without any tests to identify the pathogen, leading to the drug not being effectively at all or not being strong enough to completely wipe out the pathogens, leaving many to mutate and develop resistance.

Even with prescriptions issued by healthcare providers, many patients have poor adherence to the instructions. When people feel better, they tend to stop taking the medicine out of negligence, not realizing that failure to meet the prescribed dosage will leave the pathogens inside their bodies, not enough to cause an illness, but just enough to mutate a few times. Multiply that by billions of people around the world, and it is almost certain that a pathogen that caused someone a sore throat for 5 days now has become a superbug.

In developing countries where the regulation over drug control is still vague and the correct equipment to supply and preserve medicine correctly could be unavailable, sub-standard drugs are yet

another factor contributing to a rise in AMR. To save time and money, some healthcare providers skip necessary testing stages and choose to over-prescribe broad-spectrum medication to a patient, which could cure them, but also increases the selection pressure, encourages mutations and the growth of mutated pathogens as it no longer has to compete with the good bacteria, the probiotics, being wiped out by the medicine. Research published by the AMA Journal of Ethics estimated that 1 in 10 medicines in low and middle-income countries are substandard, leading to prolonged treatment and could be fatal. In addition, it is almost ironic that studies have shown that hospitals are the perfect breeding ground for new, powerful strains of superbugs. The extensive use of multiple drugs, the existence and exchange of countless pathogens on commonly-used surfaces that are not being sanitized correctly, combined with the heartbreaking reality that many hospitals across the world are overloaded with patients waiting in cramped hallways means that pathogens are exposed to more drugs that they can then learn to defeat and infect the patients with the most vulnerable immune systems. Many of the bacterial pathogens listed as critical to the world's health by the WHO are considered opportunistic pathogens that cause almost no harm to an otherwise healthy person but are detrimental to a patient with a weak immune system.

Lack of new antimicrobials

VietnamPlus

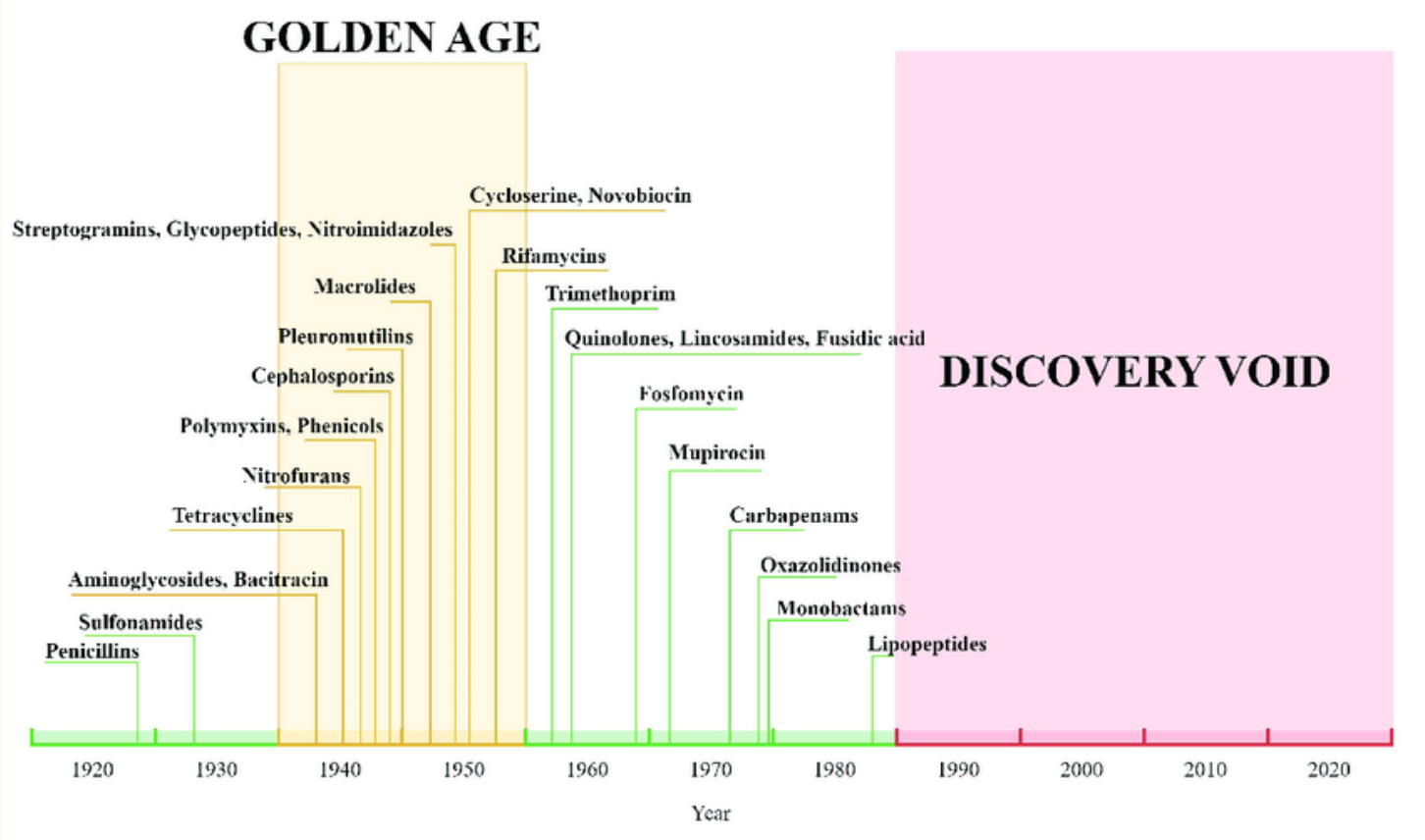
Investing in new antimicrobial discoveries and other therapeutic options is not the most profitable endeavour in the world of healthcare science. If efficient, antimicrobials should be used very minimally and some options like vaccines only need to be used once by a person in their entire lifetime. Many medium-sized and small biotech companies that aim to discover new classes of antimicrobials and improve the current status quo often end in bankruptcy or exit at a loss even below investment cost. One such company is an American company named Achogen, whose bankruptcy in 2019 raised worry after its first drug, plazomicin, was just approved by the FDA that June.

The lack of investment not only affect the biotech companies but also independent research institutions. For long, academia and research jobs have been considered extremely underfunded, and many scientists with aspiring ideas and talent are forced to delay or give up on their dreams due to financial barriers.

Where are we heading?

The problem with global AMR is a multi-faceted crisis that cannot be resolved by a single policy. On one hand, it requires the independent effort of the national government to improve healthcare regulations, improve hospitals to reduce the cross-exchange of pathogens and monitor drug prescriptions as well as drug quality. On the other hand, it requires a global effort to source and distribute quality medication to areas in need, focusing investment into research of new classes of drugs with new mechanisms or future innovations such as vaccines or bacteriophage therapy. It is not a problem to be solved within a day, but we can start by educating the public about the issue, helping people use medicines better and safer, encouraging more young scientists to pursue research in related fields, and increasing antibiotic stewardship in clinical practice.

The trajectory of the AMR crisis may paint an undesirable future, but it is not set in stone.



Discovery of various antibiotic classes, ResearchGate

FIBONACCI sequence

ARIA

What is the Fibonacci Sequence?
You've probably heard of the Fibonacci sequence at least once in your life, but do you actually know what is it and why is it so widely recognized?

