MAGAGENE

CODING FOR THE NEXT GENERATION'S GENII

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SCIENCE BEHIND AUTUMN LEAVES

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THE EPIGENETIC TRUTH BEHIND LAMARCK'S THEORY

Discover how acquired phenotypes can be passed on!

AMYLOID AND TAU; THEIR ROLE IN ALZHEIMER'S

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CHILDBIRTH PROBLEMS: TECHNOLOGY VS. EVOLUTION

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Editor: Maddie Charvill , Designers: Olivia Hogan, Tara Schwarze Chintapatla and Mhairi Ellis

LOWER SIXTH WORK EXPERIENCE

Covance Laboratories

For my week's work experience I went to Covance Laboratories in Harrogate. For those of you that don't know, this company runs tests and analyses compounds that could potentially be used in new medicinal drugs. At the time I was totally unsure as to what I wanted to study post A-levels so I didn't know what kind of experience would be most relevant to me. Having said that, I knew I enjoyed working in a lab, and studying the three sciences and mathematics meant that this seemed like a good option. I can safely say that it was a great choice. We got showed around the entire site, and visited many different areas, such as the bioanalytical and metabolism departments. We even got to look around the animal house. Even though this was somewhat distressing, we learnt a lot about the treatment of the animals while they are in there, and just how much time and effort is dedicated to looking after their needs. If you have any interest in medicine or are even just a 'science person' and want to see a few areas that a career in science can lead to, I would highly recommend this placement!

Holly Robson Powell

Foxglove Covert

Foxglove Covert is a Local Nature Reserve situated in Catterick Garrison, and it is where I chose to do my Year 12 work experience placement. The reserve has a wide variety of habitats, including wetland, heathland, and woodlands and it is therefore extremely biodiverse, with more than 2600 species so far recorded on site. This wide variety of habitats requires specialist management, and monitoring of the species found there – something I contribute to through bird ringing which takes place around the reserve.

During my work experience week my main activities were helping to prepare for an event which was to take place over the coming weekend, celebrating Foxglove Covert's 25th anniversary. Some of the most important activities included general maintenance, such as bracken bashing, as well as filling up feeding stations both for birds and Water Voles, and preparing resources for activities that were going on over the weekend.

I was also working as a volunteer guide and bird ringer during the Foxglove 25 weekend, taking on roles such as showing round and talking knowledgably to VIPs, as well as explaining to guests about the bird ringing process during the demonstration on Sunday. Volunteers and visitors had a memorable time over the weekend; I was very glad to not only have been privileged enough to be working as a volunteer, but also to help prepare for the event in my work experience – with the highlight definitely seeing two Water Voles on one of the feeding stations in the early hours of the day.

I thoroughly recommend visiting Foxglove Covert; it is a fascinating and very beautiful reserve, rich both in terms of the wildlife that thrives there, but also the knowledge the staff and volunteers have, enabling visitors to leave feeling more engaged with nature.

Alicia Hayden

Wetheriggs Animal Rescue and Conservation Centre

I had the delight of spending my week's work experience with the crew at Wetheriggs where I worked with a lovely group of people to look after the animals there. I spent the mornings feeding and mucking out the wide range of animals from pigs to mongoose to terrapins to meerkats which gave me the afternoon to spend time with the macaws and the other animals from the 'exotics' barn. The image to the right is of two of the macaws, Gandalf and Florence, who are quite characterful. Gandalf has a bad habit of plucking the feathers out his chest due to previously living with a man who smoked and the nicotine having an effect on him whereas Florence can say 'peekaboo' if you look at her and cover your eyes. Other delightful characters included this pig who is playing with a football and whose water trough always needs refilling because she enjoys flipping it over. Chinchillas are another animal they have in their collection and they were a particular favourite of mine, partly, I have to admit, because they are so soft. The centre also gets involved in conservation projects, such as a current breeding programme for the rare breed pig, the Tamworth, and undertaking surveys on bat and water vole populations, which I look forward to helping with.

Olivia Henderson

INTERESTING CAREERS THROUGH BIOLOGY

Biology is an incredibly wide and diverse subject and there are many places that biology could take you. Some of these careers might be...

Zoologist:

Zoologists and wildlife biologists study animals and other wildlife to see how they interact within their ecosystems. They also study behaviour and the physical characteristics of animals and the impacts human beings have on natural habitats. A career in zoology would involve collecting and analysing data in a lab or outdoor environments. Within the study you would also look at the origin and development of species and therefore doing wider reading through the works of Darwin would be highly beneficial. It is also a great opportunity to get involved in conservation and make a difference to the planet's ecology. Many zoologists are employed by universities and colleges where they teach students and engage in research.

Dietician:

A dietician is an expert in dietetics (human nutrition and the regulation of diet). They are regulated healthcare professionals licensed to assess, diagnose and treat nutritional problems. They are able to counsel patients on nutrition issues and healthy eating habits by developing meal plans to suit their patients. This means that they are able to provide customised information for specific individuals. Most dieticians work in hospitals, either state, local or private and they can work also full or part time. You would need a bachelors degree and to have completed supervised training in order to become a dietician but many people have advanced degrees or a PhD in their area of expertise.

Horticulturist:

Horticulturalists work with plants, applying their knowledge to fruits, vegetables and non-food crops to maximise their health and growth. Horticulture itself is actually a very large field where horticulturalists can find themselves working in plant production, management, marketing, education and research. Some are self-employed in fruit or vegetable production, landscape design, plant nurseries, greenhouses and garden centres. They might conduct research into horticultural science, such as breeding new plant varieties, increasing drought resistance or increasing yields. Researchers may also use their expertise to suggest improvements for canning and freezing companies, seed companies and manufacturers of growing equipment and supplies. This career path may not be suitable for someone with allergies because workers may be exposed to plant, pollen and chemical allergens for long periods of time.

