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The latest edition of the Beacon explores various aspects of the word 'future'. It has been fascinating to see the ways in which this year's Upper School scholars have interpreted the theme. Their thought-provoking articles reflect the variety of perspectives on offer as to what lies ahead, from evolutionary game theory and predicting the apocalypse, to the future of Classics and philosophical enquiry. The essays truly showcase the multifaceted nature of the theme, as well as the individual passions of each scholar. I hope you enjoy reading this collection as much as I have.

AADYA, UPPER SIXTH
Chief Scholar

Contents

06

Global Warming, a Buzzkill: Exploring the Impacts of Climate Change on Insect Populations and their Ecosystems

ANASTASIA, LOWER SIXTH

08

Do the Classics Have (or Deserve) a Future?

CAMILLE, YEAR 11

10

The Future of Medicine in an Age of Institutions

CHIARA, YEAR 11

12

Future

CLARA, LOWER SIXTH

15

When Literature Alters the Future: Chernyshevsky's *What Is to Be Done?*, the Russian Revolution, and the 2008 Financial Crisis

ELEANOR, YEAR 11

16

Predicting the Apocalypse

ELLA, LOWER SIXTH

18

To What Extent Is Our Future Determined by Fate?

GABRIELLA, YEAR 11

20

Survival of the Fittest: Evolutionary Game Theory and Predicting Strategic Behaviour

ISABELLA, LOWER SIXTH

22

Can Progress Be Made in Philosophy, and, if so, How?

JESSICA, YEAR 11

24

The Delphic Oracle's Significance in Ancient Greece

KATIE, LOWER SIXTH

26

Back to the Future

LOIS, LOWER SIXTH

28

Genetically Modified Crops and Food Insecurity: Hope for the Future?

MAGGIE, LOWER SIXTH

30

The Future of Personalised Medicine: Should We Look at the Disease the Person Has, or the Person the Disease Has?

MARIELLA, LOWER SIXTH

32

Will BRICS Pose a Threat to the West in the Future?

OLIVIA, LOWER SIXTH

34

Pharmacogenomics: An Answer to Cancer?

RACHEL, LOWER SIXTH

36

What Impacts Will Climate Change Have on the Future of Our Generation and Is It Too Late to Prevent the Climate Crisis?

SCARLETT, LOWER SIXTH

38

Temporal Dimensions: The Interaction Between the Past, the Present, and the Future

SOPHIA, YEAR 11

40

Deep-Sea Mining: The Future of Green Energy?

TALIA, LOWER SIXTH

42

Digital Erosion: Why Our Dependence on Technology May Be Paving the Way Towards a Digital Dark Age

ZARA, LOWER SIXTH

Global Warming, a Buzzkill: Exploring the Impacts of Climate Change on Insect Populations and their Ecosystems

ANASTASIA, LOWER SIXTH

On hearing the phrase 'climate change', we perhaps think of the immediate and devastatingly direct effects: polar ice caps forcibly losing their contents of concentrated methane gas; loss of soil fertility as the warming atmosphere loots the Earth's water content; and the increased frequency of wildfires devastating forests and grasslands alike. It is easy to neglect issues where the repercussions do not affect us immediately or seem irrelevant – not a pressing concern. Yet it is vital to our sustained future on this planet for us to understand how enhanced climate change is giving rise to numerous issues for insects, which in turn cause rapid changes to our levels of security. We can view this as if the effects of climate change are a melting iceberg: we may not be aware of every impact below the surface, yet every fracture in the ice and evidence of thawing contributes to rises in sea levels.

The term 'climate change' refers to "long-term shifts in temperatures and weather patterns. Such shifts can be natural, due to changes in the sun's activity or large volcanic eruptions. But since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels" (United Nations, 2023). Through the enhanced greenhouse effect, "Earth's temperature has risen by an average of 0.06° Celsius per decade since 1850" (Lindsey and Dahlman, 2024). The impacts of these changes trigger insect populations to undergo physical conversions within their lifecycle; their interactions with other organisms become more invasive – with the emergence of a larger risk of insect-transmitted diseases – and their altered abundance becomes clear, as severe differences in geographic distribution are recorded. Our biggest secondary impact and concern from these issues is global food security, already heavily affected by the increased droughts and inundation; the loss of pollinators and their diverse habitats will decrease crop yields and the adaptability of our ecosystems, pushing us towards a critical threshold.

Changes to the natural biogeography and climate of areas have resulted in insect populations expanding in their locational range, including migration distances travelled. Every organism has optimal conditions for survival and most insects have a specific body temperature that is suited to their environment, meaning that even microscopic fluctuations in their climate will affect some of their bodily functions and development. During the winter, insects often enter a type of hibernation known as diapause but this requires low temperatures. They may have to move to more suitable habitats to survive, so in their traditional ranges, there will be a decline. A study by the UCL Centre for Biodiversity and Environment Research shows that "in areas with high-intensity and substantial climate warming, the number of insects was 49% lower than in most natural habitats with no recorded climate warming and tropical areas saw the biggest declines in insect biodiversity linked to land use and climate change." The range of insects is also expected to shift to higher altitudes by 2055, especially in central Europe. Yet certain species like alpine butterflies can only exist in short temperature ranges with very particular diets. The recent summer highs of over 40C across Europe have meant that many more insects are facing the risk of extinction as they are pushed out of their natural habitat, pushed away from their customary food source, and pushed into new arenas with new predators from which they have to protect themselves.

Phenology is the timing of biological organisms' annual cycles. As seasons are shifting due to rising temperatures, insects are experiencing alterations in their period of hatching or emerging from diapause. Spring has been inching earlier over the past 200 years, meaning that the cooperative relationships formed between pollinators and blossoms are becoming less interdependent and more fragmented as timings go askew. For species such as the Winter moth (Operophtera brumata L.), increases in temperature are affecting the timing of larval hatching and the caterpillars are therefore emerging before the bud of their host plant (Quercus Robur) breaks. The intricately woven food web is being slashed down by the climate emergency, and predators cannot survive without prey. As arguably an apex predator, humans cannot survive without the pyramid's base remaining stable.

Furthermore, milder winters and warmer summers are going to push certain species of pests northward and create novel ecological niches. This creates an issue for both natural habitats and humanity because crop yields and species diversity are suffering. There is an obvious correlation between the expansion of locust hotspots and global warming, as hotter temperatures and prolonged heavy rainfall create better conditions for breeding, which causes the abundance. Unfortunately, it is not simply just the product of our crops being infected by 70mm beasts – our crucial pollinators are also drowning in the ocean of problems caused. Changes in temperature and precipitation are affecting the abundance of pollen and nectar, and this impacts bee foraging patterns. Honeybees pollinate over 130 types of fruits and vegetables and, especially in the changing, more plant-based world that we live in today, we need their ecological service to healthy soils, clean water, and hardy plant communities. By 2050, the global population is expected to hit 10 billion; to feed everyone, the United Nations Environment Programme predicts that it will take 56% more food than is produced in the world today. Without pollinators, the food chain would snap at every joint, as each trophic level suffers from a plant-based food shortage.

Moreover, insects are a major cause of both plant and animal diseases, since they act as vectors. The insect order Hemiptera includes aphids that can transmit mosaic viruses as they move from stem to stem. Ants' entangled life systems are also being affected. As ectotherms, their body temperature depends on their environment, so warming temperatures can present lethal consequences. As symbionts, their relationship with mycorrhizal underground networks of hyphae splinter and break down, and the lack of biomass being passed between fungi and the wood-wide web causes an unravelling of the structure of ancient forests, degrading their health and success as global carbon sinks.

In conclusion, insect populations are struggling with consequences that are primarily our fault. As we continue to pump greenhouse gases into the atmosphere, a menacing and unfortunate future is propelled forward. As a global community, we must understand that, with proper mitigation management and adaptation, we can prevent smaller issues from becoming large problems in the chain reaction of a changing climate.

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Do the Classics Have (or Deserve) a Future?

CAMILLE, YEAR 11

At first glance, the study of Classics seems as if it should be the enemy of modernity. It is the leather-bound book in an empty library; the wrought-iron lamppost that only burns oil; the house sitting in the middle of a highway, cars swerving wildly, the owner unable to bring themselves to sign over the rights. In an era whose culture seems as fluid and unforgiving as the wine-dark sea Homer wrote about all those years ago, it can seem difficult to reconcile the realities of the ancient world with the legacy of classical studies, a legacy which is often not unfairly criticised. There have been calls to rename the discipline entirely to correct the apparent elitism or opacity inherent in the term 'Classics', with departments (notably UC Berkeley's) rushing to change their name. Many have criticised the 'whiteness of the discipline,' or a perceived focus on language at the expense of archaeology or the ancient Mediterranean outside Greece and Rome. Critics have even expressed scepticism at the potential for original engagement with texts already so thoroughly studied.

If it is not the Classics that have changed but the society that ultimately influences the way that we interact with them, it is worth considering if this is a change that benefits the student. The modern world doubtless has the potential to correct many of the historical flaws in the field. Efforts are being made to make the field more inclusive, whether by affirmative action or by adjusting the language requirements for admission (though Princeton recently came under fire for doing just this), and even apart from conscious efforts being made, it seems probable that improvement is a natural product of the next generation of students, who have been steeped in a culture increasingly aware of systemic discrimination, and able to, perhaps for the first time, address the interdisciplinarity which is the foundation of classical study. The harms caused by practitioners in the millenniums separating us from antiquity are indeed undeniable. Classics has often been used to venerate 'Western civilisation' and past scholars (often male, white and wealthy) have used the discipline to validate wrongly their personal views on slavery, racial hierarchy and even colonialism, a habit which has endured for much of the right wing today. Members often hold up the ancient Greeks and Romans as the originators of so-called white culture. Online reactionaries have adopted classical pseudonyms; the white-supremacist website Stormfront displayed an image of the Parthenon alongside the tagline "every month is white history month." Yet while this history of racism and exclusion is an undeniable part of the discipline's history, the classicists of the future seem better placed than ever to dismantle it. Academics such as Sarah Derbew and Dan-el Padilla Peralta write compellingly on the necessity of untangling race and antiquity, and Peralta even goes so far as to argue that the Classics have been instrumental in the invention of "whiteness," as well as its continued domination. Yet paradoxically, while Peralta argues that the Classics neither have nor deserve a future, it seems to me that he is the very reason they do. If the Classics have acted as the scaffolding for exclusion, they must also be seen as a means to dismantle it. If one is to see the past as an actor separate from morality (as seems necessary to avoid projecting our moral binary onto it), then the Classics do not 'deserve' anything. The question is rather whether classical study is still well placed to act in the interest of society, and whether the Classics can still speak on what it means to be human.

"Perhaps the continued vitality of the classical discipline requires not an abandonment of its chequered history, but an abandonment of human arrogance."

Peralta's calls for the death of Classics use the word as synonymous with racism, elitism and oppression, an act understandable when considering his childhood growing up in the Dominican Republic, where dictator Rafael Trujillo often invoked the classical legacy to venerate the "impeccable whiteness" of Ancient Greece, embarking on horrific campaigns of racial violence against the residents of neighbouring Haiti, people he believed to be racially inferior. Indeed, many Dominicans bear classical first or middle names, a remnant from slavers who would bestow classical names on their charges as a mark of their 'civilising mission.' Trujillo himself bears the middle name Léonidas, after the Spartan king who martyred himself at Thermopylae. Peralta, against all odds, finds himself at the top of the very field which sought to keep him in subjugation, and it is almost natural that he calls for the death of the 'Classics' he knew. For Peralta and many, Greek and Latin have been the language of oppression, and the silence of his white peers, despite half-hearted claims that they "respect his work," serves as an uncomfortable reminder that the Classics one grows up with is not only a demarcation of class but one of race. Joel Christensen, a professor of Greek literature at Brandeis University, addresses this conflict succinctly. "Classicists generally identify as liberal," he states, "but we can do that because most of the time we're not in spaces or with people who push us about our liberalism and what it means."

What Peralta's detractors, who accuse him of 'killing' Classics, fail to recognise is that it is not the Classics of the classroom he wishes to see die, but the Classics of his childhood – the Classics of Trujillo.