The Fibonacci sequence is a series of numbers where each number is the sum of the two preceding ones. It typically starts with 0 and 1, and continues as follows: 0, 1, 1, 2, 3, 5, 8, 13, 21, and so on. This fascinating sequence appears in various natural phenomena and has applications in mathematics, art and computer science.

The sequence is named after Leonardo of Pisa, also known as Fibonacci, an Italian mathematician who introduced it to Western mathematics in his 1202 book "Liber Abaci." While Fibonacci is credited with popularizing the sequence in Europe, Indian mathematicians had known about it as early as the 6th century.

One of the most intriguing aspects of the Fibonacci sequence is its connection to the golden ratio, a number approximately equal to 1.618 that appears frequently in art, architecture and nature. As the sequence progresses, the ratio between consecutive Fibonacci numbers approaches this golden ratio.

The Fibonacci sequence has practical applications in various fields. In computer science, it's used in algorithms and data structures. In nature, it can be observed in the spiral arrangement of leaves on some plants, the branching of trees and even in the shape of certain shells. The sequence's inherent balance and proportion make it a popular tool in design and architecture, where it's used to create aesthetically pleasing compositions.

Furthermore, there is a rule you need to follow if you want to find what number is in which position of the sequence:

$$x_n = x_{n-1} + x_{n-2}$$

Where:
xn is term number "n"
xn-1 is the previous term (n-1)
xn-2 is the term before that (n-2)

For example, term 8 is:
x8 = x(8-1) + x(8-2)
x8 = 13 + 8 = 21

the *truth* behind INTRONS

ISABELLA CASS

What are introns?

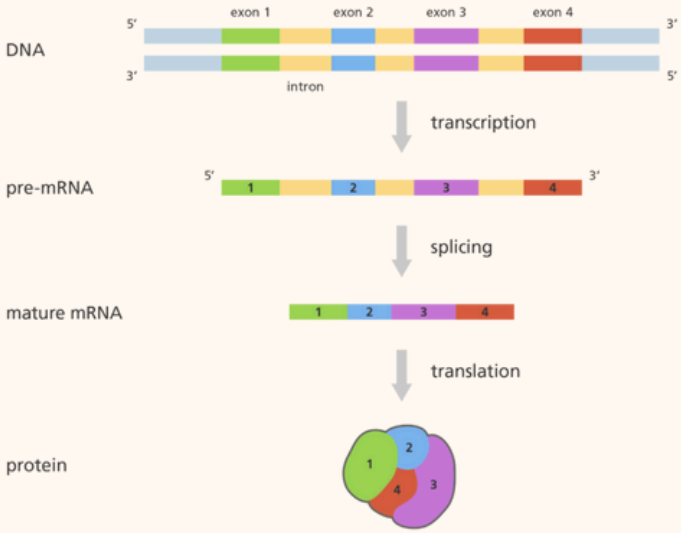
Introns, previously known as 'junk DNA', are non-coding sections of DNA that are spliced out before the RNA strand is translated into a protein. Pre-mature RNA containing both introns and exons (coding sections of DNA) goes through a modification process called splicing where introns are cut out leaving just the exons. Splicing produced a mature mRNA that can then be translated into proteins.

The discovery

Before the discovery of introns and exons, mRNA molecules were thought to be copies of DNA, with each mRNA being an exact copy of the DNA strand. However, genes in eukaryotes have a type of interruption within the chain known as introns. Richard Roberts and Phil Sharp confirmed that eukaryotic mRNA is shorter than its complementary DNA strand. The discovery of splicing changed the way scientists look at the human genome. On average, introns typically contain 90% of DNA sequence within a whole gene and most of this non-coding region was thought to serve no purpose for a long time.

Splicing

Splicing is a biochemical mechanism where introns are removed from the transcript. Occurring in many steps, splicing is catalysed by a small nuclear ribonucleoprotein (snRNPs). The snRNPs attach at the 5' end of the intron cutting out the introns. Eukaryotic genes with longer introns also contain exonic splicing enhancers which help position the snRNPs and are found on the exons of the gene.



The process of RNA splicing, Laura Olivares Boldú

Distribution of introns

Introns can be located in one of three different phases. Phase -0 where introns are located before the first nucleotide of a codon and are the most frequently occurring type of intron. Phase -1 where introns are located after the first nucleotide of a codon and phase -2 where introns are located after the second nucleotide of a codon and are the

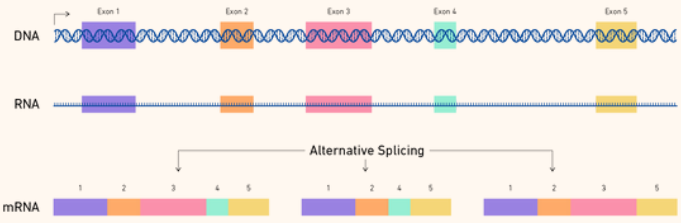
least frequently occurring introns.

Roles of introns

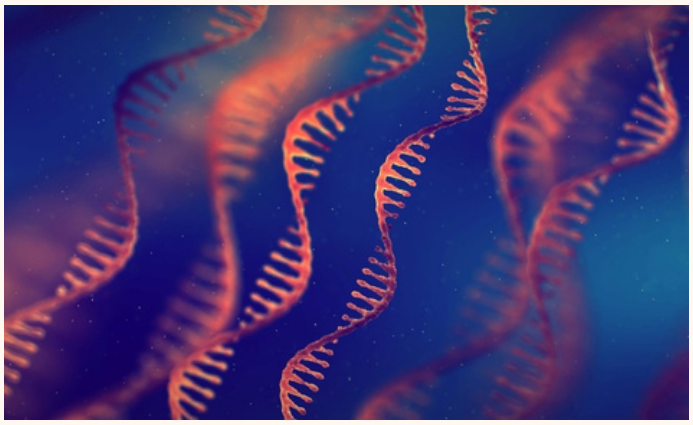
Although introns were thought to be useless for a long time, hence the term 'junk DNA', over time the roles of introns have been greatly explored.

The role of introns having an impact on gene expression was first discovered during an experiment of viruses with and without introns. Results showed that the protein products without introns were significantly diminished and eventually was shown that constructs with introns were expressed to 400 times higher than constructs without introns.

Introns also play a major role in alternative splicing. Alternative splicing is a controlled molecular mechanism which produces multiple variations of a protein from one singular gene within a eukaryotic cell. Introns carry cis-acting



Alternative splicing, Technology Networks



mRNA, Shutterstock

elements that help regulate the alternative splicing process.

Spliced transcripts are able to leave the nucleus faster compared to unspliced transcripts and this is down to the work of introns. Genome-wide mapping analysis of nucleosome positions has also showed that nucleosomes are depleted within regions containing introns, suggesting introns are pushing the nucleosome away toward the exons.

There is still a lot more research to go before we finally have a definitive answer to what introns really do but with current ongoing research there is no reason why new information won't be discovered very soon.

