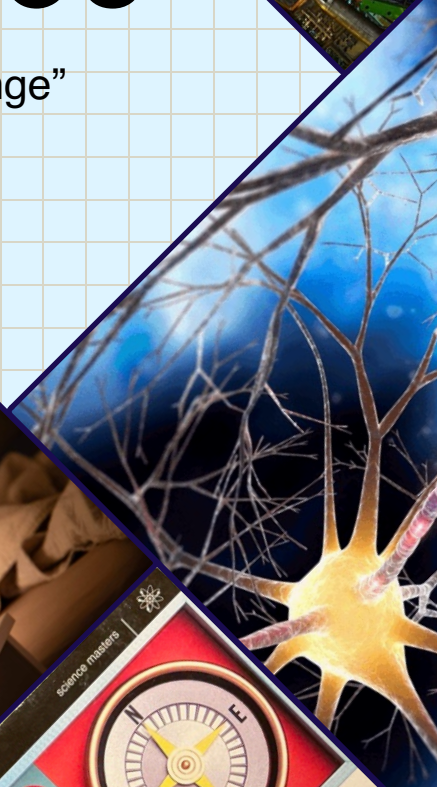


May 2026

# Beths Science

“Intelligence is the ability to adapt to change”  
~Stephen Hawking~



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# Why Should We Sleep?

Harvey Todd

Sleep is the natural restorative process, by which animals heal and the brain forms long term memories (thus the importance of sleep for studying and cognitively-challenging work).

Whilst the importance of sleep is clearly important, the way to get good quality sleep is not so immediately obvious.

Everyone has different sleep patterns, most of which are determined by something known as a “chronotype”.

This describes the tendencies for the sleep patterns that we all have whether a “Night Owl” or a “Morning Bird”.

These are genetically determined traits for sleep patterns that are characteristic for everyone.



Good quality sleep can be determined two factors: Sleep hygiene and a routine.

Firstly, sleep hygiene involves the environment within which you sleep, from the cleanliness of your room to the lighting and the placement of your phone or other mobile devices. Whilst this does play into the idea of a routine, the use of a phone immediately before sleep, can trigger internal hormonal responses to delay your circadian rhythm (which determines the daily sleep routine - similar to an “internal clock”).

Whether it is putting your phone in another room or having a clean space, these seemingly trivial tasks can add up to provide a revitalising quality of sleep.

Secondly, a sleep routine entails all of the activities or actions carried out to lead up to when you fall asleep. This includes brushing teeth, dimming lights and turning off screens or reading etc. By having a consistent routine, this acts as a biological reset through the use of hormonal activities.



**Stephanie Smith**

Achieving a Bachelors and Masters degree in Microbiology, Stephanie then went on to a Ph.D. in Environmental Sciences (although with a microbiology focus).

To this day, Stephanie is an Associate Professor at the WSU School of Food Science and a specialist in Consumer Food Safety.

With publications spanning the safety of the surface of Mars to the work with the safety standards required for apple-packing, Stephanie's inquiries are extensive.

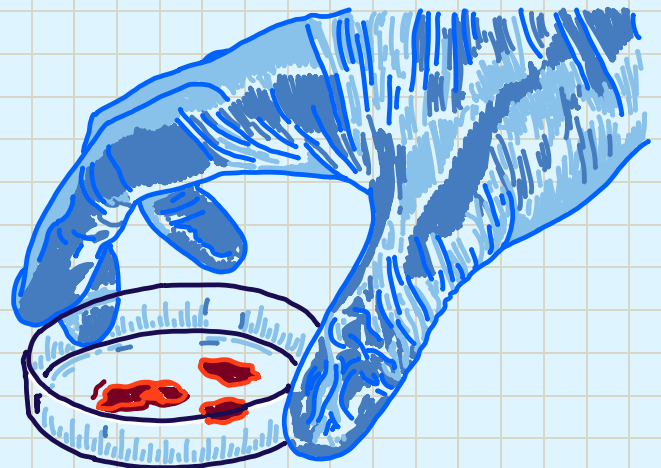
What made you decide to pursue a career in science?

"It really started a long time ago when I was a child.

My father was a microbiologist, and I loved going to his laboratory to look at all the microbes and play with the equipment.

When I reached college age, I knew that I, too, wanted to pursue microbiology. The more I studied, the more interested I became in environmental microbiology. I always say "microbes as a group can do everything!", and this is what truly fascinated me. As I completed my bachelor's degree, I decided to pursue a master's and a Ph.D. so I could become a professor and conduct my own research."

