



YOUNG SCIENTISTS

journal

Refreezing the Arctic

An article discussing the plausibility of refreezing the Arctic to combat Climate Change

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Left-Handed genes

An article that discusses the discovery of a genetic marker for left-handedness

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A Message from the Team:

“

This academic year marks a change in the editorial team for our school's Young Scientist Journal (YSJ) as the previous year 12 team have taken over from the departing year 13s as they have embarked on the next stage of their education. We would like to take this opportunity to thank Marcus and Zain not only for their dedication and hard work in sustaining the YSJ ethos, but for also guiding us through this transition.

Looking to the future, LGS YSJ looks to focus at attracting and fostering the interest of science in all years. We would like to get more people involved with the journal, especially from the younger years. The team is also looking for more people to help compose articles; whether that be keen photographers to take photos for backgrounds or covers, or IT and Publishing experts who could help us refresh the journal's layout and design.

A reminder to all budding scientists throughout the school of all ages that any input, whether that be writing an article or helping to design the layout of the magazine, is much appreciated and valued. If you would like to get involved, then please do not hesitate to contact lgsyoungscientists@gmail.com or come and speak to any members of the team.

This issue sees a wide range of topics from refreezing the Arctic to look at the genetics of being left-handed (to name a few).

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Who are We?

We are a collection of Leicester Grammar School students who have come together to produce a variety of pieces of writing about the world of STEM. As a school, we have become a hub for the Young Scientists Journal, an international peer-review written and edited entirely by young people.

Contact Us

Anyone interested in joining the YSJ to help to write, edit and publish is more than welcome to meet us at our meetings during lunchtimes (specific details will be in the daily notices). We welcome submissions from all year groups on any scientifically-related topic; so come along to a meeting or email us at:

lgsyoungscientists@gmail.com

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Young Scientists Journal



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Refreezing the Arctic

Oscar Schwabe discusses the method of refreezing the Arctic to combat global warming

The Arctic is in crisis; it is warming faster than any other part of the world. Arctic sea ice has shrunk by 1.07×10^6 km per decade since 1979 and this causes the albedo effect (reflectivity) to drop significantly as ice is much more reflective than the sea. This loss of ice has the same warming effect as many years of human CO₂ emissions. According to Dr Hugh Hunt, from the Cambridge Department of Engineering, a transition to a lower emission way of life is simply not enough. To think that by driving electric cars, eating less meat and flying less is sufficient, would be to totally misunderstand the seriousness of the problem.

It is for this reason that geoengineering methods to refreeze the Arctic sea ice are being considered. A team from Arizona State University propose the installation of 10 million wind turbine powered pumps on the Arctic sea ice. These would pump large volumes of sea water onto the ice during the winter, producing a much thicker ice sheet. They say that adding 1 metre to the thickness of the ice would significantly increase the time it takes to melt during the summer. Installation in the early 2030s would return the ice cap back to the state it is now, rather than the totally ice-free summers predicted. However, the scale of the project is staggering; they estimate that to deploy these pumps over the entire Arctic ocean would require 100 million pumps and 100 million tons of steel per year during the construction – greater than the annual steel production of the US. Producing this would of course have a significant environmental impact in the extraction of materials and the manufacturing.

Other proposals include seeding clouds over the Arctic sea, reflecting more sunlight or spreading reflective particles over the ice, essentially making it whiter and more reflective. The effect that these particles have on wildlife would of course have to be seriously considered.

It is clear that there is not yet a fully formed solution to the problem. What is clear is that drastic action is needed in all areas of society to reduce greenhouse gas emissions and it is vital that this is not neglected such that we are relying on a miraculous yet sadly non-existent geoengineering solution!

Oscar Schwabe

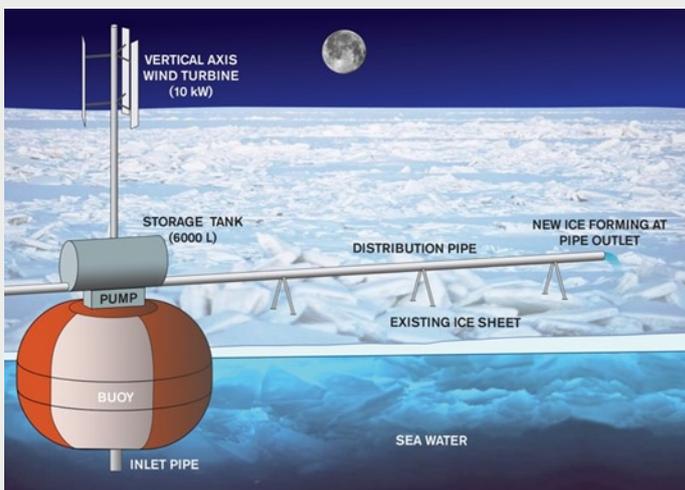
Bibliography

United Nations, Global Issues: Climate Change
<https://www.un.org/en/sections/issues-depth/climate-change/>

University of Cambridge, Refreezing the Arctic
<https://www.cam.ac.uk/news/refreezing-the-arctic>

Science Alert
<https://www.sciencealert.com/scientists-have-announced-a-plan-to-refreeze-the-arctic-and-it-s-wild>

New Scientist, Articles, Refreezing the Arctic
<https://www.newscientist.com/article/mg24332450-700-refreezing-the-arctic-how-to-bring-the-ice-back-with-geoengineering/>



I'll sleep on it

Nishika Bhatt discusses the symbiotic relationship between depression and sleep

It comes as no surprise that sleep and mental health fall hand in hand. Your mind plays a mammoth role during sleep; coordinating the subconscious, painting dreams, and most importantly, keeping you alive. The problem arises when the mind is in a state of poor mental health. As sleep deprivation deteriorates your psychological state, your psychological state can enhance your sleep disorders and so a person gets stuck in a vicious cycle that only worsens with time. In fact, people with mental health problems are more prone to developing sleep disorders such as insomnia. Chronic sleep problems affect 50-80% of typical psychiatric practice compared to the national figure of a reported 22% in the general population. Fittingly, this survey was carried out by the Mental Health Foundation with the aim to raise awareness of the importance of sleep for physical and mental wellbeing.