Yet, amidst the discrediting of the Classics, even by those as educated and eloquent as Peralta, there is an internal tension. While texts have provided the basis for horrific acts of oppression (such as Aristotle's belief that some people were "slaves by nature"), many have also acted as inspiration for civil rights movements and marginalised groups throughout history. Indeed, it is difficult to imagine telling the Haitian revolutionaries of the eighteenth century, who viewed their leader, Toussaint L'Ouverture, as the 'Black Spartacus,' that the classical legacy which afforded them strength deserved erasure, or indeed that by engaging with it, they were somehow complicit in an act of 'self-colonisation,' as Peralta would claim. What would be Simone de Beauvoir's response, when confronted with the idea that the untamed, complex, destructive women of Greek tragedy (such as Euripides' Medea) were no longer effective symbols of patriarchal resistance? When wading knee-deep through the magnitude of antiquity it is easy to allow personal feelings, traumatic experiences or modern culture to transfer from our psyche to the page in front of us.

Indeed, this relatability is of the reasons Classics has such an enduring charm and electricity, for both a child such as Peralta, in a small library on the top floor of a homeless shelter in New York, and Mary Beard, knee-deep in the Shrewsbury mud on an archaeological dig. Both of them came from vastly different racial, geographical and socioeconomic backgrounds, yet both of them were compelled by classical study, even before they learnt a single principle part.

However, modern criticisms of the classical world or its art risk leaning too far into this sense of familiarity, establishing the reader's ideas as essential principles of world history, rather than modern inventions.

For a society still in the process of deciding what it will and won't accept, the tendency to label past behaviours as 'good' or 'bad' is what encourages stagnation, as the past is expected simultaneously to contain both the same transhistorical realities as the present (whether on race, gender, or inequality) and to stand in often idealised contrast to the modern world. In other words, in the effort to find analogues between the past and the present, the lines between the two are at risk of being blurred or, at worst, eradicated. Mary Beard famously stated that "although Classics may become politicised, it doesn't have a politics." While on one level this may seem avoidant, a refusal to commit to any one reading of the past and as such a refusal to lend support to classicists such as Peralta, it is, on another level, arguably a more holistic approach to a subject that has been lent too much societal power. The Classics, Beard would argue, can act as a vehicle for both supposedly 'good' and 'bad' messaging, a view which makes claims that 'the whole ship is rotten' and that Classics is somehow unsalvageable, seem unlikely, and indicative of a fundamental misunderstanding of what the past is.

If the Classics are still to inspire the same fascination and devotion in future students, the past must be engaged with without expectations of morality. Attempts to both define and defend the past must be cast off, permitting individual interpretation and subsequent self-actualisation to occur as many times over as is needed, since each student and scholar will be touched by antiquity differently. For if the Classics engage with what it means to be human, in all its pain and cruelty and inequity, perhaps scholars must fight the urge to shield their eyes from the glare of this reflection. Perhaps discomfort is unavoidable. Perhaps the continued vitality of the classical discipline requires not an abandonment of its chequered history, but an abandonment of human arrogance.

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The Future of Medicine in an Age of Institutions

CHIARA, YEAR 11

In past decades, medicine has progressed exponentially, with discoveries such as fMRIs, gene therapy and monoclonal antibodies dramatically improving the lives and treatment of patients. The far reach of these projects highlights the incredible variety that exists within medical research – a variety that has called on thousands of specialists and their skillsets. To give structure to this varied landscape, research institutes have formed around disciplines, from the UK's Dementia Research Institute (DRI) to the USA's National Cancer Institute (NCI). These institutions bolster medical research; they impose ethical standards and maintain trial protocols, as well as providing grants. However, their size leaves them vulnerable to political forces, and their extreme specialisation can result in fixation. Are these institutions therefore restricting progress as they become more prominent, and the value of independent research increasingly overlooked?

The fears of institutions can strangle progress, demonstrated when concerns from the NCI almost prevented the development of combination chemotherapy. In 1961, Emil Frei and Emil Freireich presented their preliminary plan to treat childhood leukaemia with a four-drug combination chemotherapy (called VAMP) at an NCI meeting on blood cancers. Whereas previous chemotherapy drugs – already referred to as "poisons of the month" by NCI staff – were usually given in isolation (or at most in triples), Frei and Freireich proposed giving four highly toxic drugs to children simultaneously. The NCI was outraged and refused to fund VAMP, branding Frei and Freireich insane, incompetent and cruel. Frei eventually wrangled a compromise with the NCI; research into VAMP would proceed, but would be separate from the ALGB (the research group ostensibly responsible for studying chemotherapy at the NCI). VAMP ended up proving the first systematic cure of cancer using drugs: combination chemotherapy is now standard for the treatment of many cancers.

The NCI's hesitancy was warranted: had a child died in the trial, the NCI – a federal institute – would have been accused of experimenting on children, and likely closed down. But, had the NCI prevented the trial, thousands more children would have died of leukaemia. The greater levels of public scrutiny large instructions face build fear in their administrators, confining progress, as the bold steps needed to progress research – bold steps that either lead to spectacular failures, or miraculous discoveries – can no longer be taken. Frei and Freireich were sure of their data before commencing their trial and should therefore have been allowed to proceed with it. Scientific freedom is key to scientific progress, and fears about institutions should not curtail it.

Institutions can suffer not only from fear, but also from fixation. In the 1970s, the NCI became caught in an increasingly manic search for cancer cures, whilst entirely neglecting preventative treatments – until 1990, only 20% of the institute's grants focused on prevention research. Now, prevention is recognised as the most cost-effective and sustainable way of decreasing cancer mortality.

Moreover, institutions can become deeply permeated by the status quo, and hence unable to challenge it. When Ernest Wynder (the eventual co-author of the first large-scale study concluding that smoking caused cancer) first sought to study the link between cigarettes and cancer, he was told by his medical school that the effort would be "futile". When he then tried to approach the surgeon general's office, the rebuff was even harsher – Wynder was told that "there exists no reason why experimental work should be conducted along this line" and that his study would be unable to prove anything. Smoking had become so normalised within the US that major institutions could not conceptualise it being a problem, and hence refused to fund research into it. Wyndler did eventually succeed, but had he not, the major carcinogenic effects of tobacco would not have been recognised until many years – and many deaths – later.

The 'status quos' that permeate institutions can come from not only wider society but also from the doctrine of disciplines themselves. In the 20th century, the standard treatment for breast cancer was an operation called the radical mastectomy – an operation in which not only the breast was removed, but also its underlying chest muscle and lymph nodes of the axilla. Throughout the 1950s and 1960s, practice of the radical mastectomy became more and more extreme, moving into the

superradical and ultraradical mastectomy, which could go as far as to remove the clavicle. This occurred despite a lack of evidence correlating increased surgery with increased success. Surgeons, enshrined in the radical dogma, became obsessed with an ineffectual treatment that left women permanently disfigured for life. This unquestioning outset was largely the result of an echo chamber effect within the field: as individuals surrounded themselves with other individuals carrying out radical surgery, they became further convinced that it was the only way. As institutions grow larger, bringing even more like-minded individuals together, these echo chambers become even more powerful, as well as the institutions' ability to silence challenges to their doctrines. In 1967, a man named Bernard Fisher tried to disprove the efficacy of the radical surgery as compared to the simple mastectomy, but experienced a vicious opposition. American surgeons put up constant barriers to patient recruitment, to the point that Canadian surgeons and patients had to be recruited to finish the study, and the study barely made it to publication, taking ten years to gather the necessary data. But when it was finally published, its results were shocking; it found that there was no difference in effectiveness between the simple and radical mastectomy. The story of the radical mastectomy highlights how large organisations can encourage extreme dogma within them, and then act to dissuade its disproval. This should be taken as a lesson in the dangers of allowing institutions to dominate medical fields.The story of the radical mastectomy highlights how large organisations can encourage extreme dogma within them, and then act to dissuade its disproval. This should be taken as a lesson in the dangers of allowing institutions to dominate medical fields.

Scientific freedom is key to questioning the accepted truths of large-scale organisations and allowing research free from political constraints. So how will medicine avoid the pitfalls of institutions? The obvious truth is that institutions cannot be abolished; they are the basis of much of the prestige, faith and trust in the discipline of medicine. However, they must be careful not to dominate fields to the point of edging out independence. In addition, they should embrace interdisciplinary approaches, to avoid becoming islands of isolation in which doctrine thrives unchecked. Ultimately, the role of institutions should be to bolster research – not barricade it.

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Future

CLARA, LOWER SIXTH

On 23rd March 2001, an unlikely champion was born in an allotment in Cefn Fforest in Wales. The foal's training was paid for by a group of 23 people, which is where his name, Dream Alliance, came from. He went on to become a racing star, winning the Perth Gold Cup in 2007. But a year later, at a preparatory race for the Grand National, the horse in front of him knocked an obstacle and Dream stumbled, slicing one of his front tendons with his hind hoof. Most horses with a severed tendon would have been euthanised on course, but Dream's team weren't ready to give up on him. Instead, they paid £20,000 for Professor Roger Smith to perform a new stem cell treatment on the damaged leg. Smith extracted stem cells from Dream's sternum and purified and multiplied them in a laboratory. He then executed a keyhole surgery, implanting the stem cells into the leg. The process of repair could work two ways: either the stem cells would turn into new tendon cells, or they would encourage the cells around them to make new, healthy cells. Either way, it worked, and Dream made a miraculous recovery. This was greatly consequential, as although Smith had treated around 500 equine tendon injuries with stem cells before Dream, performing the process on Dream publicised it hugely and many people were in awe of this relatively new method.

But how does this treatment work? In short, stem cells are undifferentiated cells – they have the potential to become any type of cell. There are three main types of stem cell: totipotent stem cells, which can become any type of specialised cell; pluripotent stem cells that can become a variety of cells but cannot form a whole organism; and multipotent stem cells, which can only differentiate into cells that are part of a specific type of tissue. The stem cells taken from Dream's sternum were multipotent mesenchymal stem cells. Mesenchymal stem cells are found in the umbilical cord, bone marrow, and adipose tissue and can differentiate into bone, muscle, tendon and cartilage cells.

Dream's treatment resulted in a rise in interest in equine stem cell therapies. The treatment of tendon injuries with stem cells halved the re-injury rate due to reduced scarring around the damaged area. The use of stem cells meant that there was much less scarring, which therefore meant that the tendon retained most of its pre-injury elasticity, as scar tissue is very brittle. The success of equine stem cell therapies got scientists interested in using this treatment on humans. In 2014, a small study was done to measure the effectiveness of treating chronic Achilles tendonitis with stem cells. The results were positive and Achilles tendonitis can now be treated with the patient's own stem cells, although this treatment is not yet widespread due to its cost and the other treatment options available.

The amazing thing about this is that the treatment of racehorses paved the way for the treatment of humans. In this way, the horses treated were a natural disease model, allowing scientists to mimic the treatments used on horses on humans, with a similar result. This begs the question: can other animals with other conditions also be used as disease models for humans? Well, firstly, the animals must naturally have a condition that occurs in humans. For example, cats can have hypertrophic cardiomyopathy, a condition where, in the heart, the wall of the left ventricle thickens and stiffens, affecting the way the heart pumps. Humans can also have this condition and so there is potential for cats to be used as a disease model. Dogs can experience a neurological condition similar to Parkinson's in humans, so this is another example of where an animal could be used as a disease model. In fact, there are already attempts to treat Parkinson's

with stem cells, as the current drugs with which it is treated have severe side effects.

Parkinson's disease is a neurological condition caused by a loss of nerve cells in a part of the brain called the substantia nigra, which leads to a loss of dopamine in the striatum of the brain. This causes involuntary shaking and slow movement. The current treatment is focused on controlling symptoms using dopaminergic drugs, which, while they improve symptoms to do with motor skills, have adverse affects because of their non-targeted and non-physiological delivery of dopamine to the brain. The idea behind using stem cells to treat Parkinson's disease is that an undifferentiated cell can be made into a dopaminergic neuron, which can be grafted into the brain. The most promising type of stem cells for this are embryonic stem cells and induced pluripotent stem cells. In the early twentieth century, embryonic stem cells were directed into becoming dopaminergic neurons and were transplanted into rodents, where they survived and produced some motor recovery. In this way, animals have already been helpful in research into stem cell treatments for Parkinson's, and it is possible that dogs could help us in the future, as they can suffer from a condition similar to Parkinson's.