Microbiology is the study of microscopically sized organisms, only seen through the use of a microscope. One of the main reasons for studying microbes is to learn more about prehistoric planetary conditions, due to the longevity of the organisms themselves. In addition to this, microbiology includes that of pathogens, thus allowing us to understand more about the organisms that cause illness and death across the world (Microbiology Society, 2026 access).



“During this time, I had opportunities to work with NASA and JPL on planetary protection, and I continued to work with these agencies through graduate school and my postdoctoral studies. Another aspect I always enjoyed was sharing my knowledge and passion with others.

As I was finishing my postdoctoral studies, an opportunity to work for WSU Extension in food safety became available. The goal of Extension programming is to “develop sound science, instruction, and outreach to meet local and regional needs and make immediate and long-term economic impacts”. I felt like this would be a wonderful opportunity to share my scientific knowledge with the public and make a difference through my programming.

I was hired for this position, and I have held it for ten years. Microbes are microbes whether they are in space, on food, or on surfaces. Understanding microbes, finding ways to prevent their growth when it is detrimental, and sharing my knowledge are what I love about my job.”



<https://wsu.edu/about/>

WSU (Washington State University) spans multiple campuses and courses, where it empowers its students and teachers, via its motto and its mascot: the Cougar (see left). Its mission is to “provide a brighter future day in and day out.”

An Insight into

# Rates Of Change

Mr Blyghton

Very few things in life are constant but there are many that constantly change. We can compare two characteristics that depend upon each other and calculate a rate at which one changes with respect to the other.

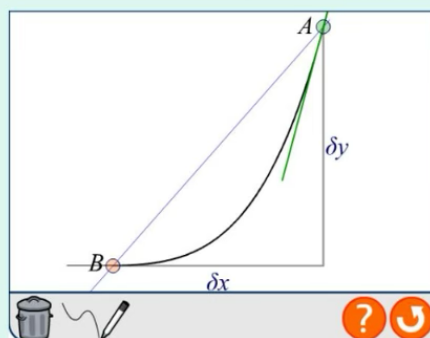
Some rates of change are given a different name, such as the rate of change of distance/displacement with respect to time is called the speed/velocity and likewise the rate of change of speed/velocity with respect to time is called the acceleration. However, if we are to compare the temperature of a heated metal bar with the length of it, we can calculate the rate of heat loss along the bar.

The calculation of the rate of change would normally involve the difference in the vertical values compared to the difference in the horizontal values. This has the hallmarks of a gradient of a line joining two points. The rate of change is therefore calculated over an interval rather than at a specific point.

A calculus method called differentiation was devised by two mathematicians, Isaac Newton and Gottfried Leibnitz in the late seventeenth century to work out the rate of change between two variables at a point using the idea of infinitely small increments :

## Differentiation from first principles

Suppose we want to find the gradient of a curve at a point  $A$ . We can add another point  $B$  on the line close to point  $A$ .



$\delta x$  represents a small change in  $x$  and  $\delta y$  represents a small change in  $y$ .

As point  $B$  moves closer to point  $A$ , the gradient of the chord  $AB$  gets closer to the gradient of the tangent at  $A$ .

The gradient of the chord  $AB$  is  $\delta y/\delta x$  and in the limit as  $\delta x \rightarrow 0$ ,  $\delta y/\delta x$  becomes  $dy/dx$  which is one of the notations in differential calculus, in this case developed by Leibnitz. Newton used the dash notation with the function  $f(x)$  and the gradient function  $f'(x)$  with both working independently and publishing their work around the same time.

The idea being that as  $B$  approaches  $A$ , the value of  $\delta x$  approaches zero, so when  $B$  is at  $A$ , the value of  $\delta x$  is zero and the gradient of the chord  $AB$  and the gradient of the tangent at  $A$  are the same. It is this idea of a limit where  $\delta x \rightarrow 0$ , tends toward or approaches zero, that gets around dividing by zero at  $A$ .

You will notice that the diagram is a curve, likely to have an equation. The tangent will also have an equation called a ‘gradient function’ and this will allow you to calculate the exact rate of change at any given point on the continuous curve.

The “first principles” approach will allow you to obtain the equation of the gradient functions for each curve considered such as

if  $y = x^3$ , the gradient function is  $dy/dx = 3x^2$

if  $y = \sin(2x)$ , the gradient function is  $dy/dx = 2\cos(2x)$

if  $y = e^{4x}$ , the gradient function is  $dy/dx = 4e^{4x}$

This methodology allows you to establish the basic gradient functions before you attempt the various differentiation techniques that involve products, quotients, function of a function, parametric and implicit functions. Each is a separate method but the principle of the basic differentiation process sits within each type.