One of the worst affected groups of people are those who are depressed.



Depression is a very common mental health disorder found across all ages groups on a global scale. Found more commonly in men than women, depression has claimed the lives of many individuals every year from what started off as an innocent bad day.

Whilst depression is never experienced in the same way from patient to patient and is seldom textbook, there are ways of categorizing it in order to consider a likely prognosis. The four most

common types of depression can be categorised as:

Major depression- the most common depression that fits the stereotype we associate with depression. Patients feel detached from reality and lose interest and enthusiasm for the things they used to take pleasure in. This may be a result of an event or change in a person's life. A very common symptom for major depression is trouble falling asleep or excessively sleeping and being unable to physically leave the bed.

Persistent depressive disorder- formerly known as "dysthymia" this depression refers to a prolonged period of depression that spans over a long period of time but does not feel as climatic nor intense as Major Depression. This form of depression is often linked with a wavering sleep pattern lacking in regularity as the person's ability to live with such prolonged depression causes their mental health to plummet.

Bipolar disorder- although commonly seen as another mental illness in itself, bipolar patients tend to experience frequent intense episodes of depression. This disorder was actually previously referred to as "manic-depressive disease". Unlike the conventional red flags that indicate depression, bipolar patients tend to show characteristics of requiring little to no sleep and often hyperactivity. These episodes often end abruptly and result in extreme fatigue and a period of depression

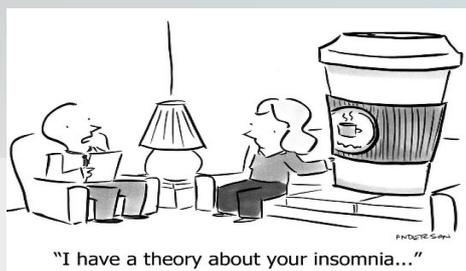
Seasonal affective disorder (SAD) - This rather unknown yet surprisingly common form of depression emerges as days get shorter and nights get longer. The phrase "September

blues” alludes to this general feeling of low mood felt nationwide. People experiencing SAD often find it difficult to fall asleep during these long, dark periods.

Though there are many symptoms that overlap across the various forms of depression, all of them are strongly affiliated with sleep. This common denominator between the different types of depression makes people with depression particularly susceptible to a sleeping disorder.

Studies sampling the various groups of clinically depressed patients concludes that an estimated 60-90% of adult patients with major depression and a further 90% of children diagnosed with major depression experience a sleep problem. The most common being insomnia whilst approximately 1 in 5 suffer from obstructive sleep apnoea.

Insomnia- a sleep disorder where people have trouble sleeping or staying asleep as long as desired. This is later followed with day time fatigue and an irritable mood.



Obstructive sleep apnoea- a condition where the walls of the throat relax and narrow during sleep interrupting normal breathing and hence interrupting sleep at regular intervals.

Night Terrors- a deep sense of fear and anxiety that is often vividly experienced and puts the patient in a state of sleep paralysis. Can result in high blood pressure and excessive perspiration.

Narcolepsy- patients suffer from extreme sleepiness, often at inappropriate times in the form of sudden sleep attacks. May arise from a lack of consistent sleep.

It has also been found that insomnia and related sleep problems increase the risk of developing depression. A study conducted in Michigan concluded that those enrolled under a sleeping disorder were four times as likely to develop major depression as opposed to those with a regular sleep cycle.

An issue that psychiatrists are often faced is the classification of these sleep disorders. Since mental health disorders are a spectrum, the lines

between where someone has low lying depression as opposed to someone feeling miserable are questionable. Given this, psychiatrists often find it difficult to judge whether the sleep disorder arose from a mental health disorder such as depression or whether it is something else entirely.

Furthermore, was it that the sleep disorder arose from the poor mental health or vice versa? These are common dilemmas faced by psychiatrists and often is impossible to come to a satisfactory conclusion.

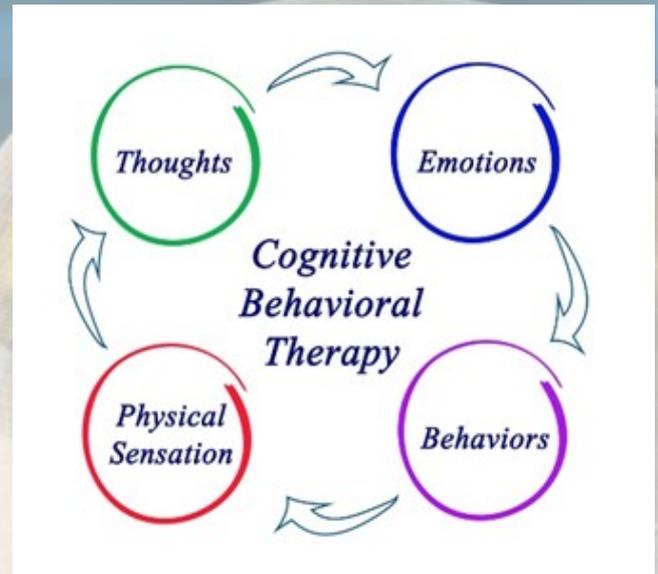
The focus on a sleep intervention in a young adult population is important. Young people with incipient disorders might be very reluctant to seek help for psychiatric problems. Trouble sleeping is a common complaint with little stigma. Hence, it provides a much more acceptable focus for a first step in a care pathway.

One of the most effective methods is Cognitive Behaviour Therapy. Since people with insomnia tend to become preoccupied with not falling asleep, cognitive behavioural techniques help them to change negative expectations and try to build more confidence that they can have a good night's sleep. These techniques can also help to change the "blame game" of attributing every personal problem during the day on lack of sleep. This method has shown to have a 70% success rate amongst depressives with sleep disorders.

The most common and well known treatment for insomnia is sleep-inducing medication, also known as hypnotics. Drugs can be useful for short term insomnia, but there is little evidence to suggest that they are appropriate for chronic insomnia. Yet, whilst sleep medication is easily attainable from your local general practitioner, it is also important to acknowledge that drugs do not solve a root underlying mental health disorder but merely deals with the sleep related problems.