In using animals as disease models, we must consider ethical and moral issues. Animals must naturally have a condition that also occurs in humans, as it is unethical to give an animal a disease just to test a treatment. There must also be vigorous testing done of any treatments tried on any animals, so that the treatments are safe and will not harm the animals.

To conclude, using animals as natural disease models has been and could be incredibly useful. In the case of Dream Alliance, his stem cell treatment greatly publicised the method and got people interested in using it on humans to treat chronic tendon issues. Although this treatment is not yet widespread due to it being time-consuming and expensive, it can greatly increase someone's quality of life.

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When Literature Alters the Future: Chernyshevsky's *What Is to Be Done?*, the Russian Revolution, and the 2008 Financial Crisis

ELEANOR, YEAR 11

The most influential novel of the nineteenth and twentieth centuries is one you've probably never heard of, but its immense power made life curiously imitate art and showed how literature has the incredible power to alter the future for billions. The novel in question is What Is to Be Done? by Nikolai Chernyshevsky, an 1863 utopian novel which, although mocked by his fellow writers, became an operating manual for revolutionaries, beginning with his radical contemporaries and ending with Vladimir Lenin and the Russian Revolution in 1917.

In What Is to Be Done?, Chernyshevsky argued for a twin ideology called 'rational egoism', the belief that rational action always maximises self-interest and that, when it became universal, it would result in happiness, and harmonious political, social, and economic conditions: a perfect utopia. It tells the story of Vera Rozalsky, a young woman living with her parents in St Petersburg in the 1850s. Vera's mother wants to marry her off to an army officer, which Vera rejects, and is instead saved by a young medical student named Dmitry Lopukhov, whom she marries, and with whom she frequently discusses socialism. The two move to their own apartment, but maintain strict rules to guarantee both their privacy and freedom. Lopukhov is in love with Vera, but Vera does not reciprocate his feelings, instead falling for his best friend Alexander Kirsanov, another socialist. Lopukhov selflessly decides to remove himself from the situation by faking his suicide and relocating. To do this, he is assisted by an enigmatic hero named Rakhmetov, who brings the grieving Vera a note from Lopukhov, explaining the situation, allowing her to marry Kirsanov. In the end, Vera marries and studies medicine, and Lopukhov makes his fortune in America, with the two eventually reuniting and reconciling.

Most readers found the most impactful character in the novel to be Rakhmetov, whom Chernyshevsky presents as a hero, despite his more minor role. Chernyshevsky makes it clear that Rakhmetov is some kind of radical socialist, but nothing is made explicit, given his fear that the Tsar's censor would stop the book from being published and released. Rakhmetov sleeps on a bed of nails for no clear reason; he trains his body for what is implied to be future revolutionary fighting; and at one point, he even vanishes, promising to return in three years, when 'he would be able to do more'. Readers correctly interpreted Rakhmetov to be a model revolutionary, theorising that upon his return to Russia, he would lead an uprising to overthrow the regime, clearing the way for a utopia based on rational egoism. The book was not at all well received by his contemporaries, with poet Afanasy Fet saying that Chernyshevsky's 'totally helpless clumsiness of language' made 'reading […] the novel a difficult, almost unbearable task', and with Ivan Turgenev writing that 'I had never met an author whose figures stank […] Chernyshevsky unwittingly appears to me a naked and toothless old man who lisps like an infant'. Despite the novel's socialist content, the Tsar's censor allowed the novel to be published, arguing that the questionable writing style would damage the revolutionary cause.

However, the novel went on to have a greater social impact than anyone could have imagined; for decades after the novel's publication, to imitate Chernyshevsky's heroes, young men would enter into fictitious marriages with young women to free them from oppressive families, and these partnerships would follow the rules of living that Chernyshevsky set out in his novel, with private rooms for the husband and wife. What

Is to Be Done? also radicalised a generation of young people, with Nikolai Ishutin forming a revolutionary group the same year the novel was published, and his followers lived in imitation of Rakhmetov by devoting themselves to revolutionary activity and sleeping on the floor. Ishutin's cousin, Dmitry Karakozov, made an unsuccessful assassination attempt on the life of Tsar Alexander II, for which he was hanged; however, referencing the mysterious words about the return of Rakhmetov, the date for the assassination Ishutin and Karakozov chose was 4th April 1866, three years to the day after the publication of What Is to Be Done? Through the choice of this date, Karakozov was clearly attempting to become a living version of the fictional revolutionary Rakhmetov, making Chernyshevsky's work of fiction a reality.

In the early 1900s, Lenin reflected that he had read *What Is to Be Done?* five times after his brother was executed for plotting to assassinate the tsar, and that the book had 'entirely ploughed [him] under'. After those readings, Lenin emerged as a real-life Rakhmetov. In 1902, he named his first pamphlet What Is to Be Done? as a direct reference to Chernyshevsky's novel, and, like Rakhmetov, he trained and hardened himself to the suffering of others. Lenin Revolution, and continued to play the role of Rakhmetov even after that, when he became the dictator of the Soviet Union; Chernyshevsky's novel, although critically panned, had gone on to alter a generation and bring about the end of tsarist Russia.

Beyond Russia, the 'rational egoism' that Chernyshevsky championed in What Is to Be Done? continued to influence additional generations abroad. Alisa Rosenbaum, who later changed her name to Ayn Rand, grew up in Russia at a time when Chernyshevsky's ideas were omnipresent among the educated, and literary scholars have built a case for Chernyshevsky's influence on Rand. The idea of 'rational egoism' is very present in Rand's work, but unlike Chernyshevsky, she concluded that the utopia of rational egoists would not be socialism, but capitalism. Rand's work later influenced significant policymakers such as Alan Greenspan, whose policies whilst chair of the US Federal Reserve have been blamed for the 2008 financial crisis, and were driven by the philosophy of 'objectivism', a child of Chernyshevsky's 'rational egoism'. The novel's impact lies in the solutions it suggested for Russia's social problems, and the problems it identified in the first place. Its condemnation of the authoritarian nature of families and social and political relations deeply resonated with readers of What Is to Be Done?, and then provided a radical blueprint for how to tackle these issues. Whilst Chernyshevsky did not live to see the impact of his work, as he died in 1889, the story of What Is to Be Done? influenced the ideologies of a generation and showed how literature can shape the future, for better or worse.

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Predicting the Apocalypse

ELLA, LOWER SIXTH

Predicting the future of our planet is much easier than predicting the future of the universe. There are many things in the universe that could obliterate life on our small mud ball with almost depressing ease: black holes, a nearby supernova, a particularly high energy solar flare, gamma ray bursts, or any flying rock heading our way that just so happens to be big enough. In fact, we know with certainty that life on Earth will end in about 1.3 million years due to the Sun's natural evolution and resulting increase in luminosity, long before the end of our planet itself. It is easy to predict how our planet will end. Predicting the end of the universe is a much more complex assignment.

Countless theories exist regarding how the universe will end, and almost all are predicated on an unknown force called dark energy. This phenomenon, thought to comprise 68% of the universe, is responsible for driving the accelerating expansion of the universe and counteracting gravity. There are other conditions required for each potential fate, but dark energy is the central variable for most. The predominant three theories examined here will be the Big Crunch, the Big Freeze, and the Big Rip.

The Big Crunch was first theorised in 1992 by a Russian scientist named Alexander Friedmann, and would result if dark energy is decreasing and eventually decays to become negative. It is thought of as being a direct consequence of the Big Bang. In this theory, the expansion of the universe will reverse, and the universe will collapse in on itself, pulling together all matter to form one super dense state, similar to a black hole singularity and in poetic symmetry with the birth of the universe. The final moments of the universe would consist of a gargantuan fireball at a temperature of infinity, where neither time nor space remains. A continuation of this theory is the Big Bounce, where the Crunch is followed by the formation of a new universe in another Big Bang, in turn followed by another Big Crunch, and so on, in a cyclic universe. New theories are being debated by scientists, such as a "Big-Crunch-style event", perhaps due to fluctuations in dark energy, but the majority of evidence suggests this theory to be incorrect, especially the observation that the expansion of the universe is actually accelerating.

The Big Rip is the polar opposite of the Big Crunch and would arise in the event that dark energy is increasing, causing the expansion rate of the universe to increase and continue indefinitely. This would cause already-distant objects to accelerate away from us at faster rates, while the energy in empty space increases. Eventually, objects currently bound together by gravity – such as galaxies, solar systems, stars, planets and even atoms and quarks (the building blocks of atoms) – will be torn apart by dark energy. In the end, empty space will gain more and more energy until the fabric of space-time rips itself apart. According to Robert Caldwell, a theoretical physicist at Dartmouth College, the Big Rip would occur in approximately 22 billion years, and Earth would explode only around thirty minutes before the end of everything. A cheerful thought! However, scientific evidence suggests this to be an unlikely fate for our universe.

The final main theory is the Big Freeze, also known as Heat Death. This theory suggests that if dark energy is constant, the universe will expand forever and eventually evolve into a state where no energy is available for any processes to be sustained. This will occur as the universe expands at an ever-increasing speed and heat is dispersed as objects are pulled farther and farther away from one another. Stars will be pulled so far apart that they will lose access to raw materials necessary for star formation, such as hydrogen and helium clouds. Once the temperature reaches absolute zero (the lowest temperature possible by the laws of physics), the universe will be at thermodynamic equilibrium, causing all movement and processes to stop as a result of simply having no more energy, and the universe will reach a maximum state of entropy. The Big Freeze theory is derived from the ideas of Lord Kelvin's second law of thermodynamics. Due to this law, the mechanical motion of the universe will cease over time as it is converted into thermal energy, meaning that the universe will expand and cool until galaxies, solar systems, and planets are alone in a universe that will remain cold and dark forever. Over time, these objects will die out through various processes, such as the natural lifecycle of stars causing them to fade into black dwarfs or explode in spectacular supernovae, or Hawking radiation, which leads black holes

LUMINOSITY

to decay inexorably, albeit over immense periods of time. In the end, the universe will be cold, dark and lifeless for the rest of time.

So, what fate will the universe eventually meet? Our current understanding of the physics and the majority of the evidence suggests the Big Freeze as the most likely finale for our universe, meaning that the curtain will probably fall on a universe that is cold, dark and empty for all eternity. As dismal as this sounds, physics is never fully certain, and most of our current theories on the workings of the universe came about simply by proving all the other options wrong. Maybe one day we'll prove these theories wrong as well, just as humanity used to believe the Earth was flat and at the centre of existence, until Aristotle and Copernicus respectively disproved those beliefs. Regardless of whether our universe goes out with a rip, a crunch or a whisper, at least we know it started with a bang. And at least we got to exist long before we have to find out firsthand how it ends!

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To What Extent Is Our Future Determined by Fate?

GABRIELLA, YEAR 11

The question regarding the existence of a god and the afterlife, as well as the idea of fate, is one that has perplexed human civilisations for centuries. What is God? What occurs after death? Why is it that we have such an innate fear of the unknown that it has driven us to believe in omnipotent higher forces that perhaps threaten our own existence? Is our life, as sung by Natasha Bedingfield, 'Unwritten', or has our foreseeable future already been set by fate?

Throughout human history, we have built up an enormous bank of knowledge; the entire world has been defined by equations and facts, as people have searched to fulfil their natural curiosity and need to foresee the future. Through science, humans have defined every single chemical reaction and every molecular collision, accurately predicting every outcome. Surely, scientifically, every molecule is already involved in an inevitable chain of reactions that has been playing out since the universe began. Therefore, since everyone and everything is made of atoms, our future is already defined. However, over the course of the preceding two centuries, many scientists have disputed this theory. Albert Einstein supported the idea that we can precisely predict any moment in the future as long as we have enough information. Famously, he claimed that "god does not play dice", implying there is no randomness in the rules of the universe. Meanwhile, quantum physics and Schrödinger's wave equation suggest that there's an inherent uncertainty in the universe, meaning that outcomes are not predictable, as the position and momentum of a particle cannot both be known with precise accuracy. Stephen Hawking argued for the inevitable unpredictability and uncertainty of quantum physics, claiming (in response to Einstein) that "not only does God play dice, but he sometimes throws them where they cannot be seen". Overall, neither theory can be accepted for certain; however, in modern science, quantum physics has become more widely accepted, thus suggesting that our future is not already being played out.