Forensic Anthropology:

Forensic anthropology is the analysis of human remains, not to be confused with a coroner, for legal purposes such as establishing the identity of a victim, being able to give a name to a victim is crucial in legal investigations. It is a specialised area of forensic science that requires detailed anatomical and osteological training. The identification relies heavily on the hard tissues of the skeleton, primarily bone, although soft tissue can be used as well. A forensic anthropologist uses markers on a skeleton to determine a victim's age, sex and ancestry, they can also potentially determine cause of death, past trauma or diseases that the victim in question has had.

"IT IS A SPECIALISED AREA OF FORENSIC SCIENCE THAT REQUIRES DETAILED ANATOMICAL AND OSTEOLOGICAL TRAINING. "

Clara Price

Caitlin McKeag

Lucy Pringle

Emma Adams

In the autumn, all over the world trees turn from green to all kind of magnificent colours, from shades of yellows and oranges to brilliant reds, pinks and purples, some even go black.

But why do they change colour?

Firstly, we need to know that the colour of a leaf depends on the pigment at the surface, and those pigments are chemicals such as chlorophyll which is green or anthocyanins which are red.
Chlorophyll is a chemical that can convert sunlight into a more useful form of energy (glucose or ATP) that plants can use. But chlorophyll uses energy when it is made, so in the autumn when the sun wanes and the level of energy it can produce drops it becomes unjustifiable for the tree. Its production slows down and eventually stops. The existing chlorophyll breaks down into colourless compounds and the leaves lose their green appearance.
The carotene below, a pigment ranging from yellow to orange in colour, is now revealed.
The red colour comes later in the tree's process of preparing for winter. The tree cuts of the supply of nutrients to the leaves, in order to keep them for the next growing season, by forming a layer of 'corky' cells, across the base of their stalk. This is known as the abscission layer. This layer also stops the sugars in the made leaves from moving into the tree. They become concentrated and are eventually converted into anthocyanins, which are red or purple in colour.

Factors that affect the 'autumn colours'

So far no one has proved that a specific factor has an effect on the autumn colours but we have theories ranging from the weather as being a very likely factor to fertilisers as a likely option. The doubt is mostly due to the lack of research done in this area of biology (any volunteers!).
Cold temperatures destroy chlorophyll and so bring the yellow carotene into view. Anthocyanin, the red pigment will be produced as long as the temperature stays above freezing (0^{o}C.). Dry weather increases the production of anthocyanin as there are more sugars kept in the leaf leading to a more vibrant red colour.
Sunlight levels also affect the production of anthocyanin as a sunny day will trigger the tree into wanting to increase its rate of photosynthesis. It will deliver more sugar to the points of photosynthesis, the leaves, but as there is only a small amount of chlorophyll left the concentration of sugars increases, leading to more anthocyanin being produced.

Why do trees shed their leaves?

Quite simply it is because they are too much effort to keep alive. They would require constant nutrients and energy and so would not allow the tree to build up any stores for the next growing season. During the winter months the trees go into a state of dormancy similar to hibernation, they try to use as little from their stores as possible so they

can have the best chance in the next year. Having leaves would also result in the tree risking drying out as the leaves have tiny, but essential, stomata pores on their underside where in the spring the tree brings in the carbon dioxide it needs for photosynthesis and making energy, but they also allow water to leave the tree. If a tree continued to allow this gas exchange throughout the winter, it would lose too much water and be unable to survive.

…Then why do some trees keep their leaves?

These are the Evergreens, (clue's in the name). These are trees that originated in the cold, northern parts of the world where the growing season is comparatively shorter than that of the south. This makes energy collection less efficient and so for them to gather enough to survive they need to photosynthesise all year round, hence they do not lose their leaves.
However, similarly to deciduous trees, they do have dormant periods but they depend upon the availability of water rather than sunlight. As long as the water is in a useful form i.e. not snow or ice, they remain active.
Some also have other adaptions such as the needles on a pine tree, which are in fact just very tightly rolled leaves; the shape allows them to conserve water as a liquid a little longer than the surroundings and stop it evaporating in warmer weather; their waxy coating also helps this.

Climate change – Is autumn about to disappear?

Trees are already changing colour several days later than they did two decades ago, with a seven to twenty day delay predicted for 2100.
As we have seen, the vibrancy of the autumn colours depends on the weather and when climate change brings more and more frequent droughts and greater cloud cover you can see why we could be worried for our delightful displays. Perhaps at more risk are the brilliant red pigments, rather than the yellows and oranges, as in cool temperatures the trees keep sugars in the leaves, allowing the production of anthocyanin, but in warmer temperatures the sugars are taken away to other parts of the tree, stopping the build-up of a high concentration of sugars and so there will be no more vibrant reds, pinks or purples.

But climate change is not the only human sparked disaster for the world's trees. Recent studies suggest that along with their many other bad-side effects, fertilisers can potentially be blamed for dulling the autumn shows. With an excess of nitrogen in the soil trees adapt to rely on this source and reduce how much sugars they store in their leaves. When autumn comes the amount of sugars trapped in the leaves when the tree cuts them off is significantly lower and so less anthocyanin can be produced, leaving our autumn displays lacking their splendour.

Gemma Henderson

Caitlin McKeag

Annabelle Paterson

Esther Arnold

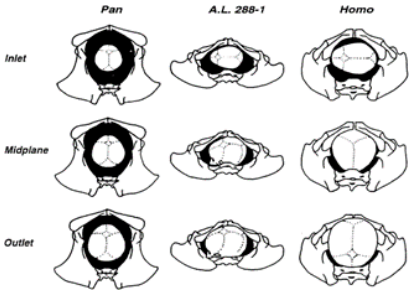
Have you ever wondered why you are the way you are? Why our bodies are constructed in a certain way? The majority of people argue genetic changes passed on by our ancestors are beneficial and that we function well as a species. In actual fact, we are an example of how species are becoming less able to survive and that many of the problems we experience today are affecting our lives and lives of future generations, particularly of those related to childbirth.