MOLLY ABBOTT

VERA RUBIN
the bright mind behind Dark Matter

Vera Rubin in 2003

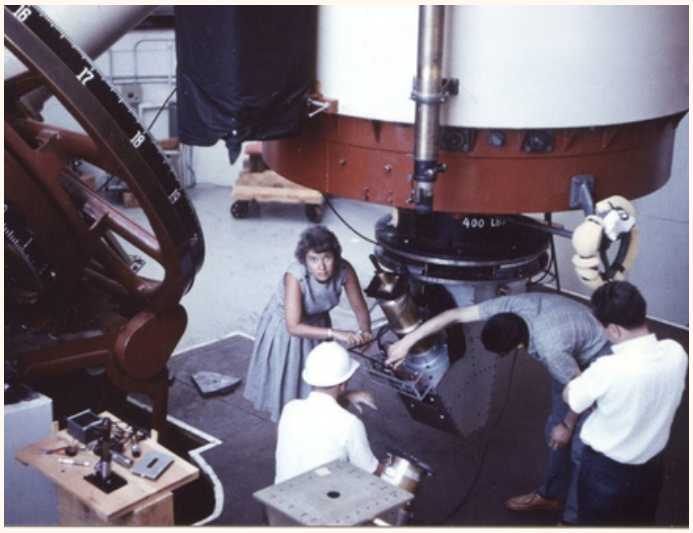
Vera Rubin was born in 1928 in Philadelphia. She was fascinated with astronomy from an early age and clearly had an incredible mind. However, gender norms of the time tried to thwart her at every turn; a teacher once advised her to pursue a career painting astronomical objects rather than becoming an astronomer, and she was not allowed to apply for a degree at Princeton University due to her gender, a policy that wouldn't be changed until 1975. She persevered and ended up studying at Cornell University under Nobel Prize winners such as Richard Feynman and Hans Bethe.

Together with Kent Ford, she researched the velocities of stars at the edges of galaxies at a time when most others were looking at the centres. The theories of the time predicted that stars further from the centre of a galaxy would be travelling slower, but Rubin's data showed that these stars had approximately the same velocity as those in the centre. This hinted that there is more mass in galaxies than we can observe, otherwise the gravitational forces would not be strong enough to keep these outer stars from escaping from the galaxy. This extra mass that we can't see with electromagnetic waves is known as dark matter and it's one of the greatest unsolved mysteries of our time. Despite nearly 50 years of research into dark matter since Rubin's discovery, we are yet to figure out what dark matter is made of or identify it in a detector.

For her revolutionary work, Rubin received the National Medal of Science in 1992 and was elected to the National Academy of Sciences. The Vera C. Rubin Observatory in Chile, soon to start observations, was named in her honour and will be suitably groundbreaking. It will feature a camera covering an area the size of a full Moon that will create

ultra-high-definition footage of the skies. One main focus of the observatory is to continue the search for dark matter that she was so instrumental to.

It's particularly important that we highlight the achievements of women in STEM, at a time when diversity in the industry is at risk. Since the start of Donald Trump's presidency and his campaign against DEI (Diversity, Equity, and Inclusion programs), certain parts of the Vera C. Rubin Observatory website, which is run in collaboration with the US Department of Energy, have been altered. A paragraph describing how science is still a male-dominated field and that the Observatory is working to increase participation from women and other disadvantaged groups has been removed from Vera Rubin's biography page, as well as the website's page about its DEI program. Vera Rubin was a strong advocate for women in STEM; she once said that "half of all brains are in women". So at times like these, it's important that we work towards seeing this reflected in the industry, because when STEM is more diverse, we widen and improve our approach to tackling the greatest problems of our time.



Vera Rubin working at the Lowell Observatory in 1965

Vera C. Rubin Observatory in Chile

Why is CANCER so difficult to *cure*?

ANDREA MAJI

Cancer is a disease that affects millions of people around the world with an estimated 3.5 million people living with cancer by 2025, 4 million by 2030 and 5.3 million by 2040 in the UK. But for a disease that has influenced the lives of millions globally, why haven't we found a cure for it yet?

What exactly is cancer?According to the NHS website “cancer is a condition where cells in a specific part of the body grow and reproduce uncontrollably”. In actual fact, cancer is simply an umbrella term for a collection of diseases. In reality there are over 200 types of cancer with breast, lung, prostate and bowel cancer being the most common in the UK. Currently Cancer Research UK has raised £719m in 2022/23 with £415m going towards ongoing research such as research projects centred on specific cancer types (£176m), research infrastructure and cancer survivorship (£89m) and basic research understanding the fundamental biology of cancer (£83m). Out of that £176m, £23m is spent on lung cancer, £21m on colon and rectal cancer, £20m on breast cancer, £16m on leukaemia and £12m on brain cancer and that is just a snippet of the cancer types invested in.

Cancer is extremely difficult to cure for a number of reasons. One of these reasons is that cancer can form many subtypes, based on certain characteristics of the cancer cells. These characteristics include how the cancer cells look under a microscope and whether there are certain substances in or on the cells or certain changes to the DNA of the cells. These subtypes behave differently as they are different on a molecular and genetic level. This means a drug can work well on a certain subtype but maybe completely unsuccessful on another so, it’s important to understand these different subtypes first, before treatment plans can begin.

Another obstacle with curing cancer is cancer cells within the same tumour have different genetic mutations. A tumour is a solid mass of tissue that forms when abnormal cells group together. These abnormal cells that make up the tumour itself, have genetic munitions and over time new mutations can develop which are completely different genetic mutations to the original causing the cells to change. So treatment may affect some cells within a tumour but leaving more resistant cells relatively unaffected and these resistant cells could divide and form a fresh tumour. These new mutations also

means that treatments can stop working over time. A patient may start on one course of treatments but the cancer cells may develop a resistance to it. The patient could be switched to another set of treatments but the cancer cells may develop resistance again due to the development of new mutations.

Finally, cancer cells are incredibly intelligent and good at surviving. Cancer cells have the ability to cause surrounding normal cells to form blood vessels to feed the tumour nutrients and remove its waste products allowing it to continue growing. They can also hide from our bodies immune system by suppressing it to avoid being attacked and killed by it again, allowing them to continue growing uncontrollably.

So what actually causes cancer? The answer is within our DNA. Cancer is caused by mutations in DNA in a cell which is simply a change in the DNA sequence of an organism. These changes could be the removal, replacement or addition in the structure of our genes. DNA contains the instructions on how our cells should grow and divide. However, if a mutation were to occur this may change the instructions of the cell causing it to divide and grow uncontrollably. This is what we call cancer. These mutations could cause cells to grow rapidly and uncontrollably and even prevent the fixing of other DNA errors. These mutations can simply be inherited from parents or be due to lifestyle or environmental factors like smoking, radiation, obesity or lack of exercise.

But what about the treatments we currently use? Surgery is one of many possible treatment for cancer. This involves physically removing the cancer from the body by cutting it out. There are other forms of surgery for cancer like cryosurgery where the cancer cells are frozen with a cold material destroying them, electrosurgery were an electric current is used to kill the cancer cells, laser surgery where a laser is used to shrink and remove the cancer cells as well as many more surgical approaches. However, with all surgeries even if they are successful there is a risk of infection, severe blood loss and a possibility not all the cancerous cells are removed. There is also some evidence to suggest that disturbing the tumour during surgery increases the number of circulating cancerous cells in the bloodstream and down regulates the immune system, increasing the chance of metastasis.

Another common treatment for cancer is chemotherapy. Chemotherapy works by killing cells that are in the process of splitting into new cells by damaging the genes of the nucleus inside the cell. As we know cancer cells divide more rapidly and uncontrollably than normal cells so the chemotherapy is more likely to kill cancer cells. However it is rather an aggressive form of treatment causing many side effects to the patient like hair

loss, anaemia, fatigue and nausea. And it is possible for the cancer cells to survive during chemotherapy as they may develop genetic mutations to the drug.