Contrasting with this, many choose a more theistic approach to their worldview and perception of fate. The word "fate" is defined in the dictionary as 'the development of events outside a person's control, regarded as predetermined by a supernatural power'. However, through a range of individuals and religions, its meaning can be interpreted very differently. For example, the belief in karma is an integral value of the Buddhist faith. This idea suggests that if you behave immorally in life, you will be punished, while if behave morally, you will be rewarded. Therefore, fate is not arbitrarily predetermined; instead, it is thought to be influenced by the decisions you choose to make. Following on from this idea, some believe that one's romantic relationships also depend on fate. For example, a popular belief among many is the concept of soulmates – whether this refers to romantic or perhaps platonic love – and this follows the hypothesis that there is the perfect person out there for everyone. This theory originated in Ancient Greek philosophy, when Plato proposed that a human has four arms and four legs, two faces and a single soul. Consequently, as a punishment for humans' arrogance and undeserving sense of pride, Zeus split humans in half at birth, leading us to spend our lives searching for the other half of our soul (our soulmate). Aristotle also showed interest in this idea, describing how "love is composed of a single soul, inhabiting two bodies". Many people have adopted the view that finding your soulmate acts less as a punishment and more as a purpose, as we become enamoured with the beauty of love and human connection. Therefore, many believe one can "die of a broken heart", due to the intense need to reconnect one's soul.

A commonly referenced phenomenon is that, in the face of death, your entire life flashes in front of your eyes. But what comes next? For thousands of years, humans have theorised millions of different scenarios for a state of being after death, desperately searching for an answer that doesn't involve our world simply going black. In religion, the idea of an afterlife is often present. Is there a heaven and a hell? If so, how might one get into heaven (i.e., the Good Place)? Are the majority of us, much like protagonist Eleanor Shellstrop, going to end up in the Bad Place? In Christianity, the presence of a heaven and a hell is very significant, and it is essentially Christians' version of the Buddhist belief in karma: there is an acknowledgment of the existence of good and evil, which become divided upon death. Therefore, many Christians believe they should spend their lives being good natured and "spreading joy" in order to reach the ultimate destiny of going to heaven. Meanwhile, influential agnostic figures such as John Lennon, a quintessential icon of the hippie movement, ask us to "imagine there's no heaven […] no hell below us, above us only sky". This non-theistic approach was not exclusive to John Lennon; many individuals refute the existence of heaven or hell. Alternatively, the Buddhist faith follows the belief in reincarnation. Buddhists believe that our soul will continue to exist in a cycle until we reach the point of enlightenment, once we have become the best version of our being. Instead of hell, they believe that those whose souls are evil are destined to spend their lives as the lowest form of being, until they are able to display ethical, "good" traits.

Fundamentally, the debate surrounding the existence of fate and the extent to which it affects our lives remains complex and inconclusive. Throughout history, various religious, philosophical and scientific perspectives have been shared, offering a diverse range of interpretations and explanations. Perhaps the paradox of the idea of fate is the existence of free will: our consciousness and the ability to make decisions. Ultimately, there is no experiment that can prove or deny the existence of free will, and thus the validity of fate's true power in life will continue to be debated in the foreseeable future.

Survival of the Fittest: Evolutionary Game Theory and Predicting Strategic Behaviour

ISABELLA, LOWER SIXTH

Game theory is a branch of economics and mathematics which studies the outcome of interactions between multiple individuals in order to try and determine the best possible strategy, either for a single 'player' or the system as a whole. It is based on the idea of interdependence, meaning that the payoff for each player not only depends on their individual strategy, but the strategy of all the other players involved. For a game with a finite number of players and strategies, at least one 'Nash equilibrium' can be found, which is when a set of strategies is played where each player, with the knowledge of all the potential strategies of the other players, does not wish to deviate from their own, as there is no profitable alternative.

Originally developed to be applied to an economic setting, applications for game theory have since been found in many other fields, including biology, giving rise to what is known as evolutionary game theory, which was first introduced by John Maynard and George Smith in 1973. Evolutionary game theory is a means of predicting the distribution of individual behaviours in a biological system as these behaviours interact, and how this develops in future generations as the individuals undergo evolution by natural selection. Unlike traditional game theory, however, in evolutionary game theory the individuals do not often choose their own strategies out of deliberation, but instead are instilled with a particular set of strategies, meaning that the strategies themselves become the players. Therefore, one strategy is more successful than the other if it is more likely to leave more copies of itself in the next generation, where the game will then be repeated. On the other hand, similar to traditional game theory, a form of equilibrium can be found, called an Evolutionary Stable Strategy (ESS). A biological system is at an ESS if no individual playing a particular strategy could improve their reproductive fitness by switching to another, and no 'mutant' playing a different strategy could establish itself within the population.

Based on these concepts, many scientists have used evolutionary game theory to provide a framework for explaining and predicting many different types of current and future animal behaviour, for instance how particular animals act in situations of conflict over resources. One way that this can be represented is by constructing a Hawks and Doves game. In this game, the Hawk represents an aggressive strategy involving escalated fighting until the individual adopting it or its opponent gives way, and the Dove represents a passive strategy, where the individual adopting it retreats before it is injured, if the opponent chooses to escalate. An analysis of the application and interaction of these strategies proves that, in this case, no individual strategy is dominant by itself, and instead an ESS is reached when a mixture of Hawk and Dove is employed.

Going forward, frameworks such as these are being applied to many more complicated areas of biology, as trying to understand more fully how certain biological systems develop could prove hugely beneficial for the future. For instance, the example of cancer can be used, where cancer cells represent the players, their inheritable traits the strategies and their survival and proliferation their payoffs. This means that the cancer is modelled as a sort of evolutionary competition between different cells that aim to optimise their own proliferation through the means of their strategies and interactions. In this way, many scientists and researchers have developed suggested evolutionary therapies that seek to both anticipate and control the evolution of treatment resistance. This could therefore be hugely beneficial, as it could potentially increase patient survival rates and decrease the drug toxicity used in certain treatments. However, as the evolution of biological systems such as cancer is so complex and often unique to the individual, like many mathematical models, evolutionary game theory can often seem to be too generalised and simplistic. However, it does provide a promising starting point that can be utilised and expanded, along with other areas of research, in order to become beneficial.

Coincidentally, by taking game theory away from its economic and social contexts and applying it successfully to a purely biological one, the subsequent development of evolutionary game theory has provided a theory which is now found to be very useful when applied back into the fields of economic behaviour, social science, computer science and even philosophy. For example, new developments are being made in the field of artificial intelligence, as, due to its rapidly increasing presence in our lives, interactions between different artificial intelligences will increasingly become more common. For example, a potential future of self-driving cars would lead to many of these interacting on the roads on a day-to-day basis. The developments of interactions such as these can therefore be analysed using evolutionary game theory to try to minimise risk, increase convenience and further develop the technology.

Therefore, evolutionary game theory and the concepts that accompany it have a wide range of multidisciplinary uses that will continue to develop as more research is conducted and, may even expand our insight into the future developments of not only the world that surrounds us, but how we behave and interact with it and each other.

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Can Progress Be Made in Philosophy, and, if so, How?

JESSICA, YEAR 11

There are no 'discoveries' in philosophy – at least, not in the way that we typically understand them. Questions are rarely, if ever, met with definitive answers; despite thorough inquiry and scrutiny, the perplexity of the world's mysteries endures. After all, when some of the most influential and enlightening philosophers, including the likes of Plato and Aristotle, seemed to live eons ago, it is easy to assume that 'improvements' in our understanding are scarce to be found. Thus, it is often suggested that there is no 'future' of philosophy – it is, forever and always, now. So, is philosophical progress truly impossible? Or is there more to it than meets the eye?

To answer these questions, one must first begin to understand the nature of philosophy and its function. Philosophy is divided into several subcategories, the most notable of which are metaphysics (the study of reality), epistemology (the study of knowledge), ethics (moral philosophy), and logic (the study of reasoning). Philosophy, literally meaning 'love of wisdom', is an endeavour centered around the cultivation of knowledge and understanding. This is not unlike the fields of science – in the past, science was considered philosophy, before we were able to prove certain information empirically. In the Middle Ages, questions about stars and planets were just as unknowable as the philosophical questions that still enthrall us today, leading to the classification of astronomy as a philosophical discipline. However, when observation and experimentation provided the answers that we were seeking, this classification was altered. Scientists were originally known as 'natural philosophers' – the word 'scientist' was not invented until 1833. This all suggests that the true questions of philosophy are inherently unknowable; if the questions can be definitively answered, then it is not philosophy at all.

But is solving problems the only true mark of progress? 'Progress' in itself has a thousand different connotations – so which should be applied to philosophy, in this context? Based on the purpose of philosophy as previously outlined, the main question we appear to be asking when analysing the concept of philosophical progress is: has philosophy gotten closer to the truth? To answer this, one can look at philosophical disputes where one philosopher seems to have been proven incorrect. For example, a fundamental question in epistemology is: what does it take to know something? Plato proposed that knowledge can be analysed as justified true belief, meaning that a person can only know something is true if they believe it to be true, and if they are justified in believing it to be true. While this assertion was never without criticism, including from Plato himself in his dialogue Theaetetus, in 1963, Edmund Gettier appeared to definitively refute this theory by providing two cases of justified true beliefs that are difficult, nay impossible, to consider knowledge. These cases, known as Gettier Problems, could be said to have revitalised the effort to define knowledge, something that continues to this day. And while now science and philosophy are recognised as distinct from one another, scientific advancement has also enabled what could be deemed philosophical progress. For example, Leibniz's Doctrine of Innate Ideas (stemming from Plato's Theory of Recollection), which suggests that certain ideas are 'innate' within us from birth and must be rediscovered throughout life, can be somewhat undermined by progressions in neuroscience, which proves that our minds develop through interactions with our surroundings, making it seemingly impossible for the brain to hold the capacity for a lifetime's worth of knowledge from birth. Thus, from these two cases, it could be said that philosophical inquiry has brought us closer to the truth, at least when accompanied by science, as it has enabled us to abandon seemingly false claims in search of superior explanations. However, can we still call this progress if no answer was definitively found in either situation, and likely never will be?

There is a secondary question underlying the notion of progress in philosophy: how far has philosophy benefitted the lives of not only the practitioners but also of the public who experience the influence of new ideas in everyday life? While the pursuit of knowledge may be the most obvious and ascertainable purpose of philosophical inquiry, for what reason do we attain knowledge other than to benefit ourselves and society? This is particularly significant in the context of ethics, where values such as freedom, democracy, and equality, though not universally celebrated, have been proposed, developed, and implemented, initiated by philosophers. Some ideas of Aristotle bear a strong resemblance to 'modern values'. For example, he wrote that 'men […] cause revolutions when they are not allowed to share honours and if they are unjustly or insolently treated', leading to his belief that peace can only be maintained when all citizens are involved in the political system. While not all of Aristotle's propositions appear so golden in a modern light, his early arguments for equality and justice could be said to have helped pave the way for our current societies, as his early works allowed newer philosophers to expand on what he set out.

Perhaps it is unlikely that anyone will ever answer the questions of 'what is the meaning of life?', 'is my experience real?', or 'do we have free will?' To some, this will mean that philosophy has no 'future': the field will not improve, make discoveries, or give the answers that the inquisitive mind craves. But perhaps also, that is not exactly the purpose of our questioning. In the words of Bertrand Russell, '[p]hilosophy, though unable to tell us with certainty what is the true answer to the doubts which it raises, is able to suggest many possibilities which enlarge our thoughts and free them from the tyranny of custom.' The 'progress' that stems from philosophy is within us; by engaging in the field, we can develop reasoning, logic, knowledge (whatever that may mean), and curiosity. This 'mental progress' proves that there is in fact a 'future' of philosophy – it will continue to enlighten minds, shed light on worldly wonders, and foster our collective drive towards understanding.