Differentiation remains an advanced topic which sits within both GCSE Further Mathematics and all aspects of the A Level. As with all STEM, it is process-driven and the order in which it is applied is all-important.

Mr B.

## Why This Matters

From modelling the natural world to economics, chemistry and physics. Very few things are static.

We live in a changing world, either with constant change (such as a car driving on a road at constant speed) or with variable fluctuations (such as acceleration of the car). Differentiation allows us to understand and to model the system so that we can anticipate its change and future positions given its current state.

By manipulation of this form of mathematics we also have a way of analysing the maximum or minimum values of certain variables, such as the maximum rate of fluid flow to the volume of a glass given a definite amount of material.





Edwin is a current Year 13 student at Beths, studying to go into the Medical field. As previous Deputy Head Boy, Edwin's impact on the school has shaped how Beths works today.

### **What has your journey been like?**

My journey into Medicine began around the time that I was taking my GCSEs. For a few years beforehand, I had actually wanted to become an author. Gradually, though, I started to develop a deep passion for Biology. It was also around this time that I really started striving to achieve top grades. In Year 12, I did a work experience placement in Guys Hospital, and it was there that I became certain about doing Medicine. As my passion grew, so did my desire to get the best grades possible. Having done my mocks to determine my personal grades, taken the UCAT, and completed interviews, I started living by my own mantra: "If you believe you'll fail, you will. So just have faith in your skills and the Grace of God, and everything will work out." I believe that, even if you aren't religious, the mantra still works – there is nothing more important than self-belief, and I am eternally grateful to my teachers and friends that continue to motivate, inspire, and support me.

### **Why did you decide to devote yourself to science (medicine)?**

Biology is just a whole lot of fun. Getting to know how the body works really fascinates me, as I am learning bit by bit about something that relates to us all. Specifically, I'm very interested in the brain. I used to be a really quiet child, oftentimes too shy to speak to my peers, which means I did a lot of people-watching. Hypothesising about what was going on in the brains of others was one thing, but getting to truly learn about the processes that make us do different things or behave in different ways is really interesting. As for Medicine, it's a timeless cliché, but being able to help people is really gratifying. The fact that I can have such a positive impact on someone while exploring my own passion tells me that Medicine is, and has always been, the right path for me.

### **What do you want to go and do after year 13?**

After Year 13, I intend to go to university and study to become a doctor. I'm extremely excited for all the aspects of university life. The self-study, the networking opportunities, the clubs and societies – it feels like the type of environment where I would really thrive in. But aside from studying to become a neurosurgeon and saving lives (hopefully!), I think I might like to keep reading, and maybe do more writing – short stories, songs, poems, and the like. I suppose I'm not entirely over the dream of being an author yet.



### **And can Beths expect you to come back and visit...**

Beths can absolutely expect me to come back and visit! This school, and the people in it, have greatly shaped the person that I have become today. I am incredibly proud to say that for the last 7 years, Beths Grammar School has been my home. I'm excited to leave, but heartbroken at the same time. I vividly and fondly remember the classes and teachers I've had across the past few years. If not to speak to younger students that are aspiring to go into Medicine, I think I would return simply to see my teachers and just exist in this place that I've come to appreciate as my second home.

# Is the NHS In Crisis?

Understanding the Pressures on Britain's  
Health System

Kushi Pravinkumar

The National Health Service (NHS) is one of the largest publicly funded healthcare systems in the world. It aims to provide free care to those in need, but growing evidence shows it is under increasing strain (NHS England, 2024). Rising demand is a key factor behind this pressure. The UK population is ageing, with more people living to an older age and obtaining chronic conditions such as diabetes, heart disease, and dementia. These conditions require long-term management instead of one-time treatments (Office for National Statistics, 2023). At the same time, there has been a cultural and medical shift towards greater awareness and diagnosis of mental health issues. As a result, more individuals are seeking help from NHS services, which adds to the demand across primary and secondary care (The Health Foundation, 2023).

The impact of the COVID-19 pandemic has also been significant. Hospitals had to postpone or cancel millions of routine operations and outpatient appointments to prioritize urgent care, creating a backlog that affects waiting times years later (The King's Fund, 2024). NHS data shows record-high waiting lists for elective treatments (NHS England, 2024).