Research patterns show that our skeletons have changed significantly from that of our previous ancestors- the apes. Whilst apes still walk on all four limbs, we've adapted to walk on two legs due to the shortening of the arms and lengthening of the legs. The earliest example of this is the remains of the species Australopithecus afarenis, found 40 years ago in Africa, dating back to around 3 million years ago and the bones reveal that she walked upright. Interestingly, her pelvis was also decreased in size and shaped differently to the common ancestors our species shared with the apes. This could be the beginning of the pregnancy problems women are experiencing today.

In addition, the shape of our spine has curved to support our head and upper torso which has caused many problems for our race. Although people receive back pain for several reasons, one common link associated with them all is this alteration of the spinal cord shape because of evolution. A huge amount of pressure is placed on the vertebrae as they are stacked upright instead of spaced out like most species. With increased weight during pregnancy, many women suffer as the vertebrae are put under more strain than other female species experience. Back operations and other surgical advancements can improve our standards of living to some extent, however extension of life has grave consequences for the population density of the planet.

Bigger brains may seem like a huge benefit as we have achieved the status of one of the most intelligent species on the planet. However, this has resulted in complications during labour. Many women are now having to go through the trauma of caesarean sections due to unborn babies' head circumference being too large to fit in the birth canal, particularly past the pelvis. Evolution trends show that the hips and pelvis are becoming increasingly smaller too (named obstetric dilemma), continuing the severity of this issue.

Over the past 50 years the rate of babies being unable to fit through the birth canal has increased from 30 to 36 in 1,000 births. That is about a 10-20% increase of the original rate, due to the evolutionary effect of obstetric dilemma. On average, human babies are 6.1% of their mother's body size compared with chimp babies (3.3%) and gorilla babies (2.7%), showing that evolution has increased the pain women have to experience as a result of childbirth.



Also, recent ideologies have been accumulated which imply that it is the metabolic demands of the foetus that influences when a child is born. At around six months, the pregnancy reaches an energy threshold where the mother cannot support the developing foetus, therefore labour starts around when this barrier is crossed (around the nine-month stage). Not only are women becoming more able to provide their babies with more energy than before, leading to increased development and less room in the birth canal, it also means that obstetric dilemma might not be the main factor in birth problems.

It doesn't stop there. Due to technologies, complications during pregnancies are often able to be fixed and the more caesareans that are performed, the more difficult it will be for other women to give birth. Historically, many women and their babies would have died in childbirth if they had narrow hips, consequently the genes for narrow pelvis wouldn't be get inherited, thus explaining the theory of natural selection and survival of the fittest. Now that these problems can be diverted, genes for a wide enough birth canal are becoming unnecessary, and therefore influencing evolution.

Our diet has also had a serious effect on bone structure and development. Archaeologists have found an increase in infant skeletons around agricultural areas, suggesting an increase in new-borns death rate due to the farming diet. Switching from the protein-rich diet of hunter-gatherers to carbohydrates has

caused women to have narrower hips and encouraged foetal growth, therefore making childbirth more challenging. When considering the amount of carbohydrates we consume currently compared to before the agricultural thrive, there doesn't seem to be an end to the increase in larger babies. Maternal mortality figures have reached 830 deaths per day. Even among women who do not lose their lives during childbirth, some studies say the process leads to life-changing but non-lethal injuries in as many as 40% of cases.

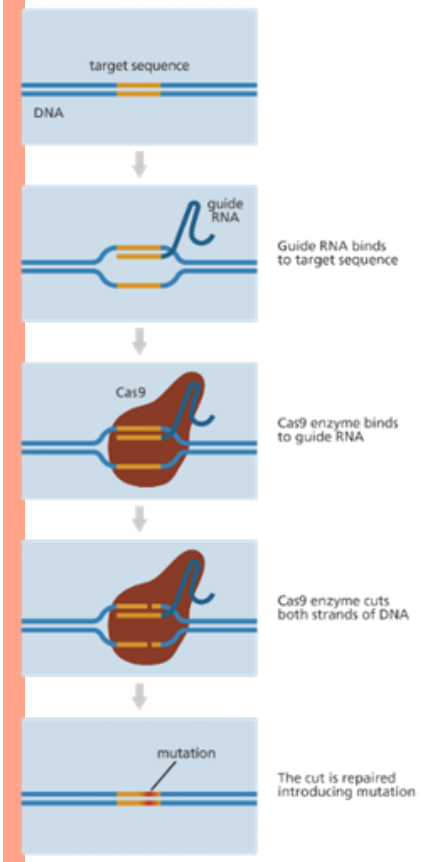
With some women opting for caesareans due to fear of the pain and injuries sustained as well as limited space, it is effectively eliminating the need for the wider pelvis, therefore the drive for natural selection is inhibited in relation to this factor. Although the slow increase of around 15% of foetuses not being able to fit per half a century, technology is proving to be a controversial factor in balancing making lives easier and altering them too far, steering childbirth and human development into dangerous waters. At this rate, there may come a time where the majority of (if not all) women will have to undergo surgery during labour, which has serious implications on ethics and living standards. Soon we will simply be unable to survive without the natural evolution that should be taking place, and relying on technological operations to fix ourselves rather than a natural course could be a seriously risky game to play.