Many people develop tolerance to hypnotics and become physically or psychologically dependent, and as a result suffer withdrawal symptoms such as anxiety, depression and nausea. This course of treatment has a negative outcome and hence is seldom used by psychiatrists.

More holistic approaches may include meditation and other forms of relaxing techniques, changes in lifestyle i.e. more quality sleep and substituting to a healthier diet. Regular exercise and keeping a generally healthy lifestyle will not only ameliorate sleep disorders but may encourage those with depression to step out and take pleasure in activity.



“A good laugh and a long sleep are the best cures in the doctor’s book.” -Irish Proverb

Nishika Bhatt

Bibliography

- <https://www.thelancet.com/action/showPdf?pii=S2215-0366%2817%2930328-0>
- <file://MHF-Sleep-Report-2011.pdf>
- https://www.health.harvard.edu/newsletter_article/sleep-and-mental-health

Discovery of genes associated to left handedness

Owen Wilson discusses the effects of genes on left handedness

A recent study carried out by the University of Oxford hinted to the possibility that left-handedness occurs in people as a result of their genome sequence and structure. For many years, it was believed that left-handedness occurred by chance in some children – possibly because they were encouraged to use their left hand to carry out tasks from a very young age. As a result, it was initially thought that the choice of hand to carry out tasks was due to their nurture rather than nature. However, recent research shows that it could be attributed to nature instead.

With only 10% of the population across the world thought to be left-handed – it is a rarity amongst the population. The unique nature of being left-handedness has sparked controversy, with it being deemed something that is associated with being 'sinister' (meaning 'left' in Latin). After all, the Victorians punished children who developed left-handedness – forcing them to use their right hand instead. An action which, due to this ground-breaking research, will have gone against the person's entire genetic hardwiring. Throughout history, left handedness was associated with the devil and bad luck. Try telling that to Sir Gary Sobers, a world-renowned left-arm cricketer or Martina Navratilova (a left-handed tennis player) who was nine-time Wimbledon Women's Champion. Even Lionel Messi, arguably the most gifted footballer in history, prefers his left foot over his right. Yet what is the genetic science behind left handedness?

Recent research at the University of Oxford has made progress in developing an understanding of why people use their left hand over their right, research which was headed by Akira Wiberg. The team correlated brain imaging phenotypes from over 9,000 UK Biobank participants with left handedness and found the loci of genes (the part of the chromosome where a particular gene is located) to be located in very similar positions along the chromosome for those who were left-handed. In addition, a genome-wide association study followed with over 400,000 UK Biobank participants being examined. This imaging-handedness analysis showed an 'increase in functional

connectability between left and right language networks in left handers'. It is suggested that the genes are hardwired, or permanently connected, into human DNA and found in a part of the brain that deals with language. Therefore, it is no surprise that studies suggest that left-handed people have better verbal skills – skills which may be attributed to this connection between genes in the brain which focus on language.

The studies enabled the specific loci responsible for the cause of left handedness to be uncovered, which were rs199512, rs45608532, rs13017199 and rs3094128. Three of which are genes responsible for encoding proteins involved in brain development and patterning.

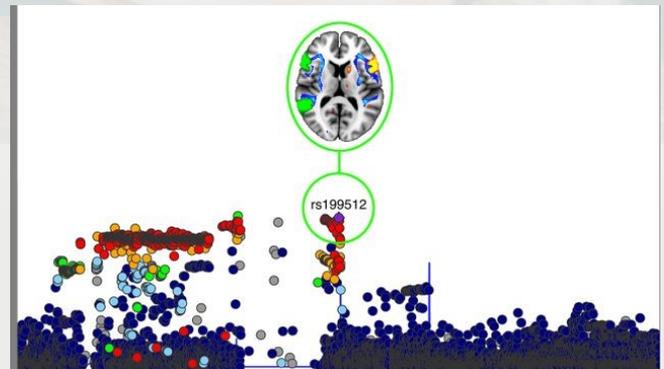
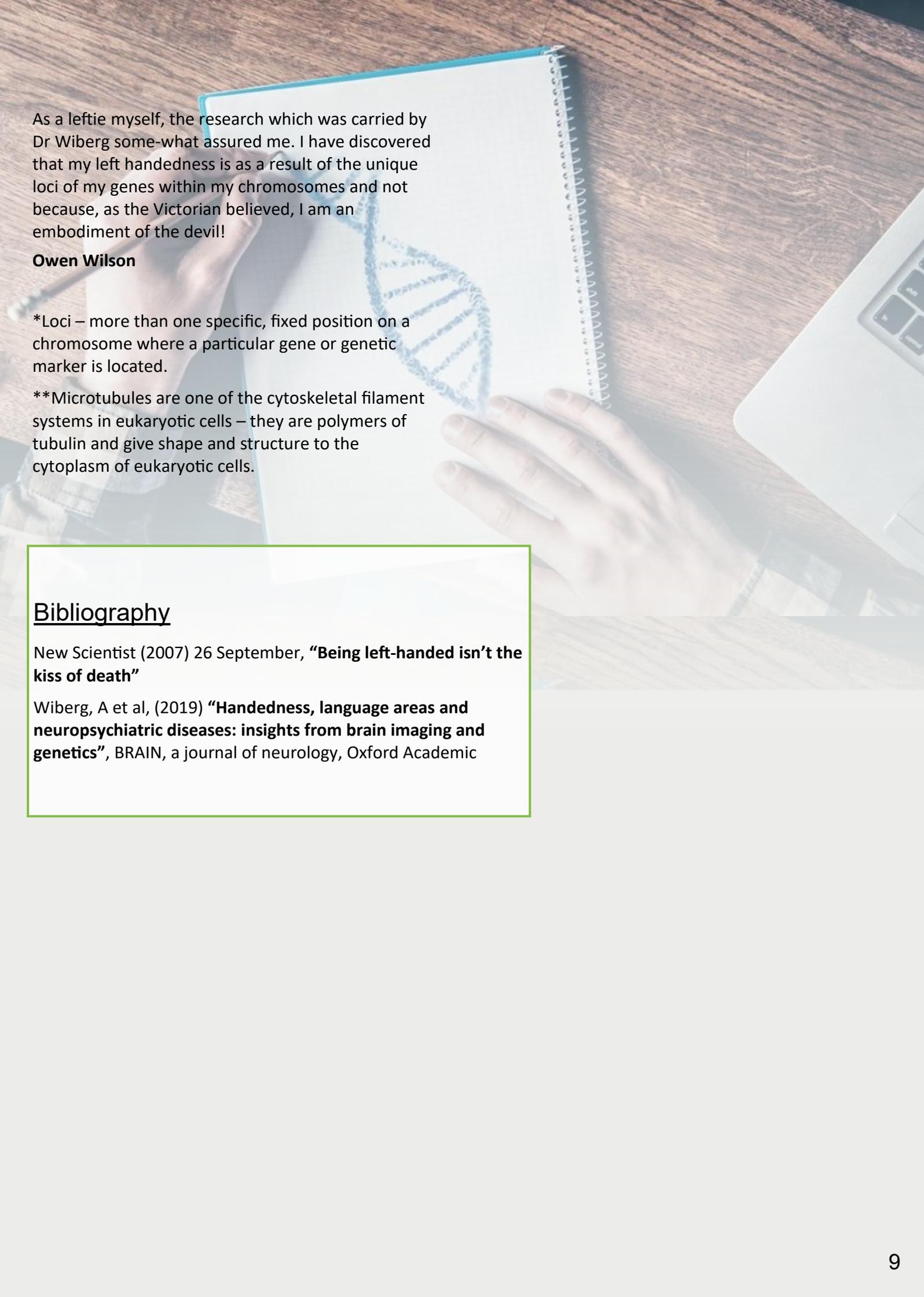