These delays are worsened by workforce shortages, as the NHS currently has tens of thousands of vacancies for roles from nurses and general practitioners to hospital consultants. Existing staff often face high stress, burnout, and job dissatisfaction, which leads to higher turnover and lower productivity (British Medical Association, 2024; The King's Fund, 2023). This, in turn, limits the system's capacity to reduce waiting times.



The issue isn't just about the number of staff. It also involves the overall capacity of the system. Many hospitals operate close to or at full occupancy, leaving little flexibility to handle surges in demand, especially during winter when seasonal illnesses rise. Delayed discharge, often called "bed blocking," is another significant factor. Patients who are medically fit to leave the hospital may not be discharged due to a lack of social care or community support. This means hospital beds stay occupied unnecessarily, causing delays for new patients (The King's Fund, 2024).

Financial pressures are also crucial. Healthcare costs keep rising due to new medical technology, the complexity of treatments, and higher patient expectations. However, funding hasn't always increased enough to match these growing demands (The Health Foundation, 2024). This leads to tough choices about resource allocation and, in some cases, outdated infrastructure that hinders efficiency (The King's Fund, 2023).

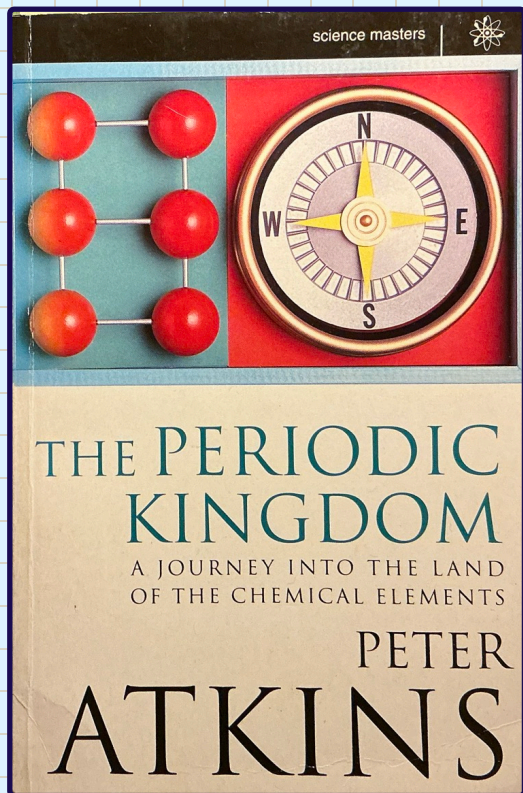
Bottlenecks in specific areas, like limited access to diagnostic services such as MRI and CT scans or delays in lab testing, can slow down the entire patient pathway. This shows how interconnected the system is and how delays in one area can cause issues elsewhere in the NHS.

Despite these challenges, the NHS continues to care for millions each year, providing life-saving emergency treatment, routine care, and preventive services. However, the gap between demand and capacity has widened significantly. This results in longer waiting times, increased pressure on staff, and growing concerns among policymakers and the public about the system's sustainability (NHS England, 2024).

Overall, the troubles facing the NHS do not stem from one issue. They arise from a complex mix of demographic changes, pandemic-related disruption, workforce shortages, financial problems, and systemic inefficiencies. All these must be addressed through coordinated policy, investment, and reform to ensure the NHS can meet the healthcare needs of the population in the future.



## What to Read

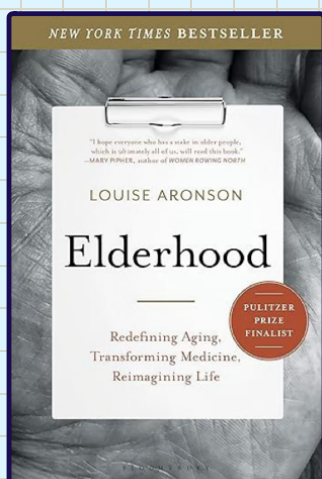


For most, chemistry is a dreary and difficult journey of exceptions to rules, memorisation and formulae. However, sometimes we forget to appreciate the brilliance of chemistry in defining our natural world. In “The Periodic Kingdom”, Peter Atkins describes the Periodic Table (chart of all universal elements), as a Kingdom across a variety of terrains. From the red lake of bromine to the apparently barren ‘Isthmus’ of the Transition Elements.