Mhairi Maxwell

DID YOU KNOW? THE WORLD HEALTH ORGANIZATION ESTIMATES THAT ABOUT 830 WOMEN DIE EVERY DAY BECAUSE OF COMPLICATIONS DURING PREGNANCY AND CHILDBIRTH

Altering the Genome: CRISPR Cas9

Throughout human existence our genome has only be influenced by random mutation and natural selection. However, in the last few years the ground-breaking discovery of the CRISPR-Cas 9 technology has meant we now have the potential to alter not just the DNA of all humans living today but of future generations. The CRISPR-Cas9 system is based on a bacterial immune system which was found by two French scientists. While studying cheese-producing bacteria for the food company Danisco, Philippe Horvath and Rodolphe Barrangou came across a bacteria that could cut the genome of invading viruses in specific places, preventing them from replicating. The bacterial defence system works by cutting off a section of the invading viruses DNA using specific enzymes. They then insert these fragments into a specific section of their own DNA, where they are known are CRISPR sequences. If the virus enters the body again this CRISPR sequence is used to recognise and attack the virus. There are two parts to this action: an RNA guide and a Cas enzyme. RNA is very similar to DNA carrying the code for a gene in the form of a sequence of bases, however unlike DNA, it is single stranded, allowing it to bind to one of the strands of DNA. The RNA acts a guide, identifying and binding to a specific point on the viruses DNA. The Cas enzyme then binds to this point on the DNA, making a cut though both strands of the DNA, paralyzing the virus.



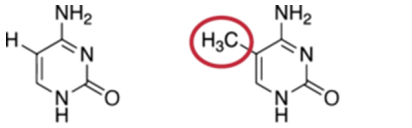
In 2011 Emmanuelle Charpentier and Jennifer Doudna realised this mechanism had the potential to be altered for use in humans. They realised if the guide RNA could be altered, then different genes could be targeted and intentional cuts could be made any desired gene. This allows the potential to insert a missing gene into the DNA or to alter existing, mutated genes. When DNA is cut the immune system immediately signals a response to repair it. Therefore by cutting the DNA, an immune response could be initiated that caused a change to the genetic sequence (a mutation). If disease causing genes could be targeted, these induced mutations could lead to the correct genetic sequence being produced.

This technology has the potential to be used in the cure of many genetic diseases which involve complete lack of a gene or mutations to certain genes. However, currently there is widespread concern about the potential dangerous implications this technology could have and whether it would be appropriate to use the technology to 'improve' ourselves. Therefore, although the technology exists, it may be many years before it is seen as acceptable to alter our genome.

Lara Sterritt

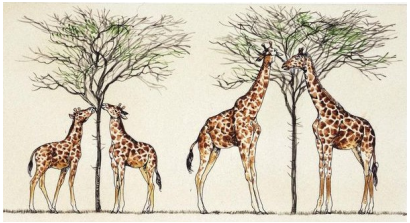
Is There Any Truth Behind Lamarck's Theory?

Epigenetics involves the study of molecular-based changes to the DNA sequence gathered during an organism's lifetime in response to its environment, meaning that the same genotype between two individuals, under the influence of epigenetic gene expressers or repressors, can be phenotypically different. One type of epigenetic modification, DNA methylation, is relevant for this article, and involves the addition of a methyl (-CH3) group to DNA. It is normally called CpG methylation, as the methyl group is typically added by enzymes to a cytosine DNA base directly next to a guanine base. In essence, CpG methylation in a region of DNA will 'switch off' the particular gene or cluster of genes it has bound to. An important note is that epigenetic modifications are generally considered to be cleared off of the DNA on passage through the germ line, however not in every case.



Cytosine methylated Cytosine

These days the generally accepted theory of evolution is Darwin's natural selection, however previously, it was proposed by Lamarck that any acquired characteristics during an organism's lifetime would be passed onto its offspring. His theory proposed that the giraffe's long neck developed as numbers of giraffes had to reach for ever-higher leaves, thus developing a longer neck which was passed onto the next generation. In another example, Lamarck recorded that the sons of blacksmiths tended to have larger muscles than the sons of weavers – he interpreted this as the blacksmiths' sons inheriting the acquired phenotype of large muscles from their fathers. These days, we would interpret that the blacksmith trade would attract those perhaps genetically best suited to it – those endowed with the genetic ability to develop larger muscles would have a selective advantage in this trade, and their sons would be likely to inherit any genetic advantage to develop larger muscles, following Darwin's theory. However, as epigenetic modifications can affect an organism's phenotype, if certain epigenetic changes were to be passed on to offspring DNA, this would surely show a mechanism for a type of Lamarckian inheritance. Remarkably, certain situations such as the Dutch Hunger Winter and experiments involving coat colour in mice, show exactly this.



The clearest demonstration of this inheritance in action is Emma Whitelaw's experiment on the inheritance of coat colour in agouti mice. Her work proved the variable coat colour in mice was due to an epigenetic mechanism, specifically DNA methylation of a retrotransposon (a DNA sequence which doesn't code for protein, and is associated with keeping a local gene switched on permanently) in the agouti gene. Mice of different coat colours had the same genetic sequence, but different methylation levels of the retrotransposon. Whitelaw worked to show that these characteristics were transferred to the next generation. Hundreds of mice later, she found that female mice with an unmethylated retrotransposon, switching on the agouti gene permanently (as opposed to a normal level), hence having yellow fur, had pups which were all either yellow or slightly mottled. If the mother was dark-furred due to a methylated retrotransposon, therefore mediating the agouti gene at a normal level, her pups were stable ratios of light, mottled and dark-furred. This showed an epigenetically-reliant phenotype in an animal could be transferred to its offspring.