Image from Nuffield Department of Clinical Neurosciences

The proteins which were encoded were microtubules, which are used in the formation of the cytoskeleton on eukaryotic cells. This may therefore dictate the choice of hand for carrying out processes, but further research must be undertaken to uncover this. The study therefore identified in the general population genome wide significant loci that determines whether you are left-handed. They identified the genes that are associated to brain development, microtubules and brain patterning – some of which may result in left handedness. It is suggested that these different genetic patterns influence the phenotype of the individual – whether they are left or right-handed.

A person is drawing a blue DNA double helix in a white spiral notebook on a wooden desk. The person's hands are visible, one holding a pen and the other resting on the notebook. A laptop is partially visible on the right side of the desk.

As a leftie myself, the research which was carried by Dr Wiberg some-what assured me. I have discovered that my left handedness is as a result of the unique loci of my genes within my chromosomes and not because, as the Victorian believed, I am an embodiment of the devil!

Owen Wilson

*Loci – more than one specific, fixed position on a chromosome where a particular gene or genetic marker is located.

**Microtubules are one of the cytoskeletal filament systems in eukaryotic cells – they are polymers of tubulin and give shape and structure to the cytoplasm of eukaryotic cells.

Bibliography

New Scientist (2007) 26 September, **“Being left-handed isn’t the kiss of death”**

Wiberg, A et al, (2019) **“Handedness, language areas and neuropsychiatric diseases: insights from brain imaging and genetics”**, BRAIN, a journal of neurology, Oxford Academic

Can Phage Therapy replace antibiotics?

Nazir Sirajudeen discusses the viability of phage therapy as an alternative to antibiotics

With the rise of antibiotic resistance in the modern climate so dependent on these medicines, the danger surrounding this crisis is unprecedented. The World Health Organisation has classified the rise in antibiotic resistance as “one of the biggest threats to global health”, whilst also commenting that it “can affect anyone, of any age, in any country” (World Health Organization, 2018). The scope of this threat has already started to be felt, with the book ‘Infection and Immunity’ stating that in Europe alone, “it is responsible for some 25,000 deaths, and at a cost of 1.5 billion euros, per year.” (Playfair & Bancroft, 2013). Yet, with the over prescription of antibiotics in cases where they prove ineffective (e.g. for treating the common cold) and even to ‘aid growth’ in livestock (Karlen, 2001), this threat will only exacerbate. It seems that an alternative is a necessity to prevent us from returning to a time where diseases such as tuberculosis were definite killers with high mortality rates.

One very promising (yet still novel) alternative to antibiotics is Phage Therapy. It is defined as the “therapeutic use of lytic bacteriophages to treat pathogenic bacterial infections.” (Phage Therapy Center, 2018). Bacteriophages (or more commonly known as phages) are a group of viruses that infect and replicate within bacteria. They are described as having “a central shaft and leglike appendages” (Shaffer, 2019). These appendages attach to specific receptors on the surface of the target bacteria, and these receptors can include proteins, lipopolysaccharides, teichoic acids and even the flagella. Once attached to the target cell, the phage then ‘injects’ its genetic material into the host cell. The bacteriophage can then undergo a lysogenic cycle before undergoing the lytic cycle (such phages are known as temperate phages) or they can bypass the lysogenic cycle and immediately skip to the lytic cycle (these are known as lytic phages).

The lysogenic cycle, which is present in the temperate phages, doesn’t kill the host bacteria cell. Rather, this stage is when the bacteriophage incorporates its double-stranded linear DNA into the host’s genome “with the help of phage-encoded integrases” (Steward, 2018), which is a type of enzyme. At this stage, the DNA of the phage is known

as a prophage and whilst the DNA of bacteria cell is being replicated, so is the DNA of the phage. As the DNA of the phage accounts for only a small percentage of the whole genome and no proteins are produced from this section of the genome, the host cells tend to be unharmed during this cycle.

The other cycle present in bacteriophages is the lytic cycle where the host cells are lysed and “destroyed after immediate replication of the virion” (Boundless, 2019). Whilst lytic phages (such as the T4 phage which infects the Escherichia coli bacteria) immediately enter this cycle, for the temperate phages, a stressor is needed to convert the phage to the lytic cycle from the lysogenic cycle. Such stressors can include “UV light, low nutrient conditions or chemicals” (Steward, 2018). In this cycle, the phage builds up early proteins that allows it to destroy the host cell’s DNA and effectively take control of the cell. This would then allow it to produce new proteins needed to build new phages using the host cells own resources before causing the cell to burst (lyse), making it ready to infect other bacteria cells.