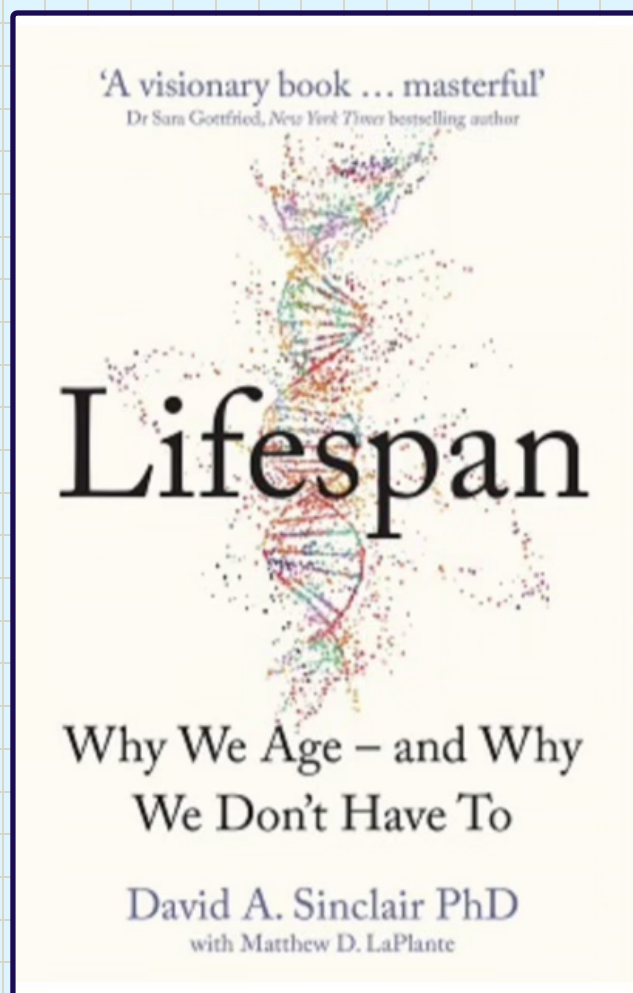
By addressing the periodic trends as mountains and valleys to the coasts of the kingdoms, the exploration of something that previously seemed vast and inaccessible seems as easy as walking through the Kingdom with him as guide.

Developing on the themes explored later on in this newsletter, the importance of ageing and the science surrounding it, is fully explored in both of these books.

These ideas are also focused on in “The Catalyst”, part of the recommended reading in first edition of this newsletter.



In an ageing population, it is now more important than ever to understand our health how science can be used to alter our pre-determined genetic lifespan.



# New Particle Discovered!

Jaipreet Dhaliwal

On the 17th of March 2026, the European Council for Nuclear Research (CERN) officially announced the discovery of a new “proton-like” particle. This discovery was achieved using the upgraded Large Hadron Collider beauty (LHCb) experiment at the LHC, which involved more than 1000 scientists from over 20 countries! So, what precisely is this particle?

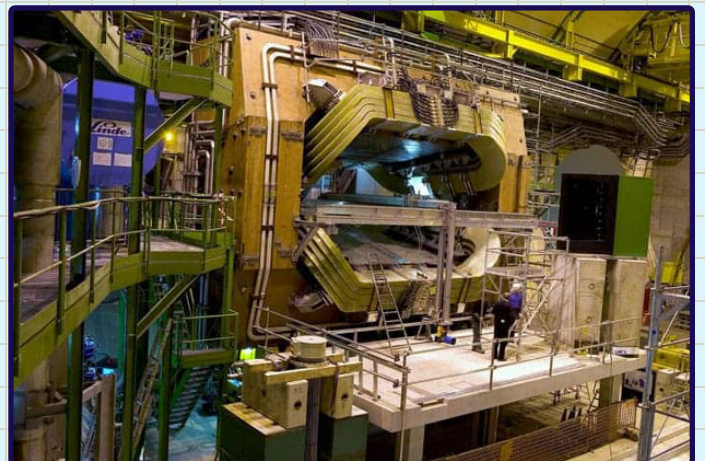
## Composition of the Particle

The particle,  $\Xi_{cc}^+$ , is said to be like a proton, but ‘built’ differently. Instead of containing two up quarks, it contains two heavier relatives called charm quarks, along with one down quark – *but what even is a quark?*

A Quark is an incredibly fundamental particles that come together to create larger particles such as protons and neutrons.

Quarks come in six main types: up, down, charm, strange, top and bottom : they combine in either groups of two (mesons) or groups of three (baryons) which together are known as *hadrons*. To create these CERN uses the LHC (Large Hadron Collider) to smash together these particles - unfortunately, these particles are quite unstable and so decay quickly. Despite this, scientists can analyse the properties of the products of this decay to figure out what the original particle was, which was how the  $\Xi_{cc}^+$  particle was discovered!