To prove it was strictly epigenetic modifications being passed on, Emma and her team then transferred fertilised eggs obtained from yellow mothers and implanted them into dark mothers, vice versa. The patterns in coat colours in their offspring was what was to be expected from the egg donor, not the surrogate mother, suggesting the uterine environment was not affecting the coat colour. Furthermore, during complex breeding schemes it was also proven that the inheritance of the coat colour was not due to the cytoplasm in the egg. Taken together, this suggests that in the experiments, epigenetic modifications were passed on along with genetic information.

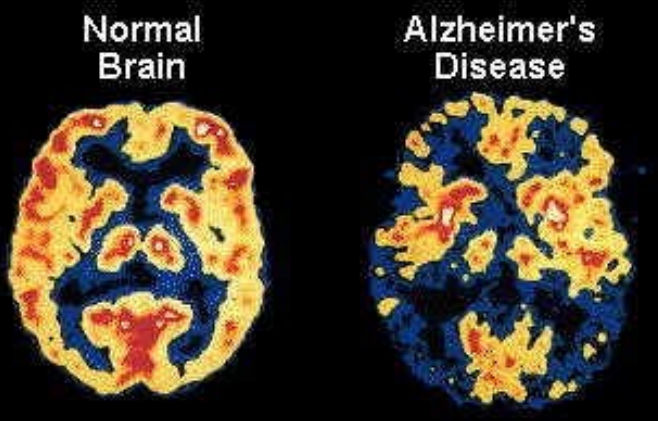
> "THE SAME GENOTYPE BETWEEN TWO INDIVIDUALS, UNDER THE INFLUENCE OF EPIGENETIC GENE EXPRESSORS OR REPRESSORS, CAN BE PHENOTYPICALLY DIFFERENT."

Whilst Lamarck had no idea about the mechanisms of genetics, it is clear that there is actually an aspect of truth behind his ideas in phenomenal cases, and future research into epigenetics may further consolidate this. Reversible and heritable changes can occur without a change in DNA sequence (genotype), induced either spontaneously or in response to environmental factors – Lamarck's 'acquired traits'. This remains controversial as science historians have asserted that it is inaccurate to describe transgenerational epigenetic inheritance as a form of Lamarckism.

Maddie Charvill

Amyloid and Tau - What's Their Role in Alzheimer's?

Alzheimer's is the most common cause of dementia, affecting 62% of those diagnosed. Although Alzheimer's is not a disease exclusive to the elderly, the majority of cases are in those individuals over the age of 65. Alzheimer's is a neurodegenerative disease which means that it gradually leads to the destruction of the neurones in the brain.

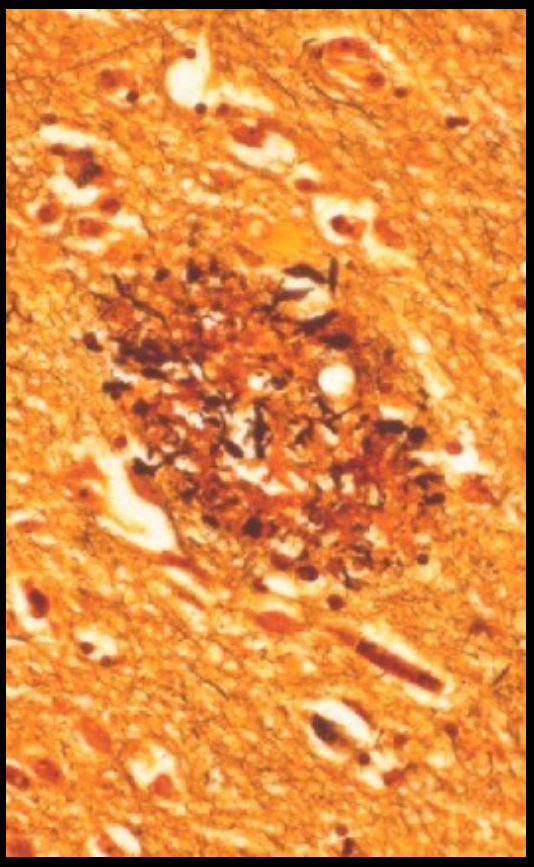


There is a plethora of things that could be held responsible for the damage to the brain such as circulatory problems and genetics but more recently it has been suggested that two proteins that congregate in the brain also have a part to play in this disease. The two proteins which are of primary interest are called amyloid and tau. The interaction between these proteins and their interactions with the brain are largely unknown. However, it is thought that amyloid accrues in sticky clusters called beta-amyloid plaques which nestle in the synapses between neurones and disrupt the connectivity within the brain. These plaques, on average, exist in much greater numbers in people with Alzheimer's disease. For this reason, pharmaceutical companies have been attempting to find drugs which break down the amyloid protein but attempts thus far have failed. This may be because amyloid plaques aren't the whole story and it has even been experimentally proven that perfectly healthy individuals have the plaques in the brain. Tau is the other protein that is thought to have a role to play in Alzheimer's. Tau aggregates in dying cells in structures called neurofibrillary tangles – these are formed by the hyper phosphorylation of the tau protein but the mechanism of this remain largely in the dark. It is believed that these tangles, like the amyloid plaques disrupt neuronal transmission but again it is controversial whether the tau tangles are a primary causative factor in the disease or play a more peripheral role.

Another factor that may lead to the development of Alzheimer's is chronic inflammation and it is thought this is linked to the two proteins mentioned above. Inflammation is a normal process but if the inflammation is perpetuated over a long period of time it can cause severe damage. In the brain there are cells called microglia, these cells have the job of processing and breaking down waste, including the two proteins Amyloid and Tau. The gene that is thought to be responsible for directing the activity of the microglia is called TREM 2 and is supposedly dysfunctional in people suffering from Alzheimer's. This means the microglia neglect the build-up of proteins and when the brain recognises this accumulation as an issue, it sends out more microglia to the rescue. However, the problem with this strategy is that the new microglia cells don't know where to go either and so end up aggregating much like to proteins which itself exacerbates the inflammation.