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The Delphic Oracle's Significance in Ancient Greece

KATIE, LOWER SIXTH

The peaceful town of Delphi, situated on the rich green slopes of Mount Parnassus in Greece, is quiet today; the wind rustles the fir trees and whistles through the scattered ruins of ancient monuments. However, Delphi was once home to the most prestigious oracle of the Mediterranean world: the Pythia, who supposedly spoke the god Apollo's prophecies. People from all over Greece, and sometimes even further afield, would make a long and challenging pilgrimage to consult the priestess and receive a prophecy on topics ranging from battle strategy to marriage. The Pythia's response was usually adhered to without question, and thus it became a hugely powerful entity that contributed to the development of Western civilisation.

"The Pythia's response was usually adhered to without question, and thus it became a hugely powerful entity that contributed to the development of Western civilisation."

Most Greeks believed that Delphi had been a religiously significant place forever. According to mythology, Zeus simultaneously released an eagle from either end of the world in an attempt to find the centre of the Earth, and the eagles eventually crossed paths above Delphi, thus signifying that the site was the navel (ὀμφαλος) of the world. Zeus marked this spot with a sacred marble stone, known as the Omphalos of Delphi, which was symbolically decorated with two gilded eagles. Modern-day excavations have led to its rediscovery near where the Pythia likely would have been situated in the sanctuary. Ancient Greeks believed that Delphi was originally inhabited by the goddess Gaia, mother of the gods, and that this prophetic stone was protected by her serpent-dragon son, the Python. However, Apollo later succeeded Gaia as an infant and founded his own oracle there, naming his priestess, the Pythia, after the Python. Some literary sources suggest that this succession was peaceful, whereas others describe Apollo slaying the Python and subsequently repenting for eight years. A few make no mention of other deities in Delphi, perhaps to present Apollo as the most important god associated with Delphi. In the Homeric Hymn to Apollo, the god addresses mortals: "Here I intend to build a beautiful temple to be an oracle for humans, who will always bring perfect hecatombs here to me […] in order to request oracles: to all of them therefore I would deliver infallible counsel prophesying in a rich temple." This reflects the reciprocal connection between visitors and Delphi, as those wanting to receive an oracle had to bring offerings for Apollo in return.

Putting the mythological narrative to one side, evidence from archaeological digs in Delphi suggests that it was occupied by Mycenaean Greeks from 1600 BC onwards, until a major rock fall around 1400 BC brought the settlement to an end. Following the Dark Ages of 1150-800 BC, excavators believe that Delphi became a powerful establishment, due to the large volume of pottery and bronze dated back to the Archaic period that was discovered at the site as dedications to Apollo. In addition to the Temple of Apollo being a site of prophecy, the god was worshipped for healing, and the Pythian Games, only second in importance to the Olympics, also took place every four years in Delphi to commemorate Apollo's victory over the Python.

Although many visitors travelled to Delphi to participate in athletic competitions as part of the Pythian Games, most went in an attempt to consult the Pythia. For ordinary people, this would mean a journey through the mountains before climbing the Sacred Way, which led to the temple, and offering sacrificial animals and objects to the god. A long queue would often form, as the Pythia only prophesied over nine months of the year, excluding the winter months, and even only one day a month during the summer. Wealthy and affluent nobles were able to pay large sums of money to be prioritised before the common folk and skip to the front of the queue. Once the Pythia deemed an offering to be sufficient, she would cleanse herself with water from the Kastalian Spring and then sit on a tripod in the adyton, an underground chamber in the Temple of Apollo. Pilgrims would ask their questions to the Prophetai, priests of Apollo, who would subsequently relay them to the Pythia. Literary sources describe the Pythia as inhaling vapours from a crack in the floor, falling into a trance and murmuring Apollo's words incomprehensibly. Modern geological analysis of the area has concluded that these gases were likely to be hydrocarbons emitted from fault zones in the rock, which would have psychoactive effects on whoever breathed them in, perhaps explaining the Pythia's ravings. The priests, standing on the floor above, would hear her voice through the floor and translate it into a neat, yet often ambiguous, hexameter verse for the questioner. By leaving lots of room for interpretation, the Pythia was rarely denounced as wrong – instead, the person's analysis of the prophecy was often blamed if things did not occur as expected, meaning the Pythia's reputation as an accurate oracle was not tarnished.

It was partly for this reason that the Delphic oracle was regarded as the most reliable in the Panhellenic world, but Delphi's geographical location likely also contributed to its fame. It was situated in Phocis, an ancient region separate from the powerful Greek city-states which enabled the oracle to maintain neutrality, and it further benefitted from increased levels of trade around the 8th Century BC. As well as this, the generous offerings that individuals made before consulting the oracle added to the site's wealth. Despite Delphi being repeatedly ravaged by fires and wars, it was always rebuilt with the help of donations from rich kings and generals, which allowed it to prosper until the rise of Christianity, before it was finally abandoned in the 4th Century AD. However, Delphi maintains a sacred atmosphere even in the modern day; standing beside the remaining columns of the Temple of Apollo, it is easy to understand why so many people made the pilgrimage to the sanctuary, and why they trusted in the oracle's prediction of the future.

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Back to the Future

LOIS, LOWER SIXTH

The song 'End Game' by Taylor Swift is a trio performance with Ed Sheeran and a rapper called Future, both of whom wrote the music and lyrics with her. The words feature a reference to a party Swift hosted when Sheeran met an old school friend whom he hadn't seen for years. Their friendship was rekindled and they ultimately married. Even someone with a name like Future might have struggled to predict that turn of events.

This is a case of a present moment shaping the future. The past, present, and future are often considered in isolation, as phases we move through, and which are clearly defined. Yet, more often than not, they are not silos. There is a continuity passing from one into the next. You may, to a greater degree, consider the past (a foreign country, where they do things differently, to paraphrase a famous line by E.J. Hartley) as isolated from the present. In fact, the past often defines the present. As for the future, it is harder still to differentiate between that and the present. When exactly does one end and the other begin?

Then again, we can, even without a film so named, go back to the future. There is the circle of life. Or, more precisely, there is life's cyclical nature. Take fashion: trends in womenswear are reckoned to have a ten-year loop. For menswear, the cycle is twice as long. In both, the present is just about waiting for the past to become the future again. And on we go, over and over and over again.

The future, present, and past can be embodied in people as well as clothes. As Leader of the Opposition in 2005, David Cameron taunted the Prime Minister of eight years, Tony Blair, with the words that "he was the future once". Then Blair's successor, Gordon Brown, taunted Cameron five years later with the suggestion that he never spoke any more of the future and indeed he, himself, used to be the future once. Cameron ultimately completed the trilogy when, after resigning following the EU referendum in 2016 and signing off from the House of Commons despatch box for the last time, he admitted that he was the future once. Vindication for Brown, perhaps, albeit after losing office in 2010. A wry smile from Blair, to be sure, a decade on.

Politicians are more comfortable in the future and in thinking of what might be yet to come. Blair's election anthem was perfect for this: 'Things Can Only Get Better', it went (without saying exactly how much better…).

"Just because you make a good plan, it doesn't mean that's what's gonna happen…."

In suggesting the good things that are ahead, politicians almost always avoid using numbers. That is because they don't want the present to be one in which they are directly accountable. In making their predictions, they draw heavily on the past, usually of their opponents. They suggest that the future will be an improvement, based on present thinking, just without giving precise details of exactly what that future holds over and above a general feeling of wellbeing. Rishi Sunak, the current Prime Minister, has left himself a hostage to fortune by promising that the economy will grow and that he will "stop the boats". In the future, his success, or otherwise, will be easily measured. And even if he is proved right, such a claim will be disputed. His pledge to halve inflation may have been achieved. At the same time, respected economists suggested that, in this instance, to predict inflation would fall was akin to betting that the sun would rise in the morning and set in the evening.

Predicting the future happens in the present and draws on the past. We are confident that the sun will rise tomorrow because it did so earlier today and yesterday (as well as – you get the picture – the day before, and the one before that, and so on). Of course, one day the sun won't rise. You might even say that every day it's 50-50. The weather forecast of rain, which is given as a percentage chance, is based on how conditions today reflect the past. In other words, a day like one in the past, when there was no rain, also has no chance of rain, echoing the philosophy of David Hume. Except, of course, the future is not the past. The future might be different. When it is different, that is banked as data for the next time a prediction of what the weather will be is pending. The past and the future can be related, but they are sometimes just cousins, rather than close family.

Sleep well tonight. The sun will rise. Tomorrow will be another day. There is much ahead to relish and anticipate. Equally, live now, for the moment. Be present. Enjoy life like there is no tomorrow. The past is the past. Be in the moment. But it is best to refer back to Taylor Swift: "Just because you make a good plan, it doesn't mean that's what's gonna happen…"

CONTINUITY

Genetically Modified Crops and Food Insecurity: Hope for the Future?

MAGGIE, LOWER SIXTH

Food insecurity, defined by the Food and Agriculture Organisation (FAO) as a lack of 'regular access to enough safe and nutritious food for normal growth and development and an active and healthy life', is a prevalent and pervasive issue that affects people both in the UK and on an international scale. According to Action Against Hunger, an estimated 49 million people are at risk from famine or severe hunger crises across the globe, while a total of 3 billion people are unable to afford a healthy and nutritious diet (and therefore experience food insecurity, by the FAO definition). Unfortunately, food insecurity is likely to only worsen in the future, so it is imperative that we take action to improve this situation.

The negative global impacts of food insecurity extend far beyond the more evident and direct consequences, such as malnutrition. For example, food insecurity exacerbates poverty and inequality, as those without enough to eat are more likely to suffer from chronic illnesses and miss out on education and job opportunities, which perpetuates a vicious cycle in which poverty leads to food insecurity and vice versa. It can also have a destabilizing impact on regions and even entire nations, since widespread food insecurity can lead to social unrest, conflict over scarce resources, and political instability. Extreme food insecurity can even result in refugee crises or mass emigration, as people are forced to leave their homes in search of food.

Conflict and political instability are two of the main issues contributing to food insecurity, as they can often lead to food shortages because of disruptions to food access, the destruction of agricultural infrastructure, and the displacement of communities. This is evident in regions currently experiencing ongoing conflict, such as Syria, Myanmar, and Gaza, and in fact, according to the United Nation's World Food Program (WFP), around 60% of people experiencing extreme food insecurity 'live in countries affected by conflict and poverty'. Political instability, corruption, and inefficient government can also result in food aid being blocked, diverted, or poorly organised, in the event of conflict or natural catastrophes, which further exacerbate the issue of food insecurity.

However, the most significant driver of food insecurity is arguably climate change, as extreme weather events such as droughts, cyclones, floods, and heatwaves are becoming more frequent and severe, disrupting agricultural production, reducing crop yields, and shortening growing seasons. This leads to food shortages and price increases, and reduces overall food security, particularly for those who rely on subsistence agriculture for survival.

The Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report found that the emission of greenhouse gases has already warmed the planet by 1.1°C, and that the extent of global warming could even reach 1.5°C as soon as 2029. Over the next few years, the impact of the climate crisis on food insecurity will only worsen. Additionally, the agricultural industry itself is heavily contributing to the climate crisis, accounting for 30% of global greenhouse gas emissions, 70% of all freshwater withdrawal, and around 1.3 billion metric tons of food waste produced annually.

The future of food security can appear very bleak, as addressing these underlying causes will require an immense effort from governments, NGOs, and individual communities to ensure that adequate nutrition is a reality for everyone. However, one extremely promising potential solution is the possibility of using genetic modification to improve crop quality, increase nutritional content, and enhance resistance to disease, pests, and unsuitable conditions, thereby increasing agricultural yield and reducing food insecurity.