From the analysis of the collisions (which took place in 2024), the new baryon was found to have a statistical significance of  $7 \text{ sigma}$ . A sigma is a unit used in a normal distribution to identify whether a new particle was really found, as there can be many fluctuations and anomalies which can occur in testing. With the threshold being  $5 \text{ sigma}$ , the new particle definitely exists!

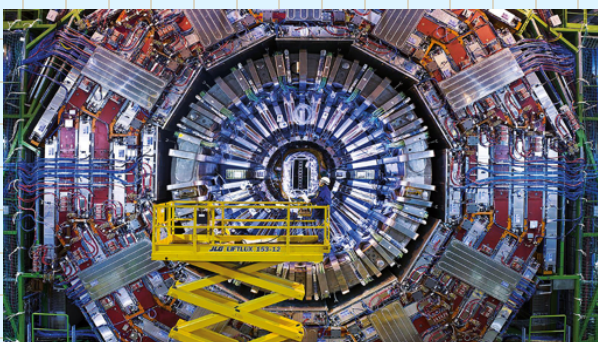


## Importance of the discovery

In context, this discovery could be compared to “finding an extra planet” (- Hassan Jawahery – member of the LHCb experiment) since this isn’t a new fundamental particle (which are quarks). However, this experiment shows an extraordinary capability and potential of the upgraded LHCb detector, which was installed in 2023, along with the  $\Xi_{cc}^+$  being the first new particle identified using it.

“This major result is a fantastic example of how LHCb’s unique capabilities play a vital role in the success of the Large Hadron Collider.

It also shows how upgrading experiments at CERN leads directly to new discoveries, paving the way for the exciting science expected from the High-Luminosity LHC.”  
– Mark Thomson, Director General of CERN



“This is the first major discovery from the LHCb upgrade.

It shows we can now make measurements with just one year of data that were out of reach using a decade of data from the original detector.

I am looking forward to seeing what else we can reveal in the coming years using this unique international experiment.”

– Tim Gershon of the University of Warwick (recently elected to lead the international LHCb collaboration from July 2026)

## Why This Matters

From the establishment of the scientific method to the present day, physicists have sought of away of explaining the things that we see as humans. From the fundamental universal forces to the building blocks of matter, the theories that have been developed help us to understand everything that we see today. The progress of experimental techniques to match theoretical prowess, will be the next step in physics and in the other scientific disciplines.

The LHC upgrade has proven its value with its detection of the  $\Xi_{cc}^+$ , but who knows? There may be more still left to be found...

# TED What to Watch

N



A voyage into the stars, the story of Interstellar is one of a scientifically flourishing humanity, however one where climatic conditions on the Earth has changed to construct a harsh environment with the decline of food sources, and no hope as to being able to replenish them.

Exploring the fantasies of any aspiring astronomer, Interstellar travels to the Saturn for a chance to reach another galaxy with the possibility of a safe haven for the continued existence of humanity.

Beautifully put together, Interstellar is for any curious individual keen to learn more about nature. One of the most amazing aspects of Interstellar is its scientific accuracy, where all occurrences are scientifically backed, with more abstract occurrences as current speculation.

# Is Ageing a Disease?

If so, then can we treat it?

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Katie Herd

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## What is Ageing?

Ageing is something every human experiences, yet whether it should be considered a disease remains widely debated. Some scientists argue that ageing fits the definition of a disease because it involves progressive decline in biological function, while others see it as a natural, inevitable process.

Understanding this distinction matters, because it shapes how society approaches treatment and care.

A disease is typically defined as a condition that disrupts normal bodily function and causes harm. Ageing does involve physical decline - such as increased risk of illnesses like heart disease or dementia. In this sense, ageing shares features with disease.

However, ageing differs in one key way: it is universal. Unlike most diseases, it affects everyone over time and is not caused by a single identifiable pathogen or defect. Because of this, many argue that ageing is better described as a risk factor for disease rather than a disease itself.

Ageing is not purely negative.

It includes both beneficial elements, such as increased experience and knowledge and emotional regulation and resilience; and harmful ones including: reduced immune function – which can increase levels of physical pain and discomfort. Recognising this balance is important. Treating ageing as entirely pathological ignores the meaningful and valuable aspects of growing older.

## Treatment

The concept of ‘treating’ ageing varies in definition, where some may consider it necessary to slow down or potentially reverse the process, and to others it involves eliminating the discomfort of ageing naturally; as to accept the inevitable process rather than combat against it.