What is described above is only one of many potentially causal factors in the development of Alzheimer's. Other factors include excessive breakdown of acetylcholine (neurotransmitter) and also the genotype of an individual, with one particular version of something called the APOE gene seeming to predispose people to the disease.

Maya Mellor



For thousands of years, humans have been able to use the materials that nature provided us with to build the tools and devices resulting in the creation of the modern world. We have made flying vehicles, pyramids and even robots. Notice, however, that these inventions all share a theme. They are inanimate; they are lifeless. The idea that we can create life itself may seem absurd. After all, all life as we know it came from some life before it, its genome created inside a parent cell through a natural method that has existed for billions of years.

Synthia, or Mycoplasma micoides JCVI-syn1.0, is an exception to this. It is a single cell and its genome was created in a computer. John Craig Venter-a geneticist and biotechnologist-and a team of his were part of a project which took fifteen years and roughly $40 million to get them from their starting point of sequencing the first complete genome in 1995, to the synthetic organism, Synthia. After the genome was created on a computer, it was assembled in a machine from four bottles of chemicals (the raw letters of the genetic code: A, T, C and G). The DNA was then inserted into yeast cells, which manufactured the chemical blocks into a complete bacterial chromosome. This was then transferred to a recipient bacterial cell, thus transforming the cell into a new bacterial species.

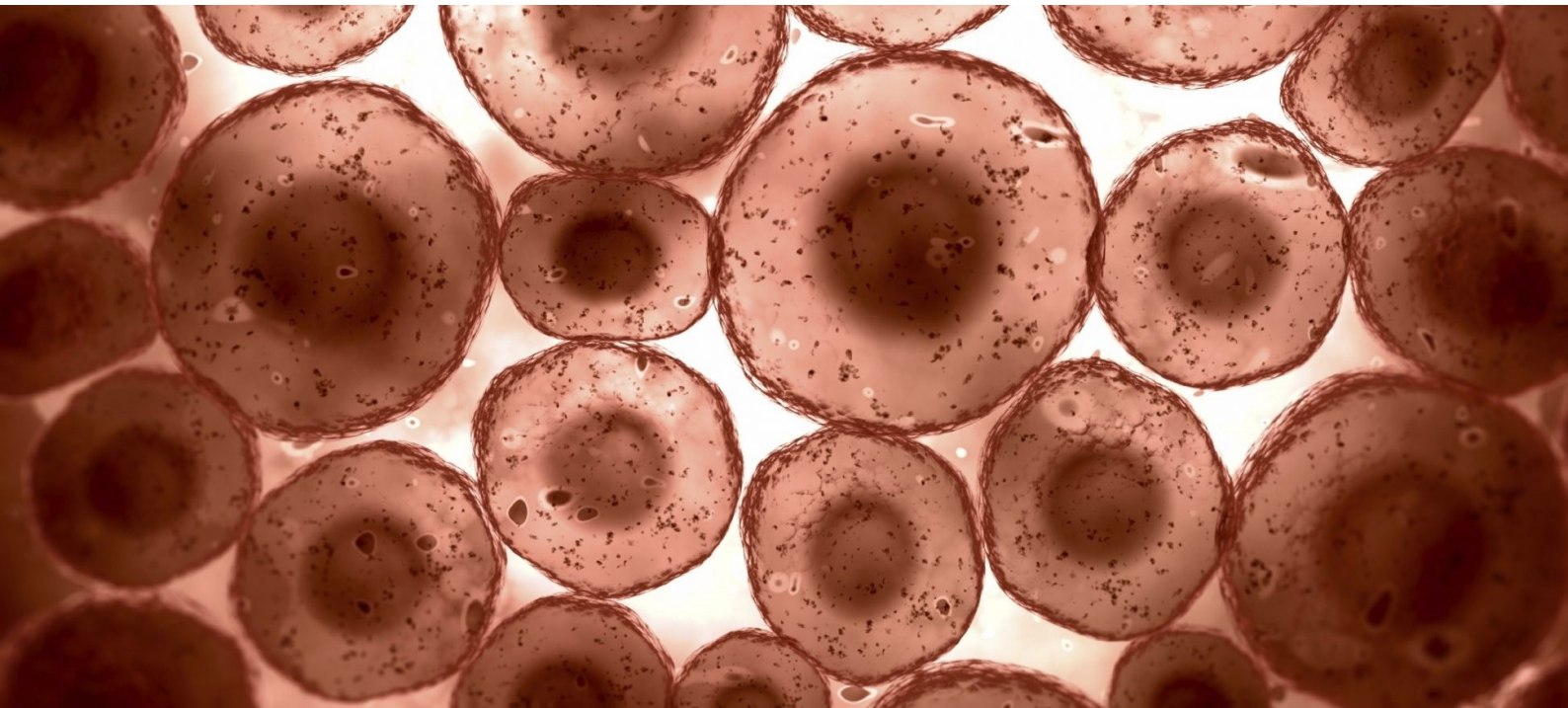
The team needed to find a way of distinguishing the synthetic cell from a naturally occurring one. To do this, they invented a code which they could use to translate hidden messages into the genome, putting a watermark on their creation, much like an 'Easter egg' in computing (this is a unique hidden message or image that is buried within the game). Mathematicians have been hiding and writing messages in genetic code for a while, but in this scenario, the code of the mathematicians would probably lead to the synthesis of new proteins (and those proteins would have unknown functions), making it unsuitable. The code that Mike Montague and the team invented contained all twenty six letters of the alphabet, along with punctuation and numbers. The synthetic genome is encrypted with the names of forty six different contributors to the project, Synthia's own website address and three rather philosophical quotations. My favourite of the three would be "See things not as they are, but as they might be." taken from a biography of Robert Oppenheimer. This clever trick showed that DNA can act as a data storage device for information that is not biologically relevant.