Immunotherapy is a type of therapy that uses substances the immune system to help the body fight cancer, infection, and other diseases. It causes our immune system to become more active making it better at finding and attacking the cancer. Some examples are treatment vaccines which boost your immune systems response to cancer cells, immune system modulators that enhance the body's immune system against cancer or immune checkpoint inhibitors which block immune checkpoints allowing immune cells to respond more strongly to cancer. However, by making the immune system more active it does cause side effects like rash, pain and selling in the joints, tummy pain and it has an effect on glands that release hormones for example the thyroid, by causing it to release more or sometimes less hormones causing symptoms such as weight changes, excess sweating and increased hunger or thirst .

But despite the challenges of treating cancer researchers are still developing new treatments such as the new mRNA therapy, a type of immunotherapy that works using messenger RNA. The patient's immune system is presented with common tumour markers. This exposure to the markers will hopefully train the patient's Immune system to potentially recognise and fight the cancer cells that also present those markers. Although it is still in its clinical trial phase it could be a huge step forward in less aggressive and toxic cancer treatments that leave patients with a myriad of side effects. There are also new cancer treatments being used in hospitals right now. A new immunotherapy treatment, known as a checkpoint inhibitor, dostarlimab added to chemotherapy has been found to slow down forms of endometrial cancer. The NHS began offering the treatment on March the 5th 2024 and it is estimated 150 to 200 women will be eligible for the new treatment each year. During Clinical trials 64% of patients treated with dostarlimab along with chemotherapy had their cancer progress at a two times slower rate than patients who received chemotherapy alone.

Cancer is an incredibly complicated and intelligent disease that constantly adapts and develops to avoid our immune system making it extremely difficult to cure. We have many possible treatments but no course of treatment is 100% effective with many of them greatly negatively affecting the patients themselves. However globally scientists, doctors and researchers are working hard to find a way to tackle this disease in ways that will destroy the cancer but also maintaining patients wellbeing and quality of life at the same time. But we can expect newer and promising developments in treating cancer in the near future .

the *E*nvironmental and *T*echnological impact of the expanding SPACE industry

STEFANIA-FLORENTINA RADU

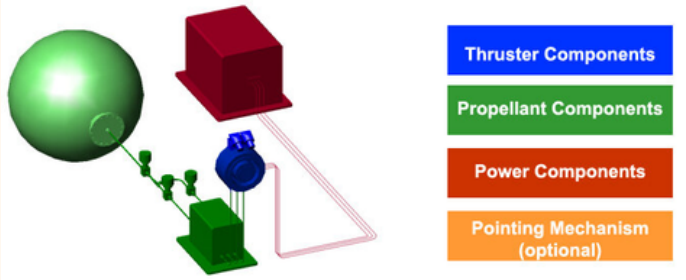
The global space industry is undergoing significant expansion, driven by commercial ventures and governmental space agencies. This growth has led to an increase in rocket launches, satellite deployments, and the adoption of advanced propulsion technologies. While the benefits of these innovations are vast, ranging from improved communication to deep-space exploration, the long-term environmental and technological impacts require careful consideration.

Over the past 15 years, annual rocket launches have nearly tripled, and the number of operational satellites has increased tenfold. Furthermore, applications for satellite spectrum for approximately one million satellites have been filed with the International Telecommunications Union. Although not all of these plans will materialize, experts predict that by the end of the decade, around 100,000 spacecraft could be orbiting Earth. This rapid increase in satellite activity raises concerns about the sustainability of current space operations, as well as the potential for further advancements in propulsion technologies.

The rise in rocket launches and satellite deployments has led to an increase in space debris. Over the past decade, the amount of old satellites and spent rocket stages falling back to Earth has doubled, with several hundred tons of space junk vaporizing in the atmosphere annually. Most of a satellite's mass burns up at altitudes between 37 and 50 miles (60 to 80 kilometers), contributing to the accumulation of ash and metallic particles in the stratosphere. This has led to concerns that long-term pollution at these altitudes could alter atmospheric chemistry and climate.

Electric propulsion has emerged as a crucial technology for modern spaceflight, utilizing electrostatic or electromagnetic fields to accelerate propellant at high velocities, thereby enhancing fuel efficiency. First demonstrated in the 1960s, electric propulsion systems now play a vital role in spacecraft maneuvering and

long-duration missions. Compared to chemical propulsion, electric thrusters require significantly less propellant and provide sustained low-thrust propulsion, making them ideal for satellite station-keeping and deep-space exploration and polluting a lot less than chemical propulsion does.

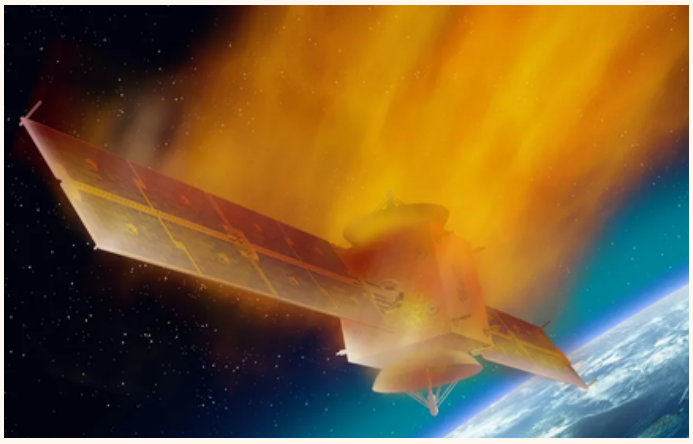


Electric Propulsion System main building block, ESA

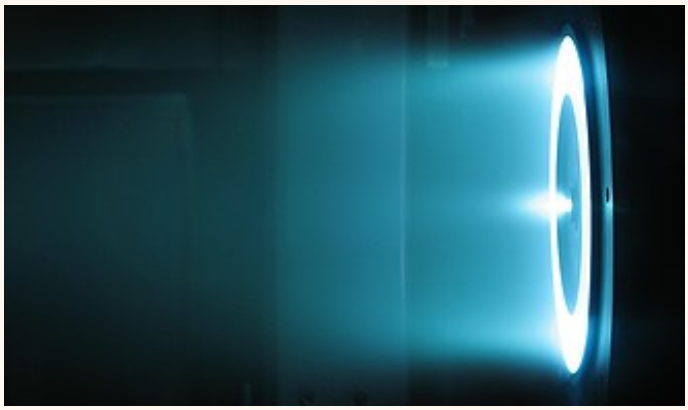
Most rockets in use today rely on fossil fuels, producing soot emissions that absorb heat and could contribute to temperature increases in the upper atmosphere. Additionally, the incineration of satellites upon reentry releases aluminum oxides, which may affect Earth's thermal balance. Both soot and aluminum oxide emissions have the potential to deplete the ozone layer, which protects the planet from harmful ultraviolet (UV) radiation. Unlike ground-based pollution sources, rocket emissions are injected directly into higher layers of the atmosphere, where they can have prolonged effects.

Electric propulsion, when compared with chemical propulsion, is not limited by energy constraints but rather by the available onboard electrical power. This makes it particularly suitable for low-thrust, long-duration applications, reducing the reliance on high-emission chemical thrusters. By utilizing propellants such as xenon or argon, electric propulsion systems minimize environmental impact while maximizing efficiency. Future developments in space technology must incorporate sustainable propulsion methods to mitigate environmental risks associated with rapid industry expansion.