To understand how we could ‘slow down’ the ageing process, we must first understand what happens to our bodies biologically (note without the affects of chronic illness).

As with the beginning of all human life, its end starts at the cells – also known as the building blocks of life in which both up you and I are composed of. Cellular damage accumulates from radiation exposure and metabolism collapse over time; this causes a plethora of side effects, one including the shortening of the telomeres on all chromosomes.

Telomeres are located at the tips of eukaryotic chromosomes and function like the hard caps at the end of your shoelaces (aglets), to prevent fraying or fusion of the chromosomes which could cause genetic dysfunction. Although, with every mitotic cycle, a small portion of the telomeres is lost, and when they become too short, the cell becomes senescent (gradually deteriorates) or dies. ( ‘Telomere and Telomerase’ – National Institute of Medicine)

This eventually stops cell division, meaning cells such as stem cells can no longer replicate and therefore old, damaged or deficient cells cannot be replaced, encouraging the gradual deterioration of the human body since it can no longer repair itself.

In theory, increasing telomerase concentrations – telomerase being an enzyme responsible for elongating telomeres to prevent replicative cellular senescence – could prolong the life of chromosomes, and thus the lifespan of a human cell.

However, rather than “curing” ageing, most current research focuses on slowing its harmful effects more naturally, as to maintain a sense of purpose and connectivity in human life, by promoting regular exercise, a balanced diet and, good sleep and stress management. Ageing sits in a grey area between natural process and disease. While it shares characteristics with disease, it is also a universal and meaningful part of life. Perhaps the right approach is not to “cure” ageing, but to reduce its harmful effects while respecting its role in human experience. By focusing on health, rather than simply lifespan, science can help people live longer, healthier, and more fulfilling lives.



# What are Mirror Neurons?

Dammy Ogundalu

## “Mirror” Neurons?

Mirror Neurons are a type of sensory-motor cell located in the brain that is activated when an individual performs an action or observes another individual performing the same action.

Thus, the neurons “mirror” others’ actions. This can easily be observed in the phenomenon of a person yawning causing those observing them to also yawn. How fascinating!

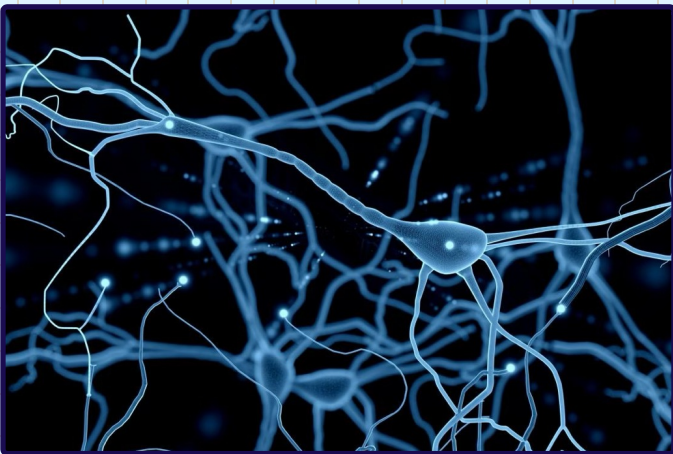
Mirror neurons are of interest in the study of certain social behaviours, such as empathy and imitation, and may provide a mechanistic explanation for social cognition, which we will go into greater detail later on in this article.

Mirror neurons were first described in a seminal paper in October 1992, thanks to the work of Giacomo Rizzolatti and his colleagues at the University of Parma, as a class of monkey premotor cells discharging during both action execution and observation. Despite their directly unknown and debated origin and function, recent studies in several species revealed that these cells (now properly referred as Mirror Neurons), were a variety of cell types distributed among multiple motor, sensory and emotional brain areas to form a ‘mirror mechanism’, much more complex than we initially idealised.

## Where it all began

The journey to discovering mirror neurons began in the early 1990s at the University of Parma, Italy. Here, Professor Giacomo Rizzolatti led a team of neuroscientists, including Vittorio Gallese and Leonardo Fogassi, who were deeply engaged in mapping the motor cortex of macaque monkeys. Their primary objective was to understand how the brain controls specific hand and mouth movements involved in actions like grasping and eating. The researchers focused their investigations on a region of the premotor cortex known as area F5, which was already recognized for its role in planning and executing motor actions.