Earth is bursting with life. Evolution has led to the existence of a multitude of different cells, each with different functions. So why do we need man-made cells if our home is replete with so many that nature provided? Unfortunately, evolution does not work in the favour of one species, and it cannot help us undo some of the destruction we have caused to the planet. By determining the smallest number of genes and minimum amount of genetic code needed to sustain a living cell, the idea is to use this genome as a foundation on which we can build new functions. Many of these functions are particularly grand. In the future we may be able to shorten the process of making vaccines, from weeks or months to just twenty four hours. Many pathogens mutate quickly, and our current vaccines can't keep up; take HIV or the common cold as examples. Another direction is to develop new stains of algae that capture CO2 from the atmosphere, or other concentrated areas. Dr Venter and his colleagues are already collaborating with pharmaceutical and fuel companies to begin the process of developing some of these systems.

The ethical issues surrounding this kind of technological advance are numerous and obvious. The Daily Mail bellowed 'Scientist accused of playing God after creating artificial life by making designer microbe from scratch-but could it wipe out humanity?' Fear not. The genome had devices built into it which prevent it from posing any potentially dangers. In general, these work by including genes which mean your modified bacteria can only grow in a very specific mixture of food that can only be made in the lab. Therefore, the cell would only be able to thrive outside of the lab if someone with molecular biology expertise modified the genetic material further. Dr Helen Wallace from Genewatch UK said "If you release new organisms into the environment, you can do more harm than good," Venter fought back by saying "…there have been extensive reviews including from the National Academy of Sciences, which has done a comprehensive report on this new field."

This is "a defining moment in the history of biology and biotechnology"-Mark Bedau, a philosopher at Reed College in Portland, Oregon. But people tend to fear what they don't understand, and although this milestone is far from insignificant, the gap between science and societal acceptance remains a very real one indeed.

Holly Robson Powell



The Lynx

The lynx is a largely forgotten predator that once roamed the forests of Britain over 1,800 years ago, so unlike the wolf has not got the bad reputation passed down through fairy tales, opening the door to potential reintroduction. It has a secretive nature, living under the cover of the forest, and is only forced out when prey is scarce, meaning it is of little threat to humans (when pushed away from its cubs a mother will not defend them and any injuries come from captured or rabid individuals). Its forest has largely been destroyed since its demise but studies show that there is still enough cover in the UK, particularly in the Scottish Highlands, and enough wild prey for the reintroduction of a viable[1] population. Research suggests that habitat destruction was not the main reason behind their extinction; the blame lying on early hunters who trapped them to sell their fur, giving us the moral imperative to at least consider their reintroduction.

Lynx are a keystone species[2] meaning they would help restore the 'broken' ecosystems of Britain; they kill foxes, for example, which allows small birds and mammals to survive and they move deer around as they hunt them, allowing vegetation to recover. Their impact on livestock is a minimum; in Europe there are over 10,000 lynx and only one sheep is taken every two and a half years. Their reintroduction could bring tens of millions to the UK economy, as it has done in Germany where the whole area of the Harz Mountain Range that has seen their reintroduction has been named the 'Kingdom of the Lynx'.

The call for their reintroduction has been met with a very positive response; the proposed trial at Kielder Forest in Northumberland received a 91% vote in favour in a survey of 9,000, 86% of whom wanted it to be in the next 12 months.

However, not everyone holds this view, farmers being amongst them who claim that their threat to livestock has not been thought through properly. The worry of potential loss of livestock damaging their livelihoods, UK lamb sales contribute £1bn to UK agriculture and food from the farmgate[3] is crucial for UK food production which in turn boosts the economy and provides jobs, has been worsened by the lack of state compensation in Britain for damage caused by wildlife, something that is costing European governments a fortune. Their livelihoods and history are based on farming and the life that comes with it and they are an integral part of their communities. The lynx has been absent for hundreds of years and the reintroduction of them threatens this, so this is why farmers are opposed; they are frightened of the change as are many people and reintroductions represent change with the psychological impact of the loss of land control and the right to roam. Especially as the outcomes of the reintroduction cannot be fully known due the nature of being a keystone species and a top predator; there are many levels to filter down with possible unforeseen significant changes to the ecosystem.

Others that disagree enjoy game hunting and believe in the multimillion pound industry that has built up to replace the top predators; they blame the lynx for keeping numbers of game down and claim threatened native species such as the black grouse and the capercaillie are under threat from the lynx, even though they only tend to supplement their diet.

However, if well managed the lynx could be reintroduced, the Scottish Gamekeeper Association has agreed as long it is clear how they are being managed, what action they can take against nuisance individuals, where they are and what they may do. They can be managed, as seen in Finland and Sweden, where quotas are set to control their populations based on these nuisance individuals. Management must also allow a balanced coexistence with humans who live with them.