Today, rocket emissions are minor compared to aviation exhaust, but scientists caution that even small additions to the stratosphere could have significant effects. Research suggests that black carbon released by rockets may function similarly to a continuous volcanic eruption, depleting ozone and affecting global climate patterns. Additionally, while electric propulsion presents a promising alternative, power generation and storage limitations must be addressed to ensure its widespread adoption for future missions. The full extent of these impacts remains uncertain, highlighting the need for further study and regulation to ensure the long-term sustainability of space activities.



Satellite burning up in Earth's atmosphere, Paul Fleet / shutterstock



6 kW Hall thruster in operation at the NASA Jet Propulsion Laboratory

The rapid expansion of the space industry presents both opportunities and challenges. Electric propulsion has proven to be a highly efficient alternative to chemical thrusters, enabling long-duration missions with reduced propellant requirements. However, the environmental consequences of increased rocket launches and satellite reentries must be addressed through sustainable space practices and regulatory frameworks. Balancing economic growth, technological advancement, and environmental responsibility will be crucial for the future of space exploration.

Psychology in Youth *FOOTBALL* Building Resilient and Confident Players

HAVIN ULUYOL

Youth football is more than just learning technical skills and tactics; it also involves developing psychological resilience, teamwork, and confidence. Understanding the psychological aspects of the sport can significantly enhance young athletes' experiences, helping them thrive both on and off the field. In this article, we explore the role of psychology in youth football, its impact on player development, and strategies coaches can implement to nurture a positive and growth-oriented mindset among their players. These are the important factors:

The Role of Motivation

Motivation is the driving force behind a player's effort, perseverance, and commitment. In youth football, it is essential to foster intrinsic motivation, where children play for the love of the game, enjoyment, and the desire to improve, rather than external rewards like trophies or praise from parents and coaches. Coaches can achieve this by creating an environment that emphasizes fun, personal development, and teamwork over winning at all costs. By encouraging young players to set achievable goals and celebrate small improvements, coaches help build a lasting passion for the sport.

Building Confidence and Self-Esteem

Confidence and self-esteem are crucial for youth football players to perform at their best. Children need to believe in their abilities, feel valued by their team, and perceive themselves as capable of overcoming challenges. Coaches play a vital role in building this confidence by offering constructive feedback, emphasizing strengths, and showing belief in each player's potential. Positive reinforcement, recognition of effort, and celebrating small successes can all boost a young player's self-esteem.

A growth mindset approach is particularly effective, encouraging players to view mistakes as opportunities for learning and improvement rather than failures. When players understand that hard work and persistence lead to growth, they are more likely to stay motivated and confident, even when facing setbacks.

Dealing with Pressure and Anxiety

Pressure and anxiety are common in youth sports, especially as players advance and competition intensifies. Young athletes may feel pressure from

parents, coaches, or even themselves to perform well, leading to stress that can hinder performance and enjoyment. It is important for coaches and parents to create a supportive atmosphere that allows children to express their feelings and concerns openly.

Coaches can also teach mental skills such as deep breathing, visualization, and positive self-talk to help players manage stress and remain focused during games. By equipping children with tools to handle pressure, they become more resilient, not only in football but also in other aspects of life.

Promoting Teamwork and Social Skills

Football is inherently a team sport, making it an excellent platform for developing social skills, cooperation, and teamwork. The sense of belonging and camaraderie that players experience as part of a team contributes significantly to their overall well-being and psychological development. Coaches can strengthen these aspects by fostering an inclusive environment where each player feels valued and respected.

Activities that encourage team bonding, communication, and collaboration help build a positive team culture where players support and uplift each other. As players learn to communicate effectively and work together towards shared goals, they develop social skills that are beneficial beyond the football field.

Parental Involvement and Influence

Parents play a critical role in their child's football journey. Their support and involvement can greatly enhance a child's experience, but it is important for parents to maintain a balanced approach. Overly critical or pressuring behavior from parents can create anxiety and reduce enjoyment for young athletes.

Coaches and clubs should engage parents as partners, emphasizing the importance of encouragement and understanding. Workshops or meetings with parents can help set expectations and provide guidance on how to support their child's development positively. When parents are aligned with coaches in creating a nurturing environment, children are more likely to thrive and enjoy the sport.

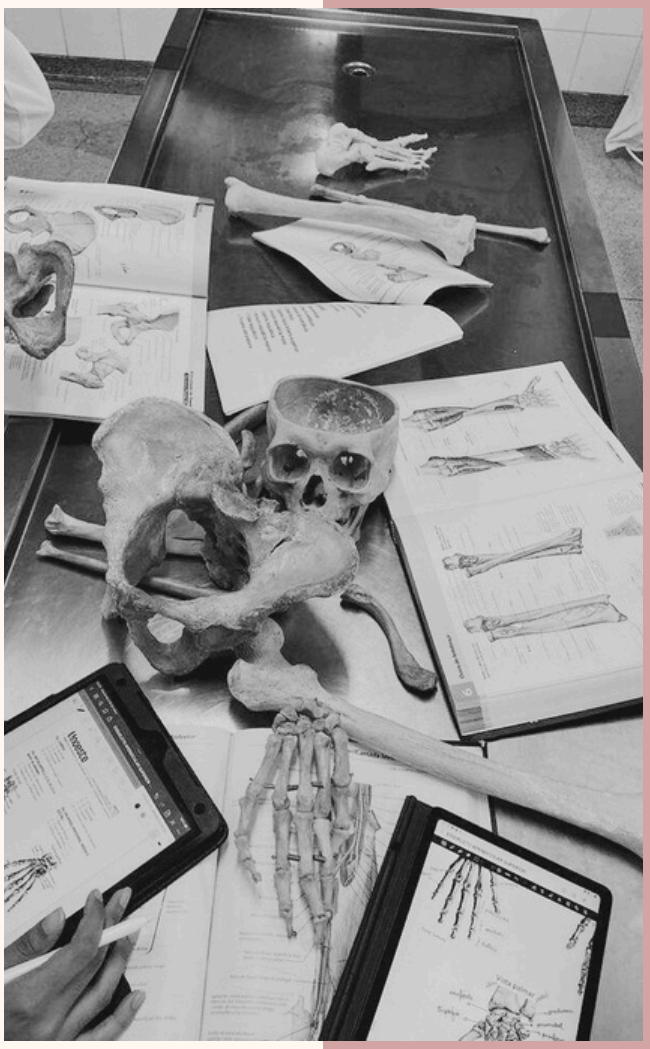
Long-Term Athlete Development and Psychological Well-Being

The focus on youth football should extend beyond immediate success and aim at long-term athlete development (LTAD). This approach ensures that players develop physically, technically, and psychologically at a pace suitable for their age and skill level. Balancing structured training with free play allows children to develop creativity, decision-making skills, and a deep understanding of the game. Prioritizing well-being and the overall growth of players, rather than a win-at-all-costs mentality, helps foster a

positive association with the sport that can lead to lifelong participation and enjoyment.

Psychology plays a crucial role in the development of young football players. By understanding and addressing the mental and emotional needs of children, coaches, parents, and clubs can create an environment where players build resilience, confidence, and social skills. Emphasizing fun, teamwork, and long-term growth over immediate success not only enhances the player's performance but also ensures a positive and meaningful experience for all involved.