So How does Phage Therapy work?

Phage Therapy typically works by designing a phage ‘cocktail’ containing a mixture of environmental phages, which must be meticulously composed in order to reach an effective outcome. In order to discover the phages needed to fight off a certain host cell, a sample containing a large quantity of bacteriophages is required. These sources could be “effluent outlets, sewage and other sources” (Bunting, 1997). If the sample of bacteriophages causes the death of the bacteria, then this sample is centrifuged and the phages at the top are collected. Those phages are then tested to see if they cause the lysis of the bacteria or suppress growth and if they are found to do so, then the phages are then “amplified on cultures of the target bacteria, passed through a filter to remove all but the phages, then distributed.” (Wikipedia, 2019). This cocktail would then usually be administered orally or topically on the infected wound (Injections tend to be avoided as any bacteria or other contaminants could be present in the sample).

What are the Pros and Cons of phage therapy?

One of the major reasons for the renewal of interest of phage therapy is the ability for the phage itself to adapt and counteract mutations of the bacteria cells. Since phages are viruses, they are also subjected to evolution and natural selection, and thus can adapt to overcome mutations of the bacteria cells.

Furthermore, phages are “inherently nontoxic” (Loc-Carrillo & Abedon, 2011) to humans and cause less harm to the beneficial bacteria in the human body compared to antibiotics. This is because each phage has a high specificity and thus can only attack certain species of bacteria.

However, there are still quite a few disadvantages of phage therapy that prevent it from being widely used. Since phages are so specific and effects can vary from person to person, the cost and time spent in order to find an effective phage cocktail for an infection will be significantly higher compared to treatment using antibiotics. This may prove unsustainable in the long run if we are not able to find a way to make this treatment more accessible and less time consuming. Moreover, there are only a few internationally recognised studies that show the effectiveness of phage therapy in humans. Thus, phage therapy currently cannot confidently be used as an alternative to antibiotics without further research.

Although the practicality of phage therapy still remains low, the prospects still remains relatively high. With further studies and trials regarding the usage of phage therapy in humans, the possibility of this treatment remains bright as we further venture into an era where antibiotics look to be phased out with the rise of antibiotic resistance.

Nazir Sirajudeen

Bibliography

- Boundless. (2019, September 9). *The Lytic and Lysogenic Cycles of Bacteriophages*. Retrieved from Biology LibreTexts: [https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_\(Boundless\)/21%3A_Viruses/21.2%3A_Virus_Infections_and_Hosts/21.2B%3A_The_Lytic_and_Lysogenic_Cycles_of_Bacteriophages](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/21%3A_Viruses/21.2%3A_Virus_Infections_and_Hosts/21.2B%3A_The_Lytic_and_Lysogenic_Cycles_of_Bacteriophages)
- Bunting, J. (Director). (1997). *The Virus That Cures BBC Horizon* [Motion Picture].
- Karlen, A. (2001). *A Plague's Progress*. London: Phoenix.
- Loc-Carrillo, C., & Abedon, S. T. (2011, April). *Bacteriophage*. Retrieved from NCBI: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3278648/>
- Phage Therapy Center. (2018). *Phage Therapy*. Retrieved from Phage Therapy Center: https://www.phagetherapycenter.com/pii/PatientServlet?com-mand=static_phagetherapy&secnavpos=1&language=0
- Playfair, J., & Bancroft, G. (2013). *Infection and Immunity Fourth Edition*. Oxford: Oxford University Press.
- Shaffer, D. (2019, February 26). *What are Bacteriophages*. Retrieved from News Medical: <https://www.news-medical.net/life-sciences/What-are-Bacteriophages.aspx>
- Steward, K. (2018, August 28). *Lytic vs Lysogenic- Understanding Bacteriophage Life Cycles*. Retrieved from Immunology and Microbiology: <https://www.technologynetworks.com/immunology/articles/lytic-vs-lysogenic-understanding-bacteriophage-life-cycles-308094>
- Wikipedia. (2019, October 11). *Phage Therapy*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Phage_therapy#cite_ref-horizon_7-5
- World Health Organization . (2018, February 5). *Antibiotic Resistance*. Retrieved from World Health Organization: <https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance>

Does melanin really protect our skin against cancer?

[Jatin Naidu discusses the relationship between melanin and skin cancer](#)

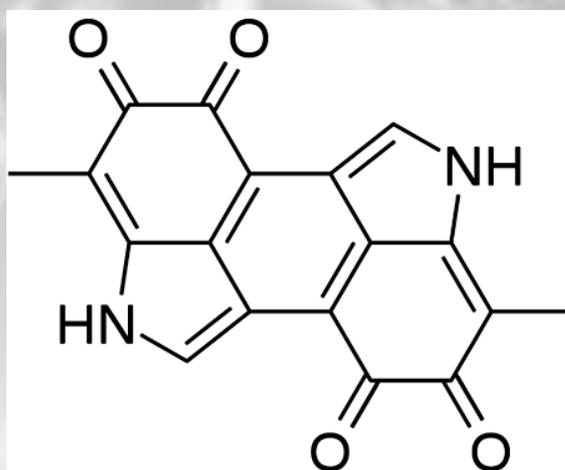
Introduction

People have always thought dark skin is less susceptible to sun damage compared to lighter skin. This is due to the idea that melanin protects the skin from UV radiation damage, and also decreases the risk of getting malignant melanomas (a type of cancer). However, recent studies have shown that this may not actually fully be the case, instead, melanin could be causing more harm than good.

Melanin is the collective name of a group of naturally occurring pigments that are produced by the oxidation of tyrosine followed by polymerisation. They are produced by cells called melanocytes, which are located in the skin's epidermis, the uvea (in the eye), the inner ear, bones and the heart. Darker-skinned individuals have high levels of melanogenesis (the process in which melanin is produced). This offers protection to the hypodermis as the colour of melanin is black and therefore UV-B light is effectively absorbed and stopped from passing into the skin's epidermis.