One key benefit of genetically modifying crops is the potential for increasing crop yield through the introduction of genes that enhance photosynthesis, nutrient uptake, or water use efficiency. This would allow farmers to produce more food per acre of land, thereby increasing food availability and reducing the prevalence of hunger and malnutrition. Although all genetically modified crops directly designed to maximise yield are still in the experimental or regulatory stage, many promising developments are being made. For example, the International Rice Research Institute (IRRI) is in the process of developing C4 rice, which has been modified to contain genes found in crops such as sugar cane and corn that allow the rice to express the same metabolic pathway and therefore photosynthesise more efficiently. Once C4 rice has passed through the regulatory phase of development, it has the potential to increase crop yield by up to 50% while simultaneously reducing the need for fertilizers and water.

Genetically modified crops can also improve crop quality by enhancing their nutritional content. A successful instance of this is golden rice, which is the first GM crop specifically created with the aim of combating malnutrition. Annually, around 3 million children experience eye damage as a result of vitamin A deficiency, which is largely due to a lack of β-carotene (the molecule necessary for its synthesis) in foods such as rice. Golden rice was developed to combat this, allowing rice to produce β-carotene by reconstructing its pathway for carotenoid biosynthesis. Subsequent studies have shown both that the body can effectively convert the β-carotene from the rice into vitamin A and that this is equally as effective as ingesting pure β-carotene and more effective than β-carotene provided from spinach. These results are hugely promising, as they suggest that golden rice could successfully be used to alleviate vitamin A deficiency on a global scale.

The field of genetic modification faces many barriers, including ensuring that the provision of these crops is cost-efficient and overcoming the prevalent stigma surrounding the safety, regulation, and ethical considerations of this field of research. However, overall, the use of genetically modified crops offers a promising approach to addressing global food insecurity and building a more resilient global agricultural system. Hopefully, a more sustainable future with food security for all can be achieved through continued research breakthroughs in the field and more widespread utilisation of genetically modified crops.

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Future of Personalised Medicine: Should We Look at the Disease the Person Has, or the Person the Disease Has?

MARIELLA, LOWER SIXTH

With the rapid development of medicine in recent decades, the traditional approach to medical treatment, in which we treat diseases generically, has increasingly been regarded with scrutiny. Hence, this outlook is gradually giving way to a more tailored, individualised system, in which personalised medicine is at the forefront of healthcare. This gives rise to a question often asked by those practising medicine: should we continue to focus primarily on the disease a person has, providing a disease-centric model of care, or should medicine's approach shift to understand an individual beyond their illness, consulting the ideas of personalised medicine by taking patients' genomes and lifestyles into account?

For centuries, the disease-centric model of treatment has been the standard of medical practice, involving categorising and treating illnesses based on their pathological characteristics and symptomatic expression, using a more 'one-size-fits-all' approach, rather than analysing each presentation of the disease in the context of an individual patient. This approach has, without doubt, led to remarkable advancements in disease diagnosis and treatment, enabling professionals to develop and prescribe remedies that largely address and combat specific diseases. From antibiotics to targeted cancer treatments such as chemotherapy, the disease-centric model has contributed to improving patient outcomes, proving undeniably vital in the initial development of medicines for a wide range of ailments.

However, the limitations of the disease-centric approach soon become apparent when considering the individuals' unavoidable variability. Two people may suffer from the same medical condition but would likely respond differently to identical treatment plans, due to factors such as their lifestyle, home and work environments, and genetic composition. This variance between individuals clearly explains why many are calling for medicine to take on a more patient-centric, personalised model of treatment, which considers the uniqueness of each patient in order to maximise the quality and effectiveness of their care.

The patient-centric perspective of personalised medicine emphasises the importance of understanding the person who is suffering from a disease. This approach takes into account an individual's genome, lifestyle choices, socioeconomic factors, and psychological well-being, allowing healthcare providers to tailor treatments to align not only with the patient's individual composition, but also their preferences, values, and circumstances. Patient-centric care acknowledges that individuals are more than the disease that they carry, as part of a more holistic approach that acknowledges individuality within healthcare. This often improves medical outcomes, due to more targeted treatments being prescribed whilst practitioners simultaneously make the patient feel as though they are being understood beyond their symptoms, which indisputably improves ultimate care satisfaction.

The field of pharmacogenomics has become integral for advancing medicine towards a more patient-centric future. The ability to analyse an individual's genome permits the identification of specific genetic variations that have been identified as affecting disease susceptibility, and the analysis of the likely effectiveness of available treatments. An example of this has clearly been demonstrated with the subtype of breast cancer linked to a gene that overexpresses 'human epidermal growth factor receptor 2' (HER2). Prior to genomic analysis, this type of breast cancer was associated with higher recurrence and increased mortality rates. However, when treated with a pharmaceutical drug called 'trastuzumab', which inhibits the HER2 protein's production, patients with this gene displayed improved outcomes, and those without HER2 overexpression showed no improvement in treatment outcomes. This treatment, one of many that would likely not have been understood or its use supported without personalised medicine, has enhanced care for many oncological patients, providing more people with hope for positive treatment outcomes than ever before, emphasising the importance of analysing the unique genetic landscapes that shape patients' individual responses to medications.

Moreover, patient-centric personalised medicine involves the use of technological innovations, such as wearable devices that collect instantaneous data on an individual's health status, providing professionals with a continuous stream of information from which they can monitor patients remotely and make timely and essential adjustments to treatment plans. Although expensive, integrating these new technological systems into ongoing health analysis further enhances the possibility of promptly displaying vast collections of data to review, identifying correlations between patients with shared genomic expressions to aid the tailoring of care for each patient.

However, in spite of the many clear advantages of patient-centric personalised medicine, concerns and challenges surrounding this field inhibit its progression. Ethical considerations, such as data privacy concerns regarding genomic screening and the fair distribution of resources for trialling advanced technologies between professionals, are a frequent source of controversy, on top of the strategic difficulties of transitioning from a disease-centric to a patient-centric model, which would require a large, global shift in both medical education and healthcare systems. This does not seem to be easily achievable as a ubiquitous model, especially when considering the wealth and social disparities between nations: not everywhere would be supportive or able to afford such a dramatic alteration to their manner of treatment.

Balancing the disease-centric and patient-centric perspectives in personalised medicine is likely the optimum solution when looking at the future practice of medicine. The disease-centric approach provides the foundations for understanding the underlying mechanisms of illnesses, which is crucial for developing generic therapies, whilst the patient-centric model acknowledges each individual's unique attributes, ensuring that treatment plans are not only effective but maximise patient satisfaction by considering their values and preferences too, so the synergy of these approaches logically seems to be what will produce the optimum standard of treatment, attuned to the diverse needs and natures of individuals.

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Will BRICS Pose a Threat to the West in the Future?

OLIVIA, LOWER SIXTH

In 2001, James O'Neill, a senior economist at Goldman Sachs, wrote that by 2050, Brazil, Russia, India and China (which he referred to as BRIC) would dominate the global economy. O'Neill could not possibly have imagined that these four powerhouses would listen to him and decide that forming an alliance sounded like a great idea. But, fast-forward five years, and that is exactly what happened. Formed in 2006 and originally only consisting of those four countries, BRIC was an informal trade bloc designed to promote growth in the member countries. In 2010, South Africa was incorporated into the group, which renamed itself to BRICS.

The aims of BRICS quickly expanded to focus not only on economic growth for the member states, but also on finding a way to counter the sphere of Western influence and economic power. They planned on doing this through a process known as de-dollarisation. This involves reducing the world's reliance on the dollar as its primary reserve currency, meaning that central banks would no longer hold the dollar, which would be used as a store of value and as a way for international trade to take place. By doing this, BRICS believed that they would be able to weaken the reliance on the dollar, making more countries turn away from the US and reducing Western economic influence. A large part of how they wanted to establish this shift was through the New Development Bank. This bank gives out loans to governments and individual projects in emerging economies to encourage them to move away from Western institutions, such as the IMF and World Bank, and become indebted to countries associated with BRICS.

While this bank has had some success, financing over $32.8 billion in emerging countries since it opened in 2016, this is far less than the $98.8 billion that was committed by the World Bank Group in 2021 alone. This highlights how limited BRICS has been thus far in weakening the dollar. Additionally, BRICS has not managed significantly to reduce the global reliance on the dollar. The majority of loans given out by the New Development Bank have been provided in dollars, with only a small proportion provided in renminbi. This suggests that, as the dollar is the preferred currency and the easiest means of carrying out international exchange, BRICS has been unable to significantly reduce the abundance of the dollar. This illustrates BRICS's lack of success so far in promoting their own self-interest by weakening the power of Western institutions and the dollar.

However, it would be misguided to ignore the potential that this bloc has to influence the global stage in the future. In January 2024, six new members were announced: Argentina, Iran, Egypt, Ethiopia, Saudi Arabia and the UAE. These countries could change BRICS's prospects. Firstly, the group may decide to pick a new name to reflect their new membership (BRICSAIEESU is probably not the way to go). The main reason that six new members joining poses a threat to the West is simply because of how large this organisation has now become. With the new members, their share of the global GDP has risen to 30% and their share of the global population has gone up to 46%. This illustrates the sheer amount of people and funds that are controlled by the members of this group and, therefore, how much power they could have to use against the West.

Additionally, the expansion of BRICS also means that they control many more natural resources. This can first be seen through their increasing control of oil and gas. By expanding BRICS, the organisation now controls around 42% of the global oil production, due to the growing number of OPEC countries that have become members. This means they have far more power to control the global production and distribution of oil, which could potentially wreak havoc for the West. Furthermore, the control of lithium, one of the key metals needed for the production of batteries that are used in electric vehicles and renewable energy sources, has also now been concentrated within BRICS. This is because Argentina, one of the newest members, is the third largest supplier of lithium in the world. The impact of this could be huge. If these countries, that are staunchly positioned against the West, are able to control a large amount of the global lithium supply, it could become challenging for the West to obtain sufficient resources in order to produce renewable energy, as well as to produce goods, including all types of electronics. Both the supply of lithium and the supply of oil being controlled by BRICS could bring about energy insecurity across the West. This would be deeply problematic.

However, the current state of BRICS means that this is unlikely to happen any time soon. The bloc is an informal alliance and they have not set any official trade agreements that would limit engagement with the West, beyond Western sanctions that already exist against a few of these countries. Although Russia and China have provided strong trading partners for many of the new members, many of these countries have only been able to grow and develop through their relationship with the West, both through trade and through their membership of institutions, such as the G20. The G20 has allowed for cooperation between countries across the globe, both developed and developing, in order to discuss issues surrounding economic growth, sustainable development, and international stability and security. This provides little incentive for new members of BRICS to distance themselves completely from some of the wealthiest nations that have strong and established relationships with these emerging economies. Countries such as South Africa, India and Egypt have strong ties with both the USA and Europe and are unlikely to cut them any time soon.

For now, the West seems safe from any threat from the BRICS bloc. However, the future is far less certain. With growing available loans from the New Development Bank and more emerging economies turning towards this bank and away from Western institutions, such as the World Bank and the IMF, as well as the expanding membership of BRICS, the West needs to be more aware that their sphere of influence may not be as dominant as they once believed.

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Pharmacogenomics: An Answer to Cancer?

RACHEL, LOWER SIXTH

Since the birth of chemotherapy in 1943, humans have waged a ruthless and relentless war against cancer on the biochemical battlefield. With technological advancements catalysing scientific breakthroughs, the past few decades have seen cancer therapies march forward at an unprecedented pace. And among these troops of viable treatments, a beacon of hope has set ablaze a new path to enemy territory, promising to revolutionise the fight against cancer: pharmacogenomics.

A branch of precision medicine, the term pharmacogenomics describes the study of how an individual's genetic makeup influences the way their body reacts to certain drugs. While there are a plethora of factors that can impact this response, researchers have recognised that up to 95% of these can be accounted for by genetics. Moreover, with the exponential focus on genomic-based medicine, pharmacogenomics has emerged as an innovative field seeking to develop and refine the prescription of tailored drugs to the individual. So, naturally, the question arises: how can this be applied to conquering cancer?