The experimental setup involved implanting electrodes into the F5 area of the macaque monkeys' brains to record the activity of individual neurons. Researchers would monitor these neural signals as the monkeys performed various actions, such as grasping a peanut or a raisin. During one such experiment, a remarkable and entirely unforeseen event occurred. While a monkey was awaiting the next task, a researcher picked up a peanut to eat it. To the team's astonishment, the electrodes registered activity in the monkey's F5 neurons, precisely the same neurons that would fire when the monkey itself grasped a peanut. At first this caused skepticism amongst the team, as scientists of that time generally believed motor neurons were solely dedicated to executing movements. But this phenomenon repeated itself multiple times over!



## Mirrors and Mass Hysteria

Mass Hysteria, also known as Mass Psychogenic Illness (MPI), is the rapid spread of physical and/or psychological symptoms amongst a group of people without an identifiable cause. This is not triggered by any pathogen, but rather spreads through visual observation, verbal communication or social influence. Now, the direct cause of mass hysteria is unknown and still very arduously researched, however our knowledge on Mirror Neurons gives us a greater understanding of this condition. A time in which this occurred is in the case of the Tanganyika Laughter Epidemic of 1962 that began in a girls boarding school and spread to over 1,000 students.

The laughter was involuntary and distressing, severely interfering with daily life. Scientists have proposed that the inhibitive component for MNS automatic imitation may not function well in individuals of the group that results in the outbreaks of mass hysteria.

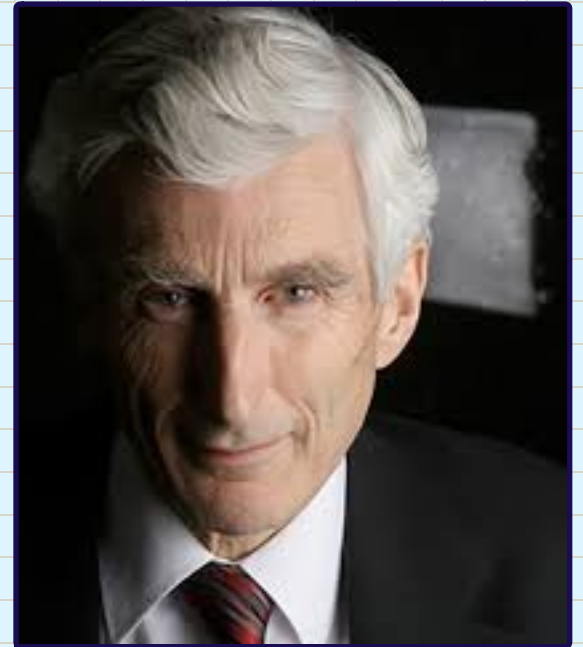
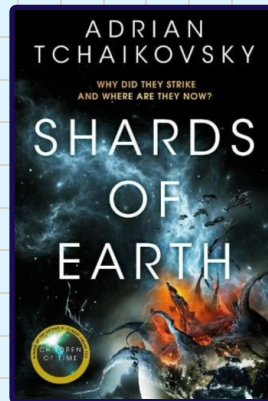
Events like these can prove to us how mirror neurons work in the body and can allow us to broaden our understanding on the cells.

# Coming Soon...

Covering a range of the scientific disciplines, this conversational podcast is hosted by Neil deGrasse Tyson, an American Astrophysicist and Science Communicator



An adventurous sci-fi book series, in a universe of “Architects”, planetary sized bodies with the ability to manipulate gravitational fields



An insight into the journey of Martin Rees - the fifteenth Astronomer Royal and Professor of Cosmology at Cambridge University



# And So Much More!

# Special Mentions

~Stephanie Smith~

~Mr Blyghton~

~New Members of the Team~

## Picture Credit

Stephen Hawking quote - [https://www.goodreads.com/author/quotes/1401.Stephen\\_W\\_Hawking](https://www.goodreads.com/author/quotes/1401.Stephen_W_Hawking)

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## Further Source Credit

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### Disclaimer

~ All links have been checked and were working as of

20/05/26 ~

## About Us

As you can imagine, as this is the first newsletter, the Team is very small in producing these meticulous arrangements of articles.

The main idea behind Beths Science is to be able to explore the sciences, free from the constraints of trying to simplify language to be able to fully explore passions. The beauty of science cannot be expressed if one has to use simple words, if there is a much more efficient specialist term.

If you would be interested in contributing to future newsletters, contact our founder/editor Harvey Todd at:

[20B-Todd@beths.bexley.sch.uk](mailto:20B-Todd@beths.bexley.sch.uk)

This can be used for both my email and for my teams account, if you drop a message I will take a look and then organise something for you, whether that is a short feature article or experience etc. or whether you would like to participate by writing as part of the Team.