MARISSA MOWERS



Marissa, 19 years old, is in the second year of her Bachelors of Forensic Science at the University of Windsor in Ontario, Canada, specializing in Life Sciences. Being particularly interested in forensic taphonomy, forensic anthropology, human identification and forensic analytical chemistry, she already had a lot of experience in the field. First of all, she is a student researcher at her university working under Forensic Taphonomist and Analytical Chemist Dr. Shari Forbes, best known for her work in opening the human decomposition research facility "AFTER". She also worked in a scavenging project where she was involved in the experimental set-up of porcine carcasses to analyse the decomposition and another one to analyse animal scavengers, fundamental for understanding what happens to the carcasses after death. Not only that but she also assisted in ground penetrating radar surveying of children's graves in local cemeteries to help identifying unmarked graves and she is also a student member of the British Association for Forensic Anthropology. Her dream of completing her Master's degree in Anatomy and Advanced Forensic Anthropology and her PhD in Human Identification as well as being a Teaching Assistant for biological anthropology is definitely get off to a good start!

What initially sparked your interest in Forensic Science and how did you decide to specialize in Forensic Anthropology and get a PhD in Human Identification?

Originally, I actually wanted to be an E.R. doctor. I've always been interested in medicine and helping others. I specifically wanted to work in the E.R. as you never know what's going to come through the door. I grew up watching "Untold Stories of the E.R." and I loved the challenge of how unique each case was. I eventually realized that path was "too much medicine and not enough mystery" for me. As I got older, let's say high school age, I also became heavily involved in social justice, specifically in celebrating cultures of my community and dismantling racist ideology in my school peers. This is when I decided I wanted to continue helping people from a justice perspective. Forensic anthropology is the perfect intersection of medicine (through skeletal trauma

and pathology), mystery, and justice. I'm still in undergrad, but I do intend to pursue a PhD in human identification as being a voice for victims has always been a priority for me. I want to be able to honour the victims through more than just their osteological profile, so the first step to getting to know the victims is to identify who they are. Much research is needed in this area, and I'd love to be the one to do it.

You mentioned working as a researcher with Dr. Shari Forbes, what would you say is the most valuable lesson you learnt from her?

I'd say the most valuable lesson I've learned from Dr. Forbes is that your career is what YOU make it. I always say that my degree feels like a "DIY" degree, and I know many of my peers say the same. I'd say this is different from, for example, pre-med, where you must learn every system, every muscle, and every tissue in the body. If you want to be a heart doctor, you must learn certain things. The same for a psychologist or respiratory doctor. It's very strict. With forensics, there's no limit to the "types" of forensic scientists. You can study absolutely anything that interests you and find unique ways to apply it to criminal investigations!

If you could work on any forensic case, past or present, which one would it be and why?

I would love to work on the Jack the Ripper case. The gruesome mutilation of his victims has always intrigued me, especially as he's never been caught. I wonder if evidence such as fibres, DNA, or specific tool markings would be present in the skeletal remains of his victims given the degree of mutilation.

Your work seems very intriguing, what are some of the most interesting or unexpected animal scavenger behaviours you observed during your analysis? Regarding your other main project, what are the biggest obstacles you faced when conducting GPR surveys in historical cemeteries and how did you get involved in such a fascinating experience?

I believe the most intriguing animal behaviour I've seen is actually the absence of feeding! There are some animals (for example, mountain lions) that will walk right by a carcass without even touching it. It gives perspective on the stages of decomposition for which a certain animal will feed, as some animals tend to feed later in the decomposition process rather than when the body is fresh, or vice versa. When conducting GPR surveys in cemeteries, the greatest challenge I've seen is actually the location of the headstones. Sometimes, as the ground shifts with natural processes, the headstones become unearthed. The cemetery groundskeepers don't know where to put them, so they just put them back up in an arbitrary location, sometimes even covering the grave. This leads to scans in front of headstones that show no grave below, or scans of a grave that are incomplete as the headstone acts as an obstacle in the GPR

scanner's path. The are actually pretty commonly not where the headstones indicate! I also do want to clarify, neither the scavenging nor the GPR is "my" project, I'm just assisting graduate forensic science students in their theses! I would never want to take credit for someone else's work, but I do have some of my own projects planned!

I believe this topic has been incredibly fascinating for many people and the visual entertainment industry has benefited from that, do you usually watch TV shows or movies involving Forensic analysis, like CSI, Bones...? What would you say are some common misconception people have about this field due to that media representation?

This is something forensic scientists call "the CSI effect", referencing the perception of forensic science through TV shows such as CSI. I think the biggest and most common misconception, which is actually related to what I said earlier, is how specialized forensics is. In crime shows such as NCIS, you'll see the same forensic scientist (like Casey) perform digital forensic analysis, paint analysis, soil analysis, DNA, fingerprints, etc. In reality, these are all different professions with very different training. In a real crime lab, you won't see one person interchangeable between departments!

Working in forensic science can be emotionally intense. How do you handle the psychological impact of dealing with death and, sometimes, even human remains?

The absolute key to working in forensics is not being afraid to ask for help. This is something your professors will drill into you since day one. Of course, anyone would face psychological impacts from witnessing gruesome, heinous crimes. In many workplaces, after particularly traumatic cases, psychological care/evaluation is actually mandatory. Regardless, reaching out for help and seeing a therapist or other mental health professional is crucial. I especially like how in this profession (and unfortunately not too many others), you will never see "fragile masculinity" or people claiming mental health care is taboo. It's an incredibly supportive community and my peers and I always support each other through our mental health.

A little bird told me you have your own project going on with your peer Quyen Ngo, can you tell us something about it?

As part of our Genetics course curriculum, we investigated the mutation 141900.0540 in the beta-globin gene HBB. This mutation is known to cause Beta-Thalassemia, Dominant Inclusion Body Type, but the reason why this mutation follows an autosomal dominant inheritance pattern is unknown. After bibliographical analysis in PubMed and NCBI databases, we hypothesized that the mutation is dominant negative. The binding of the mutated protein to the heme group (rather than the normal protein binding) is characteristic of the dominant negative effect, as the mutated protein is interfering with the function of the normal protein. We found that beta-thalassemia causes bone

deformities through aggregates in the normoblasts of bone marrow. In skeletal remains (including partial remains of the skull, ribs, and limbs), bone marrow can be sampled and analyzed through phase contrast microscopy to identity aggregates. Identification of the disease can then be compared against medical records of missing persons to aid in identification. A benefit to this application in forensics is that the disease is dominant, meaning even if the victim is undiagnosed, prevalence of the disease in the medical records of any of the victim's relatives indicates that the victim has the disease as well. Another significant benefit is the use of this disease for identification in partial remains. This is only a preliminary study and has yet to be applied in practice, so further research is needed.

Would you say Forensic Science is a male-dominated field? Have you ever faced challenges as a woman in the field? What would you tell to young girls who feel intimidated or unsure about pursuing this career because of that?

Surprisingly, forensics is actually a pretty female-dominated field! It's lovely to see so many women and girls at the forefront of a science discipline. While I have never faced challenges as a woman in the field, I've seen my peers in fields such as forensic psychology be discredited as scientists. In truth, forensic psychology students take many of the same science courses I do. Society tends to be narrow-minded with what "science" really is. I would like to tell young girls that any forensic science career you choose to pursue is CHALLENGING! Don't let anyone ever convince you that you have an "easy" career or that you may be less intelligent than other forensic scientists because your career doesn't fit their (false) definition of science. All forensic science disciplines are equally important in solving a crime and bringing a victim to justice. Each discipline takes many years of rigorous training and dedication. You should always recognize and be proud of your academic and personal achievements without regard for the opinions of others!