Olivia Henderson

[1]Having a large enough gene pool for a population to survive indefinitely

[2]A species that has a disproportionate impact on their ecosystem

[3]Raw materials that go to support other industries, such as sheep, cereal and cider apples

Biology Word Search

ALLELE
ANTIBODY
ANTIGEN
ATP
CELL
CHLOROPLAST
CLONE
DNA
ENZYME
EVOLUTION
GENE
HOMEOSTASIS
HORMONE
MEIOSIS
MITOCHONDRIA
MITOSIS
NERVE
PHOTOSYNTHESIS
RESPIRATION
SYNAPSE

L U R S Q V E W C C T F M R N E X Q Y O
P L Y Q I M X E K I W I G O F L M E M K
H T J A Y S L D A T T T I Y Q E Z C C G
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C O L H W U M K F A A K E U U N N O K F
D W C J E R M H L V C K M R A J L F M S
F P L Z J U J Z H E T O O U L B N I W A
E A X W Z S V H H G W F H R E K A C I N

Caitlin McKeag

Maddie Charvill

Mhairi Ellis

References:

The science behind autumn leaves
https://www.woodlandtrust.org.uk/blog/2016/09/why-autumn-leaves-change-colour/
http://www.bbc.co.uk/earth/story/20140929-why-is-autumn-changing
http://www.idahoforests.org/ask/trees/f_tf_17.htm?OpenScript=12858
https://sciencing.com/type-energy-produced-photosynthesis-5558184.html

Childbirth – technology vs evolution
http://www.bbc.co.uk/news/science-environment-38210837
https://www.smithsonianmag.com/science-nature/timing-of-childbirth-evolved-to-match-womens-energy-limits-18018563/
http://www.sciencemag.org/news/2013/02/human-evolution-gain-came-pain
http://onlinelibrary.wiley.com/doi/10.1046/j.1471-0528.2002.00010.x/full
https://www.sciencenewsforstudents.org/article/many-human-ails-are-%E2%80%98scars%E2%80%99-evolution
http://www.bbc.com/earth/story/20161221-the-real-reasons-why-childbirth-is-so-painful-and-dangerous

The truth behind Lamarck's theory
Evolution.berkeley.edu. (2017). Early Concepts of Evolution: Jean Baptiste Lamarck. [online] Available at: https://evolution.berkeley.edu/evolibrary/article/history_09 [Accessed 20 Nov. 2017].
Carey, N. (2012). The epigenetics revolution. Icon Books Ltd.
https://www.researchgate.net/publication/12754768_Epigenetic_inheritance_at_the_agouti_locus_in_the_mouse

The Lynx
C. Baynes, "The lynx could be back in the UK within months after a 1,300 year absence," 2017. [Online]. Available: http://www.independent.co.uk/news/uk/home-news/lynx-1300-years-reintroduced-uk-kielder-forest-a7832036.html. [Accessed 17 August 2017].
P. Bicknell, "Monbiot's vision of rewilding Britain ignores economic impact," 2013. [Online]. Available: https://www.nfuonline.com/news/staff-blogs/idea-of-rewilding-britain-ignores-economic-impact/. [Accessed 16 August 2017].
A. Vaughan, "Rewilding Britain: bringing wolves, bears and beavers back to the land.," 2014. [Online]. Available: https://www.theguardian.com/environment/2014/sep/19/-sp-rewilding-large-species-britain-wolves-bears. [Accessed 6 August 2017].
WWF, "Norwegian hunters have lynx extinction in their sights," 2017. [Online]. Available: https://www.wwf.org.uk/updates/norwegian-hunters-have-lynx-extinction-their-sights. [Accessed 10 August 2017].
WWF, "Switzerland proposes to hunt it's last three wolves," 2017. [Online]. Available: https://www.wwf.org.uk/updates/switzerland-proposes-hunt-its-last-three-wolves. [Accessed 10 August 2017].
The Scottish Farmer, "Bringing realism to rewilding," 2017. [Online]. Available: http://www.thescottishfarmer.co.uk/news/14980281.Bringing_realism_to_rewilding/#gallery1. [Accessed 16 August 2017].
A. Driver, "NFU Scotland warns of danger of rewilding Britian," 2017. [Online]. Available: https://www.fginsight.com/news/news/nfu-scotland-warns-of-dangers-of-rewilding-britain-4858. [Accessed 16 August 2017].
B. Daniel, "Return of lynx to Kielder Forest backed by more than 90 percent of survey respondents," 2015. [Online]. Available: http://www.chroniclelive.co.uk/news/north-east-news/return-lynx-kielder-forest-backed-9128738. [Accessed 17 August 2017].
M. Muncaster, "Case for and against reintroducing wild cats in Kielder Forest," 2017. [Online]. Available: http://www.chroniclelive.co.uk/news/north-east-news/lynx-effect-case-against-reintroducing-13347564. [Accessed 17 August 2017].
R. Milton, "Blog: Rewilding National Parks - The farmer's friend or enemy?," 2016. [Online]. Available: https://www.nfuonline.com/news/staff-blogs/blog-rewilding-national-parks-the-farmers-frie/. [Accessed 16 August 2017].
Cumbriacommoners.org.uk, "We reject Chris Packham's ideas to rewild Cumbrian fells | Federation of Cumbria Commoners," 2017. [Online]. Available: http://www.cumbriacommoners.org.uk/we-reject-chris-packhams-ideas-rewild-cumbrian-fells. [Accessed 16 August 2017].
Ramblers.org.uk, "Rewilding Britain - Ramblers," 2017. [Online]. Available: http://www.ramblers.org.uk/news/walk-magazine/current-issue/2015/august/autumn-2015/where-the-wild-things-are-rewilding-britain.aspx. [Accessed 15 August 2017].

Alzheimer's
https://www.alzheimers.org.uk/info/20027/news_and_media/541/facts_for_the_media. Date Accessed 17/11/17.
https://www.scientificamerican.com/article/here-rsquo-s-what-we-think-alzheimer-rsquo-s-does-to-the-brain/. Date Accessed 17/11/17.
https://en.wikipedia.org/wiki/Neurofibrillary_tangle. Date Accessed 17/11/17.
Brain Story. Susan Greenfield. BBC Worldwide Limited. 2000.
https://www.scientificamerican.com/article/could-the-ldquo-alzheimer-rsquo-s-gene-rdquo-finally-become-a-drug-target. Date Accessed 17/11/17