Traditionally, chemotherapy uses the cytotoxicity of drugs to target malignant tumours invading the body. Doctors will often meticulously select treatments for patients depending on the efficacy and toxicity disclosed in clinical trials, while acknowledging other factors, such as the patient's health. However, what many failed to conceive was that this "one size fits all" approach is arguably inefficacious due to the heterogeneity and complexity of the disease in question. Genetic mutations vary throughout different cancers, and even cells in the same tumour can face genetic alterations. Therefore, responses among patients can vary significantly. Furthermore, research has also demonstrated that genetic variants play a pivotal role in the effects of cancer treatments. Not only are these variants associated with different side effects, varying in severity, but they also influence the efficacy of the drug. Hence, it's in this manner that pharmacogenomics aims to metamorphose cancer therapy. Through the identification of genetic variations and cancer mutations, doctors can personalise drugs tailored for the individual, ensuring the best treatment is administered.

Over recent years, this approach has gradually been weaponised in various cancer therapies, a notable example being the regulation of fluoropyrimidine dosage. Fluoropyrimidines, a group of antimetabolite drugs, are commonly used to target solid tumours, which include gastrointestinal, colorectal, and breast cancers. While strikingly effective, the chemotherapy produces acute symptoms in patients. These include nausea, diarrhoea, and vomiting, with around 10–40% of patients suffering from life-threatening effects. In particular, research has established that individuals with variations of the dihydropyrimidine dehydrogenase (DPYD) gene are considerably more prone to such adverse effects. The gene is responsible for coding the enzyme that breaks down fluoropyrimidines, and consequently, its mutations can lead to a significant decrease in enzyme activity. This inhibits the body's drug metabolism, which inevitably results in worsened symptoms.

However, by incorporating pharmacogenomics, doctors can tailor this treatment to the individual's genetic profile. This is accomplished through the use of genetic testing to identify DPYD variants and, accordingly, reduce the dosage of the drugs to diminish their adverse effects. Moreover, studies have illustrated that this testing is staggeringly cost-effective for hospitals; for example, the average reduction in hospital costs was more than £20,000 for a cohort of 466 patients. The decrease in hospital admissions and critical care costs was 23% and 21%, respectively. Thus, as demonstrated distinctly, pharmacogenomics enables the perfect balance between minimising drug toxicity and maximising efficacy, a tightrope many cancer therapies still walk today.

Similarly, the conception of somatic genomic testing as a standard practice in chemotherapy has unlocked the potential for doctors to enhance and meticulously select the right treatment option for their patients. Somatic mutations are genetic variations that may occur in any population of cells or tissue, excluding the germline, throughout an individual's life. These happen either spontaneously or due to stress; however, they continue to be particularly relevant in oncology because of the possibility of them occurring within the cancerous cells of a tumour. This can not only influence the progression of the cancer but also the effect of chemotherapy; certain mutations can influence the response of the cells to different drugs.

An example of this is the alteration of the human multidrug resistance gene 1 (MDR1). Also known as the ABCB1 gene, this encodes the p-glycoprotein, a membrane drug-transporter responsible for removing foreign substances from the cell. Hence, this gene, when overexpressed in tumours, can result in the efflux of chemotherapeutics such as doxorubicin and paclitaxel, meaning that other pharmaceutical approaches must be taken. It is in this way that somatic testing in pharmacogenomics aims to shift the trajectory of chemotherapy for the individual. By identifying any mutations that can induce sensitisation or resistance to certain drugs, doctors will then be able accurately to ensure that the right treatment plan is chosen for their cancer patients.

On the other hand, while the clinical implementation of these pharmacogenomic approaches seems extremely favourable, there are many battles still to be faced. For instance, the intricacy of a patient's genetic profile poses a challenge for many healthcare professionals to integrate accurately into their treatment plans. The numerous genetic mutations that may occur and influence an individual's cancer can't all be detected, nor can they all be actionable. This presents healthcare professionals with many weighted and complex decisions regarding their patients' care.

Despite this, pharmacogenomics remains a breakthrough in cancer treatment. It symbolises a start to attacking cancer from a genetic and personalised perspective, guiding the use of the numerous therapies currently available. And with the field's ongoing research and developments, pharmacogenomics may very well provide an arsenal of personalised treatments to end the war against cancer.

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What Impacts Will Climate Change Have on the Future of Our Generation and Is It Too Late to Prevent the Climate Crisis?

SCARLETT, LOWER SIXTH

We are well aware that global temperatures are increasing due to human activities such as burning fossil fuels and that, unless much greater attempts to slow climate change are made very soon, they will likely continue to rise. Time is running out to prevent a sixth mass extinction and environmental catastrophe.

According to today's scientific knowledge, if you're younger than sixty, you have a good chance of witnessing the radical destabilisation of life on earth—massive crop failures, apocalyptic fires, imploding economies, epic flooding, hundreds of millions of refugees fleeing regions made uninhabitable by extreme heat or permanent drought. If you're under thirty, you're all but guaranteed to witness it. Scientists have been saying for years that more action needs to be taken to combat climate change, and that it is becoming too late to avert a climate catastrophe – if it isn't already, that is.

Back in 2015, limiting warming to 1.5°C was globally accepted as a goal; this was seen as realistically achievable and would ensure that the worst impacts of climate change could be avoided. However, nine years on, climate scientists say that the planet has already warmed by 1.1°C and limiting temperatures to 1.5°C is likely no longer possible. So, what does this mean for the future of our generation?

It remains true that without dramatic action in the next couple of decades, we are unlikely to keep global warming in this century below 1.5°C compared to pre-industrial temperatures. However, the more we overshoot this threshold, the more serious and widespread the negative impacts will be; as Greta Thunberg would say, it is indeed "never too late to do as much as we can." So what can we do, and what will we realistically be able to achieve?

Globally, the percentage of the population exposed to deadly heat stress is predicted to increase from the current 30% today to 48-76% by the end of the century, depending on future warming levels and location. It is a frightening but very possible reality that the planet could increase in temperature by more than 4°C by the year 2100, in which case, in some parts of South Asia, tropical sub-Saharan Africa and parts of Central and South America, the number of days with climatically stressful conditions for outdoor workers will increase by up to 250 workdays per year by the end of the century. This would cause negative consequences such as reduced food production and higher food prices. In Europe, the number of people at risk of heat stress will increase two- to three-fold, at 3°C global warming compared to warming levels of 1.5°C.

With ongoing global warming, today's children in South and Southeast Asia will witness increased losses in coastal settlements and infrastructure due to flooding caused by unavoidable sea level rises, with particularly severe losses in East Asian cities. By the middle of the century, more than a billion people living in low-lying coastal cities and settlements globally are projected to be at risk from coastal-specific climate hazards. Many of those will be forced to move to higher ground, which will increase competition for land and the probability of conflict and forced relocation.

It is predicted that by 2050, nearly 70% of the world's ever-growing population will be living in urban areas, many in unplanned or informal settlements. As a result, today's children and future generations are more likely to be exposed and vulnerable to climate change and related risks, such as flooding, heat stress, water scarcity, poverty, and hunger.

All of this sounds pretty, well, absolutely terrifying, for our generation, doesn't it? Therefore, you might be wondering, what can we do about it? The obvious solution, of course, is to cut carbon emissions, as carbon dioxide and other greenhouse gases are the main causes of global warming. Whilst climate change obviously cannot be stopped at this stage, it can be slowed. In order to avoid the worst consequences of climate change, we need to reach net zero carbon emissions by 2050, at the very latest. Net zero carbon emissions would mean that, on balance, no more carbon would be dumped into the atmosphere than is being taken out, so that carbon levels are not increasing overall. But how do we achieve net zero carbon emissions and is this a realistic possibility? Firstly, we would need a massive transformation in how we produce and consume electricity; newer, better transportation would be needed, as well as a complete halt to deforestation. Furthermore, we would need a completely climate-friendly agricultural system. The scale of such changes would require significant centralised policies to put a price on carbon; it would also require international cooperation. However, to achieve such a huge, global task, it seems unlikely that world leaders will come together in time.

Alternative methods to slow or reduce global warming have been proposed, known collectively as "climate engineering" or "geoengineering." Some geoengineering proposals involve cooling the Earth's surface by injecting reflective particles into the upper atmosphere to scatter and reflect sunlight back to space. Other proposals involve seeding the oceans with iron to stimulate large-scale phytoplankton blooms, thereby drawing carbon dioxide down and out of the atmosphere through photosynthesis. Such methods could work, in principle, but many climate scientists oppose undertaking geoengineering until they have a better understanding of the possible side effects. Additionally, there are unresolved legal and ethical issues surrounding geoengineering.

In conclusion, the future of the younger generation is going to be impacted much more significantly by climate change than that of any generation before us, and whilst some progress has been made, much more still needs to be done.

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Temporal Dimensions: The Interaction Between the Past, the Present, and the Future

SOPHIA, YEAR 11

The past, present, and future are three entirely interdependent playing cards all leaning against each other. If one of these is pulled from the temporal house of cards, the whole structure collapses. Time, given its triadic nature, is comparable to the Holy Trinity, in the sense that one entity is split into three apparently different manifestations as a way to explain a complex concept to the human mind. In the same way that God appears in different forms labelled the Father, the Son, and the Holy Spirit throughout the Bible, Dickens, through his Ghosts in A Christmas Carol, and Aristotle, in Book IV of his "Physics", both break time into three categories of past, present, and future. Rather than framing each section of the timeline as a concrete "thing", Aristotle viewed each part as more of a "nothing". Given that the past was no longer a reality, and the future not yet one, and that they were only separated by an instantly vanishing present, he questioned if it is possible to argue that time really exists at all. Whilst Aristotle does approach the question of time by splitting it into three dimensions, his idea floats on the surface of an arguably far more interesting pool of theories and beliefs.

When discussing the nature of time, it is fairly futile to focus only on the "future" – that is, all the time that comes after the "present" on the timeline. This is because each moment is at once the past, the present, and the future; as an action is being completed, it simultaneously inhabits all three realms of time. An action is in the past because, whilst it is being carried out, it is becoming an immutable fact of history accessible only through memory or recordings of some sort, all of which are an indirect way of viewing, but not truly reliving, that moment. The action is in the present because it is actually happening for the first and only time. It has always been in the future of any action before it, and it remains in the future of any given point further to the left on the timeline. It is clear, therefore, that these three dimensions of time are all part of the same singular concept: we separate them, but they are all applicable to any single thought, word, or action.

In Australian Aboriginal and Torres Strait Islander cultures, the Dreamtime (the time of the creation of the world by ancient ancestors whose spirits are still present on Earth) is a cyclical and circular, rather than one-directional and linear, understanding of time. Instead of passing by constantly and uncontrollably, cycles of time such as the changing of the seasons are renewed through and driven by human actions, which reflect a thorough understanding of nature. Depending on the season, people migrate to warmer or cooler climates, and change their behaviour and daily lives to align with the natural world and ensure that time continues to cycle in the optimum way. For example, the people who live near the southern Alps in Victoria know when the best time of year is to climb the mountains and eat the Bogong moth, and, by doing so, ensure that the moth will be ready to eat at the same time next year. The return of certain birds, insects, and mammals to certain lands and lakes, the end of the wet season and the beginning of the dry season, and the migration of a specific community or tribe to the appropriate mountain, forest, or river all happen at the same time each year not due to a coincidental converging of timelines, but because each of these changes are necessary in fulfilling and propelling forward the right temporal cycle. It is believed that a failure to respect and fulfil the duty of all living things to drive forward the cycles and circles of time that allow the Earth to be as fruitful and nourished as possible may invite famine, drought, and disease. This same element of control over and responsibility for cycles of time applies to that of the human life, too. Ceremonies that recreate the events of the Australian Aboriginal people's origin rejuvenate life, and drive the cycle of birth, initiation, marriage, death, and rebirth (and many groups, such as the Aranda, believe in literal reincarnation). Just like the changing of the seasons, life is considered circular, and any spirit, whether physically alive or dead, exists in the past, the present, and the future, as it occupies a loop of continuous life and death.