ANNE SCHAUER

Anne Schauer is a dedicated neuroscience student and mental health advocate with a passion for understanding developmental and neuropsychiatric disorders. Currently pursuing a master's in integrative neuroscience at Georgetown University, she holds a bachelor's degree in biological sciences from the University of Maryland and brings valuable research experience from her work as a research scientist at the National Institutes of Health focusing on hepatitis B virus and systemic lupus erythematosus. Anne's academic journey has been shaped by personal experiences within her family and friends, fueling her commitment to exploring developmental disorders such as the autism spectrum disorder (ASD) and neuropsychiatric disorders such as post-traumatic stress disorder (PTSD) and dissociative identity disorder (DID). This fall, she will further her expertise as she attends the neuroscience PhD program at Virginia Tech and works on developing her nonprofit, Cognitively, *which aims to bridge the gap between neuroscience and psychology.*

Can you share how your personal and family experiences have influenced your academic choices and research focus?

My academic path and research focus have been shaped a lot by my family's experiences, especially my mom's traumatic brain injury (TBI) when I was 17. I had to help her navigate life post-injury, and I saw firsthand how she struggled with certain things and how we had to make adaptations. When someone has a TBI, individuals often become easily frustrated and self-conscious about their symptoms, so as I learned more about the brain, I'd explain things to her, like, "It makes sense you'd experience this..." Seeing how she overcame challenges over the years really opened my eyes to how the brain rewires itself and adapts. On top of that, growing up with a dad and brother on the autism spectrum gave me a better understanding of autism and how to actually support them instead of just expecting them to adapt. A lot of the things they felt rigid about weren't just personality quirks but part of how their brains work.

How do you balance drawing on your personal experiences for insight while maintaining scientific objectivity in your research? Is it necessary to separate the two?

For me, personal experience actually makes me more objective, not less. I don't think it's necessary to separate the two at all. I've seen how conditions like depression, Bipolar II, traumatic brain injury, and autism play out in real life, whether in myself or the people around me. I end up asking questions my classmates don't even think about because they just don't have that frame of reference. It's sparking conversations that wouldn't happen otherwise. That said, I set good boundaries. When people ask me about their symptoms or think they have a certain disorder, I make it clear that I'm not a doctor and I can't diagnose them. I don't let my own experiences bias how I look at other people's symptoms, but I do let them shape how I approach research. Like, one time, I brought up dissociative identity disorder (DID) in class because I wanted to talk about the complexities of consciousness. Meanwhile, my classmates were stuck arguing about whether DID was even real. It just showed me how far we still have to go in talking about these things, and I feel like my experiences help me skip past all the surface-level nonsense and get to the real questions.

As you transition into your PhD at Virginia Tech, what are you most excited about exploring further in neuroscience?

I'm really excited to dive deeper into the intersection of ASD and trauma disorders like PTSD and DID. I have a theory that DID is more prevalent in ASD populations because of their lower stress tolerance and higher victimization rates. Autistic people are ten times more likely to develop PTSD, which sets the stage for more severe dissociation. There's a huge gap in research here, and I want to help fill it.

You mentioned that you are launching a nonprofit, can you tell us more about it? What motivated you to establish it and what is your goal?

Thanks to an award I received from Georgetown, I'm in the process of launching a nonprofit called *Cognitively*, which aims to bridge the gap between neuroscience, psychology and lived experience. My experiences, and those of my loved ones, have shown me just how little direction there is for people struggling with neurological and psychological conditions. Take TBI, for example. We've only realized in the last 20 years the long-term effects, yet there's still no clear guidance on how to help people recover from them. When my mom had her TBI, we had to figure everything out on our own. The same goes for ASD; when I was a kid, nobody knew how to help with sensory sensitivities. ARFID (Avoidant/Restrictive Food Intake Disorder) was dismissed as

autistic kids just being “stubborn” about food. But now, research shows their taste receptors actually send stronger signals than neurotypicals’, which explains the extreme reactions to certain textures. This kind of research is desperately needed, but stigma is holding people back. A lot of people feel bad about themselves because they don’t understand how their brain is influencing them. That lack of understanding keeps them from getting help, even when resources do exist. That’s where *Cognitively* comes in. I want to educate people about their disorders and make their voices heard. I plan to interview people with these conditions, their family members, as well as psychologists and neuroscientists. Another major problem I’ve noticed is how disconnected psychology and neuroscience are as fields. Psychologists and neuroscientists barely interact with each other, which is a huge missed opportunity. When I was looking at PhD programs, I saw that cognitive neuroscience often focuses on sensorimotor systems, not the neuroscience behind psychology itself. Neuropsychology programs are rare, and with the current political climate, even fewer people are pursuing them, which is wild, because we need them now more than ever. *Cognitively* it is my way of pushing back against that gap and making sure people get the knowledge and support they need.

Given the stigma around mental health, what strategies do you believe are most effective in changing public perceptions and understanding?

The biggest strategy I’m focusing on to change public perception around mental health is humanizing people with these disorders. For example, antisocial personality disorder (ASPD) and DID are heavily stigmatized in the media, people with ASPD are portrayed as inherently dangerous, while DID is treated as something out of a horror movie. In reality, both disorders develop from severe trauma. ASPD alters brain structures in a way that impacts emotional processing, and DID is a dissociative response to extreme trauma. These individuals are not inherently dangerous or malicious; their disorders are often misunderstood because people only have surface-level knowledge of them. That’s why my website prioritizes interviews with people who actually have these conditions. Their perspectives should be centered in discussions about their own disorders. I also integrate relevant research studies into these conversations because a major issue in the field is the lack of direct input from the people being studied. Researchers often dictate what these communities need without actually listening to them, which results in interventions that don’t align with their real experiences.

Since you already worked as a research scientist, do you see yourself continuing down the path of research or are you planning to pursue a non-research oriented career?

I plan to continue in research because it has always been my focus. I’ve worked

collectively for three years at the NIH (National Institutes of Health), and my interest in research stems from constantly questioning things and trying to understand them at a deeper level. I attribute this mindset to being undiagnosed autistic until I was 21. My goal is to conduct research that has a direct impact, providing useful insights rather than just publishing findings that never lead to real change.

What advice would you give to young girls or early-career researchers who are interested in neuroscience and how to face any personal or academic difficulty that comes with it?

My main advice is to understand that you will face doubt from others, and you have to be the one who believes in yourself the most. People will tell you that you aren't capable, that you don't belong in the field, or that they "just don't see you" in research. You cannot let their opinions hold more weight than your own. If you ever question your progress, compare where you are now to where you were four years ago. You've likely made more progress than you ever expected. Now consider where you'll be four years from now. You will likely surpass your own expectations again. Keep going!