However, researchers at Yale University discovered that UV radiation generates reactive oxygen and nitrogen, which energizes an electron in melanin. The energy generated can cause DNA lesions, which can lead to mutations leading to skin cancer. What was more striking was that they concluded that skin damage could

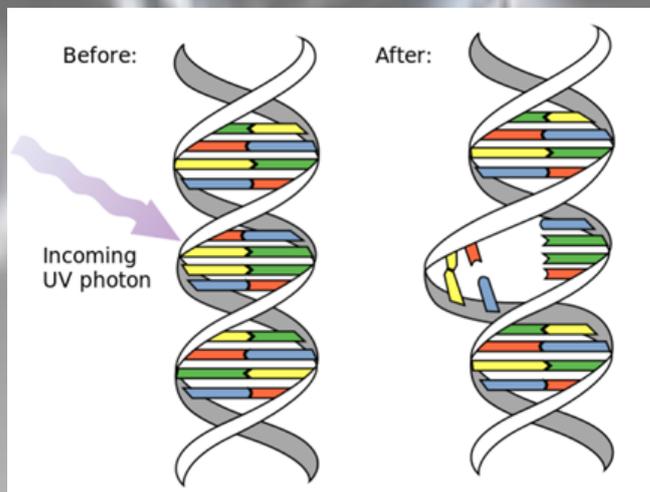
take place more than three hours after exposure to UV-A radiation. This led them to believe melanin may be carcinogenic as well as protective against cancer.



Skeletal formula of melanin (ClickChemist, 2019)

Evidence

Mice and human melanocyte cells were exposed to UV radiation using a UV lamp. This caused cyclobutane pyrimidine dimers (CPD's) to form, due to UV light causing the formation of covalent bonds between consecutive bases along a nucleotide chain (Kashef, 2019). Thereby, the normal base-pairing rule in the double stranded DNA was broken causing damage in the DNA of skin cells.



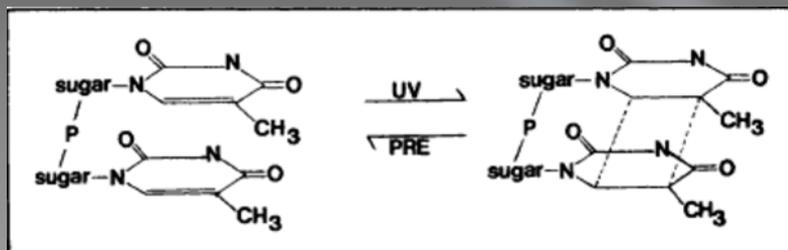
(Herring, 2010)

However, when cells without melanin were used they generated CPD's but only during the period in which they were exposed to UV radiation. This led researchers to look in to the activity of melanin in the dark. They delineated that UV light activated two enzymes that came together to excite the electron in melanin (chemiexcitation). The energy from the electron was delivered to DNA in the dark and created the same damage that sunlight caused in daytime (Kashef, 2019).

Conclusion

There is a long way to go in definitively working out the relationship of melanin and skin cancer. However, the evidence suggests that even after we leave the beach or stop sunbathing, UV radiation can still have harmful effects due to the reaction with melanin. It is therefore important to use sunscreen when exposed to UV radiation as it reduces the risk of sun damage. Research is being done into the production of a sunscreen that could inhibit the reaction to occur.

Jatin Naidu



(Jorgenson, 1981)

BIBLIOGRAPHY

- ClickChemist. (2019, March 20). *Melanin*. Retrieved November 08, 2019, from Wikipedia: <https://en.wikipedia.org/wiki/Melanin>
- Herring, D. (2010, September 02). *Pyrimidine dimer*. Retrieved November 08, 2019, from Wikipedia: https://en.wikipedia.org/wiki/Pyrimidine_dimer
- Jorgenson, T. J. (1981, October). Photoreactivating Enzyme: A Light-Activated Repair Enzyme of Microbes and Man. *BioScience*, 674.
- Kashef, Z. (2019, February 19). *Yale News*. Retrieved October 08, 2019, from Yale University: <https://news.yale.edu/2015/02/19/sunlight-continues-damage-skin-dark>

Food for thought: The development of technology in agriculture

Daniel Bennett discusses solutions to the world hunger crisis

Will we solve the world hunger crisis?

The world currently produces enough food for 10 billion people. Even though the population is only 7.7 billion, 800 million people go hungry each day and 2 billion more are expected by 2050. If we produce so much food, why are so many people not provided for? There are multiple reasons for the famine spread around the world, including:

- Climate – The weather and temperature conditions in an area over an extended period of time. If the climate is either too dry and warm or wet and cold, crops will have difficulty to be grown.
- Location and environment – The surroundings in which the agricultural activities take place. Certain livestock or plant types will fail to grow if the habitat doesn't meet their needs. Food cannot always be transported to locations in need.
- Socioeconomic status – The class of a person within a society. Agricultural products may become too expensive for certain classes and people living in destitute situations.

These current issues coupled with the dismal looking future of an ever increasing population and climate change has scientists and engineers discussing new solutions for the foreseeable future. Technology has taken the forefront of these solutions and looks promising to provide for future generations. A few of these include:

Irrigation – A process used to add moisture to an area to make it arable. Such systems allow famine threatened cultures to grow crops in areas close by which are affected by desertification. Thousands of years ago, cultures used spate irrigation to redirect flood water into crop filled areas. Since then, new