In contrast, Buddhist theology suggests that a focus on the past and future is a barrier to achieving enlightenment. The central aim of Buddhism is to free oneself from dukkha, or suffering, which characterises life within the cycle of samsara (of which the human realm is a part). Given that the cause of suffering is understood to be tanha, or cravings, the only way to reach nirvana, and be freed from samsara and dukkha, is to let go of any cravings you might have. Ultimately, cravings are characterised by a desire to obtain objects, feelings, and relationships that we either can no longer obtain or will never be able to obtain. This is believed to be true of all material desires, because verse 227 of the Dhammapada outlines that "all conditioned phenomena are subject to change and decay and are therefore impermanent". Everything that we have, whether emotional or physical, is fleeting, and holding on to things that no longer exist in the present will invariably cause suffering. With this in mind, the nature of time is, in fact, of no great importance, because people should not dwell on history, or on hoping for events which may never come to pass: through practices such as samatha meditation, which focuses on the breath as it cycles through the body, Buddhists isolate the present moment and become much closer to fully letting go of all cravings caused by a focus on the distractions of the other two temporal dimensions.

A focus on three distinct temporal realms is a hindrance to Buddhist monks aiming to achieve enlightenment, and when linear time is superimposed upon Aboriginal Australians, it disrupts the circle of life and the correct cycle of the seasons. In a rapidly advancing capitalist world, where British school children as young as 11 are encouraged to consider and worry about each possible permutation of their future, but then have to choose one specific path, and where we constantly find ourselves longing for pasts that we see as lost forever, it is worth asking ourselves if we would benefit from taking our rigid timeline, welding its ends together, and bending it into a circle.

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CYCLES OF TIME

Deep-Sea Mining: The Future of Green Energy?

TALIA, LOWER SIXTH

As the world starts to focus on meeting net zero targets, there is increasing emphasis on producing 'green' technologies, such as wind turbines, electric cars, and solar panels. However, most of these technologies require vast quantities of rare minerals; for example, the construction of wind turbine farms requires nine times more mineral resources than a gas power plant. Consequently, there is an increasing shortage of materials such as lithium, nickel, cobalt, and rare-earth elements that are necessary for the transition to 'green' technologies.

High concentrations of such materials are found in so-called 'polymetallic nodules' as a fragment of a shell or shark's tooth. They are often enriched with metals such as nickel, copper, manganese, cobalt, and molybdenum, which are used in the production of electric batteries. Polymetallic nodules often contain greater quantities of metals than economically viable terrestrial mining deposits. As the nodules lie loosely on the sea floor, they can, in theory, be harvested relatively easily. Engineers have developed mining vessels, equipped with ploughs and vacuum pumps, which crawl along the ocean floor. They collect nodules and return them, via riser pumps, to large ships on the surface of the sea.

However, although there is a clear abundance of useful minerals on the ocean floor, the terrible ecological consequences of deep-sea mining are starting to gain wider recognition. Humans have only explored a small proportion of the deep ocean; according to the National Oceanic and Atmospheric Administration (NOAA), scientists estimate that 91% of ocean species are yet to be discovered and that more than 80% of our ocean is unmapped. On average, 2000 new deep-sea species are classified every year. These species often are unique to the regions which are targeted by deep-sea mining companies.

"Deep-sea mining correlates with the extinction of deep-ocean species, for various reasons."

scattered on the deep seabed in certain regions of the Pacific Ocean. Even though commercial deep-sea mining is not yet permitted by international law, the International Seabed Authority (ISA) has granted over 30 contracts for exploratory mining in international waters, covering more than a million kilometres squared. It is therefore crucial to understand what polymetallic nodules are; the advantages and disadvantages of mining them on the deep seabed; and the legal and other developments that may facilitate – or impede – such mining operations, in order to predict their future.

By way of further background, polymetallic nodules form when metal compounds dissolved in ocean water precipitate, over millions of years, around a nucleus, such

Deep-sea mining correlates with the extinction of deep-ocean species, for various reasons. Polymetallic nodules are habitats for many organisms; their removal leaves such species vulnerable and at a greater risk of extinction. As these nodules only grow a couple of millimetres every million years, it is highly unlikely that species – particularly sessile organisms that attach themselves to the nodules – will be able to recover from their removal. The mining process is destructive: the ploughs kill creatures on the ocean floor and animals vacuumed up with the nodules die during the processes of bringing the material to the surface and sorting and cleaning the nodules. Unfortunately, species in the deep ocean also tend to experience slower growth and are, therefore, slower to recover from the impact of deep-sea mining.

Additionally, the sorting vessels used to mine the ocean floor release plumes of sediment and light pollution that interfere with animals' bioluminescence, hindering their attempts to confuse predators, attract prey, or communicate with other animals of the same species. Sediment plumes also impair the feeding and reproduction of plankton and jellyfish. These small, filter-feeding organisms form the base of many food webs, so a decrease in their numbers impacts many other species.

This is not the only reason why larger sea creatures from a range of ecosystems may be affected by the consequences of deep-sea mining. The process of mining the ocean floor and returning collected sediment to the surface also creates excessive noise pollution, which interferes with the acoustic signals of whales, dolphins and porpoises. Furthermore, waste discharge from mining vessels can spread over kilometres, which has a wide-reaching impact on local sea life, as waste sediment can change the pH, oxygen content and temperature of seawater. This is often lethal for species that are already vulnerable as a result of climate change. The waste discharge can also introduce heavy metals from the ocean floor into midwater ecosystems; fish unwittingly consume them, and potentially toxic metals thereby enter the food chain.

As the environmental concerns around deep-sea mining are brought into the public spotlight, a growing number of countries have acknowledged the risk that deep-sea mining poses to marine life. The UK now backs a moratorium on deep-sea mining, which expresses concern about the issuing of deep-sea mining contracts by the ISA. Although the moratorium has little practical impact, it is an expression of disapproval of deep-sea mining, and a message that the ISA should pause all operations until the ISA enforces suitable environmental standards to which any companies should be held accountable, and until there is a greater wealth of scientific data exploring the impact of deep-sea mining on marine ecosystems. However, although 21 states support such a moratorium, it is uncertain whether an outright ban on deep-sea mining will be introduced. The ISA has declared that it will finalise regulations concerning deep-sea mining by 2025; these regulations will reveal whether commercial mining will be permitted, and if so, how much of the ocean floor will be available for such operations.

In the meantime, the public debate surrounding deep-sea mining continues, as people question the environmental impacts and ethical considerations associated with exploiting untouched ecosystems for economic gain.

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Digital Erosion: Why Our Dependence on Technology May Be Paving the Way Towards a Digital Dark Age

ZARA, LOWER SIXTH

As a student, I'm often reminded how privileged I am to have access to the breadth of information I do, all within the reach of my fingertips. The digital world is an unfathomably mammoth and impactful resource: according to Lyman and Varian (2000), printed documents currently comprise only 0.003% of all newly generated information. The way the digital world has permeated and revolutionised our lives often leaves us ignorant of a sinister problem: what happens if all of this information disappears?

"The way the digital world has permeated and revolutionised our lives often leaves us ignorant of a sinister problem: what happens if all of this information disappears?"

In 1977, Terry Kuny, a software engineer, popularised this concept, and coined the period we are living in a "digital dark age". This concept stems from the observation that in our modern world, the preservation of information is threatened by the natural life cycle of technologies; as innovation progresses, older technologies inevitably become obsolete, leading to a decline in the retention of historical data. Kuny warns that we are "moving into an era where much of what we know today, much of what is coded and written electronically, will be lost forever". Similar to how monks painstakingly transcribed Classical texts during the Middle Ages, thus preserving that knowledge so it is accessible today, Kuny contends that digital assets must be safeguarded, otherwise we risk future generations encountering significant gaps in their understanding of our present-day lives, experiences, and history.

Digital assets are extremely fragile: Kurt Bollacker, a computer scientist at the University of Texas, and Howard Besser, founding director of the NYU Moving Image Archiving and Preservation Program, identified five factors that compromise how difficult it is to preserve digital information. Firstly, most analogue technologies (photographs, paper documents, etc) can be looked at directly to access their information, whereas with digital media, a machine and software are required to read and translate the data into human-observable form; if the machine or software is lost, the data is likely to be unavailable or lost, too. Secondly, digital media requires scheduled refreshing and back-ups, otherwise the data can be lost.

Thirdly, there may be no defined conservators of the data, e.g., no specific stakeholders may have been entrusted with ensuring the data's long-term existence and accessibility, nor may potential stakeholders have the necessary archival experience to do so. Fourthly, data translation problems may render digital media less accessible. Fifthly, where storage media are no longer the 'standard' at the time of preservation, the typical solution is to copy all data to a second system before the new technology has surpassed its predecessor; this means the storage and personnel costs for the preservation of data will increase immeasurably.

Considering how physical technologies continuously progress, the digital world has bestowed upon us "a myriad of exotic, experimental and often short-lived data media" (Bollacker, 2010). For example, when comparing the ideal expected lifetime of analogue and digital media—say, paper documents with CDs—a disparity becomes apparent. The longevity of information on paper ranges from 2000 to over 4000 years, whereas CDs typically last only 20 to 100 years. This highlights a fundamental discrepancy between analogue and digital data storage. Analogue media typically undergo gradual and predictable degradation, enabling the possibility of restoration, or analysis of unaffected segments. However, digital media, which encode information in binary digits, are vulnerable to unpredictable consequences from any damage. Unlike analogue media, where minor disruptions cause only minor distortions, a single bit flip in digital media can corrupt extensive portions of data, leading to the significant loss or alteration of information.

Moreover, app and software discontinuation further emphasise the fragility of the digital world. The demise of platforms like MySpace (which was, at its apogee from 2005-08, the most popular social media platform in the world), saw 12 years' worth of music and photos instantaneously deleted, affecting over 14 million artists and 50 million tracks. A similar phenomenon can be observed with Adobe Flash Player. Flash Player was a software used for viewing multimedia content and streaming audio/ video content. It was used to create web apps, games, videos and animations, and countless interactive tools required it. In 2021, Adobe stopped supporting Adobe Flash Player; this rendered many interactive websites unusable, and erased significant cultural artefacts—computer games and web art that were influential for what has since happened in gaming and digital art—from pop culture's collective memory.

Furthermore, the erosion of digital data not only threatens our cultural heritage but also poses challenges for fields like psychology and social research. The rise of social media has transformed it into a resource for studying public behaviour. In the past, social researchers have taken advantage of X (Twitter) data as a source of readily available insight into how a significant group of internet users behaved. However, Elon Musk's recent decision to eliminate free access to X's API (Application Programming Interface) has effectively priced researchers out of this valuable data source. Consequently, what was previously a valuable access point for data on public health, disaster response, political campaigns, economic activity, hate speech, and disinformation has since been rendered inaccessible. Since a significant portion of our data is under private ownership, we must ask ourselves if these companies have an incentive to preserve our data or make it accessible, especially considering the long-term costs involved. As our dependence on these digital platforms for gaining insights into the public grows, the potential loss of data due to either its unavailability/deliberate destruction or due to these platforms shutting down becomes increasingly alarming.

However, there are organisations and endeavours actively working to combat the risk of data erosion. The Internet Archive is a nonprofit organisation which operates a vast digital library, archiving websites, books, music, videos, and other digital artefacts. It offers free access to its collections, allowing users to browse and download archived materials. Through its efforts, the Internet Archive aims to organise and safeguard digital information, ensuring that valuable online content is preserved for future generations. The Rosetta Project is an endeavour to preserve texts of all of the world's written languages by etching miniaturised versions of more than 13,000 pages of text and images onto a durable metal disk using techniques similar to computer-chip lithography. It is expected that this disk could last up to 2,000 years because it resembles a stone tablet in its durability. Although this approach works for some important data, it is much more

expensive to use than almost any practical digital solution and is less capable in some cases (i.e., audio and video). Perhaps these solutions are better thought of as a cautionary allusion to what our future might look like if we fail to prioritise the preservation of our digital heritage and data integrity.

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High School

GDST

South Hampstead's Upper School Academic Scholars join the Beacon Programme, contributing to the scholars' journal and symposia, attending a cultural trip and dinner, and inspiring our younger pupils with a love of learning. Academic Scholarships are available at Year 7 (11+) and the Sixth Form.

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Cover artwork: Maya, one of our Sixth Form Art Scholars, created the front cover of this edition - pencil drawn portraits on the theme of future, exploring age and growth.