If you want to know more about her mission, you can visit her website:
https://www.cognitively.org/

MIA SOVIERO

*Mia's journey began with a profound connection to neuroscience. At just nine years old, she developed chronic migraines. Her experience as a child neurology patient, and watching the incredible work done by her neurologists, inspired her to pursue a career in child neurology. At the same time, her seven years as volunteer Head Coach of the Special Olympics Maryland Figure Skating Team ignited a passion for research. Upon her acceptance to Barnard College of Columbia University, she declared her major in Neuroscience and Behavior with a specialization in Behavioral Neuroscience, on a pre-medical track. During COVID lockdown, Mia began creating neuroscience education videos and documenting her journey to medical school. With a following of over 200,000, her platform grew into a hub for students eager to learn about research opportunities and neuroscience. Noticing the lack of resources that even students at one of the most prestigious research universities in the world were given, Mia decided to found Research Girl, Inc. to bridge the gap between students and research opportunities. (*from her website*)*

Could you kindly provide an overview of your non-profit organization, Research Girl, and elaborate on its future objectives? Additionally, did you foresee it achieving such a significant impact?

The current scientific research workforce is very homogeneous, women, BIPOC individuals, disabled individuals, and LGBTQIA+ individuals are all underrepresented in the field. Research Girl's goal is to empower those populations and give them the resources and mentorship needed to succeed, and in doing so, help diversify scientific research. When I founded Research Girl in April of 2024, I never thought it would gain so much traction and attention. It was originally founded as just a website of resources, but as more and more people began using it, I expanded on our programming to include a blog, mentorship program, webinars, and even conference panels. I'm so honored that my work has been able to help so many students across the country and across the globe!

You have mentioned to your audience that your EMT training enabled you to rescue a girl trapped in a four-car accident while dressed in a "Barbie-like dress," an incident which even gained media attention. How did this experience influence your career or alter your perspectives?

At the time of my “EMT Barbie” incident, I was struggling with a PTSD diagnosis from a recent sexual assault and was considering quitting my emergency medicine training because some aspects were triggering. Just as I was ready to give up, I ended up in the middle of a four-car accident while coming home from the Barbie movie, dressed in a fluffy pink dress. It’s always been my interactions with patients that have solidified my love for medicine, and this experience was no different. After my “EMT Barbie” incident, I was reminded that my “why” for medicine is the patients. It reminded me that I couldn’t give up, not just for myself and my career, but for the individuals I could one day serve.

You have authored several articles in the field of neuroscience, including your thesis. Could you please briefly discuss its content and relevance to the field?

My undergraduate work in neuroscience predominantly focused on the relationship between psychological disorders and memory. My thesis, titled “Experiential diversity, autobiographical memory deficits, and increased depression rates during COVID-19,” investigated the global increase in depression rates during COVID alongside a common anecdotally reported phenomenon: that many people describe COVID quarantine as “a blur.” Since my thesis work, I’ve moved into the field of PTSD and memory, inspired by my personal experience with PTSD. My work seeks to analyze the altered temporality in flashbacks reported by PTSD patients. Flashbacks can be one of the most distressing aspects of PTSD, so it’s important that more research is done into the ‘how’ and ‘why’ of these phenomena. By learning more about the mechanics of flashbacks, we can hopefully develop better treatment plans to help those who experience them.

What have been the major challenges you have encountered in your professional journey, and how have you navigated through them?

My journey is one of alchemizing my greatest weakness into my greatest strength. When I began studying science, I had severe anxiety about public speaking. It affected many parts of life as a scientist, interviewing for labs,

presenting research, and effectively communicating scientific topics. By the time I was in my second year of college, I was fed up. I began incorporating “exposures” for my public speaking fear into every aspect of my life. I would force myself to ask questions in class or volunteer for speaking roles, and I even started my TikTok channel to begin practicing scientific communication. Doing these exposures every day (something I still do!) slowly molded me into the antithesis of the person I had been: where I had once been terrified of public speaking, I have now become a public figure who panels and lectures at universities and engages in scientific communication daily with my mentees and viewers on TikTok.

You have an interest in writing and ice skating, as well. How do you manage to balance your professional responsibilities with personal life, given the diverse nature of your career?

I’ve always shouldered a lot of different responsibilities. In college, I was studying and attending class, creating science content for TikTok, writing my first novel, and working for the lab, all squished into the span of 24 hours. Several things made this possible: a fierce passion for each and every one of those things; the commitment to extending kindness to myself when I wasn’t able to do everything; and excellently developed time management skills. I used to sort my day into blocks (10:00 am - 4:00 pm block for studying, 9:00 pm - 1:00 am block for writing, etc). But even the world’s best time manager can’t account for the natural ebbs and flows of humanity. Some days I was able to do huge amounts of work, others, I fell flat. What was important was not to let that discourage me. I like to remind myself that even five minutes towards a goal, per day, will eventually get you where you’d like to go.

In your view, what are the essential qualities that have contributed to your success?

When anyone asks, I’m adamant that the most important “make or break” quality in my career has been my genuine love for what I do. I would never have been able to work the many years of unpaid research, or work multiple jobs while in undergrad, if neuroscience wasn’t a passion that drove me to keep going. Research and medicine are two career paths that involve lots of hard mental labor, unpaid work, and challenges to your physical and mental health. If you aren’t steadfast in your desire and passion for the end goal, it’s hard to generate that intrinsic motivation to carry you through. That being said, intellectual curiosity can be one of those qualities that help maintain your passion for science. Science is about asking questions and thinking outside the box to piece together a very complex puzzle. Individuals who are highly curious and question the world around them will always have a new scientific puzzle to solve, which will keep their love for the subject.

As a role model for young girls aspiring to pursue careers in STEM, what advice or recommendations would you offer them?

Carve your own path. It's perfectly normal to take extra time in your journey, or be a non-traditional STEM student, or make mistakes and experience failure. What matters is that you keep trying, take care of your mental health, and remember that by entering the STEM field (whether in industry, research, or medicine), you are shaking the foundation of that glass ceiling. Women are still overwhelmingly underrepresented in science. Each one of us who decides to continue forward despite the odds is contributing to a future where our daughters will be more likely to succeed. Push on!

You want to know more about her mission? You can find her on tiktok as @miadimilano and @researchgirlofficial or you can visit her websites https://www.researchgirl.org and https://www.miasoviero.com

SCI-VISIONS
the art of science

by Irina Tall Novikova

IRINA TALL (NOVIKOVA) IS AN ARTIST, GRAPHIC ARTIST, ILLUSTRATOR. SHE GRADUATED FROM THE STATE ACADEMY OF SLAVIC CULTURES WITH A DEGREE IN ART, AND ALSO HAS A BACHELOR'S DEGREE IN DESIGN

instagram: irina.tall111


SAVE

The first personal exhibition "My soul is like a wild hawk" (2002) was held in the museum of Maxim Bagdanovich. In her works, she raises themes of ecology, in 2005 she devoted a series of works to the Chernobyl disaster, draws on anti-war topics. The first big series she drew was The Red Book, dedicated to rare and endangered species of animals and birds.

Writes fairy tales and poems, illustrates short stories. She draws various fantastic creatures: unicorns, animals with human faces, she especially likes the image of a man - a bird - Siren. In 2020, she took part in Poznań Art Week. In 2022, her short story was included in the collection "The 50 Best Short Stories", and her poem was published in the collection of poetry "The wonders of winter".

A special thank you to everyone who worked hard to put this issue together and to all of you who supports us everyday!

where to find *us*

instagram: girlsinstemmagazine

email: thegirlsinstemmagazine@gmail.com

website: https://lizard-hare-1c7.notion.site/GIRLS-IN-STEM-29040ea0057c4e4384445aaadeef1e8f?pvs=4

tiktok: girlsinstemmagazine