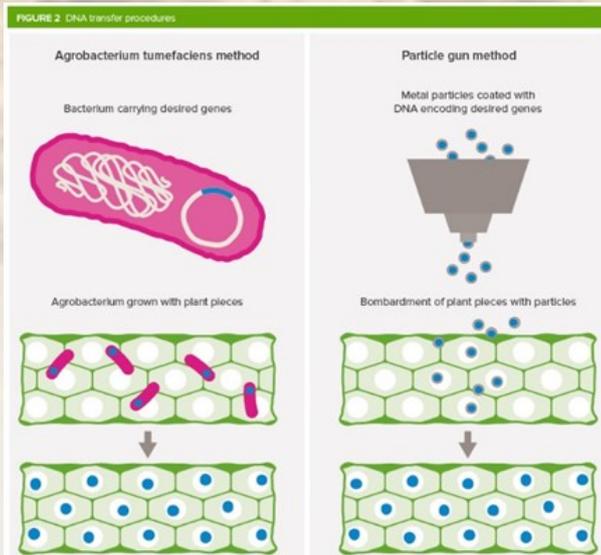
methods have been explored and introduced in a much vaster quantity. The larger areas of newly irrigated land allow for a higher produce of crops overall, feeding local communities. It also removed the need and expense of transporting food there, allowing possibly destitute cultures to eat well. Irrigation can occur in multiple ways: drip, sprinkler, lateral move and many more. The methods provide water to the crops, allowing for them to take in the necessary moisture and grow. Some methods use sprinklers and complex systems of Archimedes screws to move water from manmade wells and reservoirs to the fields. Water is dispensed onto the land at set intervals, replicating rain. This provides water to the plants and stops the breaking up of the ground there. Other methods pump water through pipes straight into the ground. This rises the water table of the land to a point closer to the surface. This allows the top layer of land to be fertile and support the growth of crops. Irrigation has been implemented in the Mojave Desert already.

Genetically Modified Crops – Crops have new and different DNA strands introduced to its genome. The DNA is usually introduced in to plant cells which then grow into crops with the new characteristics. There are two methods to modify the crops; through bacteria or using a particle gun (as shown in the picture below). The changes to the plants can allow them to grow in climates unusual to the species, like cold resistant crops in locations such as Siberia. This method can provide countries with a larger range of possible crops to grow and feed the nation. This leads to a higher level of food security for communities and lets them keep the changed DNA structures for generations to come.

Aquaculture – Growing and breeding marine plants and animals to feed a community. Recently, new Biofloc systems have been introduced which ups the efficiency and quantity of aquatic sources grown. They do this by closely monitoring and correcting the levels of carbon and nitrogen in the surrounding waters. These systems are already being implemented in India, allowing for a larger proportion of their population to have access to fish and other seafood like shrimp.

To paraphrase the novelist William Gibson, this means the future’s food is already here – it’s just not evenly distributed.

Daniel M Bennett



With a moderate amount of India’s population being vegetarian, there is another perk to the Biofloc, they can help grow immense amounts of seaweed too.

The growing demand for food produce by agriculture and the threat of global warming look to pressure the industry and force many more people into famine. However, with the technology mentioned and more being developed, it seems that the world may emerge from this state of localised hunger and be able to meals for all.

Bibliography

<https://medium.com/@jeremyerdman/we-produce-enough-food-to-feed-10-billion-people-so-why-does-hunger-still-exist-8086d2657539>

<http://factsanddetails.com/world/cat52/sub331/item1184.html>

<https://royalsociety.org/topics-policy/projects/gm-plants/what-is-gm-and-how-is-it-done/>

<https://www.theguardian.com/preparing-for-9-billion/2017/sep/13/population-feed-planet-2050-cold-chain-environment>



Flying through life

Tejas Easwar discusses the effects of age on the rate of movement on *Drosophila* flies

The *Drosophila melanogaster* fly (the common fruit fly) is a superstar when it comes to research, with eight Nobel prizes being awarded for research using this organism. *D. melanogaster* is typically used for a few following reasons: they only have four pairs of chromosomes (therefore it is easier to study their genetics), they have short lifespans (mean lifespan, 2-3 months), more than 75% of all of known human disease genes have similar fly homologs and they breed quickly.

Genetic and Environmental Factors that may affect ageing

Ageing research (Lin et al. 1998) has shown that certain single genes, such as the *methuselah* (*mtg*) gene, have been found to increase the lifespan of *D. melanogaster*. Clearly, genetics have a role, thus it is important to choose flies of a similar genetic makeup.

Piper et al. (2011) showed that diet is a major environmental factor that has an impact of lifespan and ageing. My experiment used primarily a cornmeal diet with sugar and yeast extract. All the flies had sufficient quantities of food and was refilled when necessary. Illadi et al. (2010) observed how an animal's mobility, circadian rhythms (the natural biological body clock), sleep patterns and cognitive function affected ageing.

The gradual decline of locomotion has been associated with ageing in many species, including humans. Parkinson's disease is a neurodegenerative disease exacerbated by age that typically causes tremors in the hands at rest, limb rigidity and slow movement. If age affects movement in humans, one might expect a similar effect in *D. Melanogaster*.

There are two main methods that scientists have used to measure locomotion in flies. The first method is rapid iterative negative geotaxis (RING) which tests the climbing ability of adult flies. *D. melanogaster* exhibit a negative geotaxis behavior, an innate response during which the fly

ascends the wall of the test tube after being tapped to the bottom. The other method is *Drosophila* activity monitoring (DAM). Flies are kept in sealed activity tubes and placed in a system that records each time a fly break an Infra-Red.

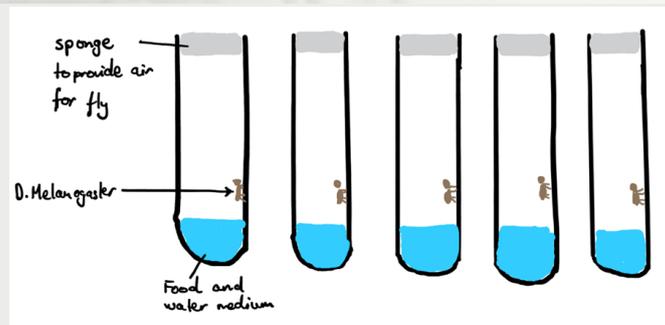
I choose to use the first RING technique and look to measure the speed at which the flies move up the tubes

Method:

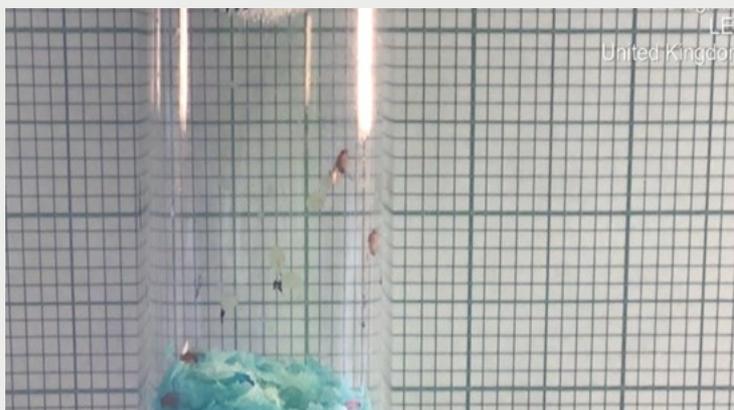
I recorded the flies using my iPad. I set the tube behind a piece of graph paper (to measure the distance moved). I then used an app that had 'time-stamps' to calculate the time. Dividing these two values gave me a speed for the flies. I took readings of several flies to work out a mean. I then measured the same test tube of flies set periods of days later.

I came up with two potential setups for the procedure

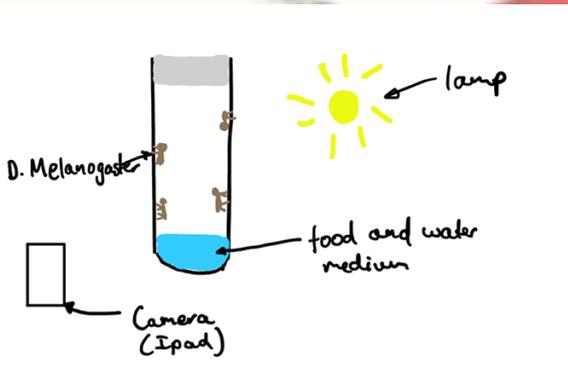
Method 1



Method 1 uses five separate boiling tubes and separates individual flies. Thus, it was possible to observe the individual changes of age on movement for each separate fly. Several speeds were calculated for each fly. I initially placed several pupae into boiling tubes. I measured the speeds of the fly once they hatched and subsequently every two days. There were a few main drawbacks from this method. Firstly, if the fly in one tube died, such as trying to escape the sponge or not feeding then a whole set of results would be lost. Indeed, in one trial run, only two out of the five flies survived. In addition, the experiment was much more time consuming.



Method 2

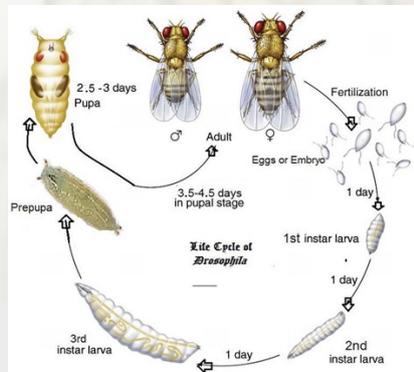


Method 2 involved a single boiling tube and placing several flies. This method was quicker. Furthermore, all the flies were kept in the same conditions throughout the experiment. However, a drawback was that individual flies could not be separately measured. Biological organisms are often slightly different and travel at different speeds. To reduce this error, I used similar genders, species and types of flies.

I also realized during the experiment that the same flies would travel at different speeds at the same age. Flies get stressed easily.

Lifecycle of *D. Melanogaster*

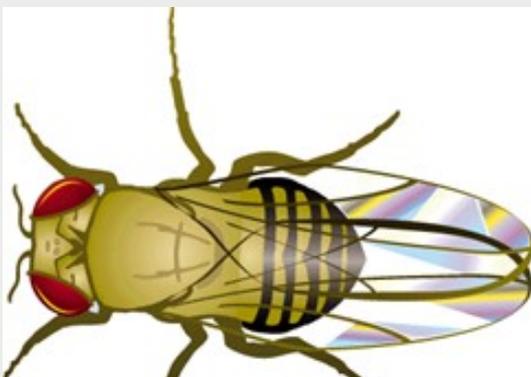
D. Melanogaster undergoes complete metamorphosis (the animal looks completely different as its life progresses). The larval stage has three instars (the developmental stages until sexual maturity is reached).



Typically, it takes approximately 10 days until eclosion occurs (when the adult emerges from the pupa case). However, this value varies depending on various factors.

Selecting the type of *D. Melanogaster*

Normal Fruit Flies or 'wildtype' are the most common form of *D. Melanogaster*. I initially started using this fly:



During the trials of my experiment, I found that the wild-type flies often flew up the tube rather than climb up. This made it difficult to measure the relative speeds of the flies. Instead, I began using vestigial winged (short winged) *D. Melanogaster*. These flies have a recessive mutation on the second chromosome of their 'vestigial gene':

During my experiment, I used 'vestigial-winged' flies, which enabled me to record more speeds.

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BIBLIOGRAPHY

Reiter LT, Potocki L, Chiron S et al. (2001) *A systematic analysis of human disease-associated gene sequences in Drosophila Melanogaster*. Genome research

Lin YJ, Seroude L, Benzer S, *Extended life-span and stress resistance in Drosophila mutant methuselah*. Science. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/9794765> (Accessed 09/11/19)

Piper MD, Partridge L, Raubenheimer D et al. *Dietary restriction and ageing: a unifying perspective*. Cell metab. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/21803286> (Accessed 09/1/19)

Illadi KG, Boulianne GL, *Age related behavioural changes in Drosophila*. Academic Sci.

Bargain JW, Martin I, Bhandari P et al. *Rapid Iterative negative geotaxis (RING): a new method for assessing age-related locomotor decline in Drosophila*. Exp Gerontol. Available at: <https://www.ncbi.nlm.nih.gov/pubmed/15919590> (Accessed 09/11/19).

Sun Y, Yolitz J, Wang C, Spangler E, Zhan M, Zou S, (2013) *Ageing Studies in Drosophila melanogaster*. Methods in Molecular Biology. Available at: Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4664065/> (Accessed 09/11/19)

Exploratorium. *Mutant Fruit Flies*. Available at: https://annex.exploratorium.edu/exhibits/mutant_flies/mutant_flies.html (Accessed 14/09/19)