

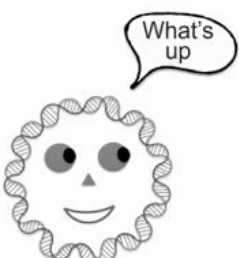
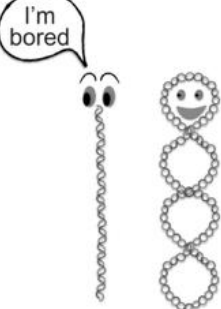
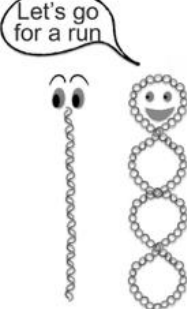
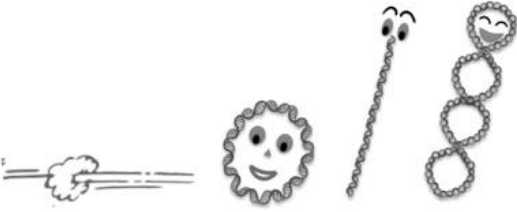


VOLUME 7, FEBRUARY 2019

LIGNUM VITAE 2019



The Department Of Life Science and Biochemistry
St. Xavier's College (Autonomous), Mumbai



			
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A Constant Journey Towards Change

Painting by
Aryaa Apotikar FYBSc

EDITORIAL

They say “Change is Inevitable” but everyone’s perspective of what ‘change’ really is, differs!

Science undergoes change every second. From the evolution of our furry, foraging apes to the possible colonization of Mars or the turbulent journey of scientists attempting to generate life from scratch, to each and every cell of our bodies undergoing a magnificent number of constant changes- it is astounding!

Renowned breakthroughs in biological sciences over the years would not have come to realization without contributions from various fields. This amalgam of ideas leading to some spectacular changes is what we wanted to explore.

We went through a lot of brainstorming as a team to finally put this little outlook of ours into a theme, encouraging writers across diverse disciplines to give us their perspectives on ‘change’. We are very proud to present this year’s Lignum Vitae 2019 theme as ‘A Constant Journey towards Change’.

As a team, we wanted to bring to light the changes our society has gone through in accepting pure science and research as a career for both males and females. The stigmas women faced while stepping out from their houses and taking up a career which is challenging and taxing and how much of change this thought has undergone. Breaking stereotypes about Science being a field which is male-dominated and not deemed fit for women. We wanted to trace these stepping stones over the past decades, which have lead to Science being a wonderful and a very welcoming field for anyone, from any discipline, age, gender to explore and attain a multitude of opportunities in.

We are elated to have personalities like Dr. Indira Hinduja, Dr. Vishwas Sarangdhar, and Dr. Samuel Namdas answer some our questions for this year’s edition, inspiring youth by their journey, the experience of highs and lows and constant changes.

We received a wonderful response from writers across various streams who very skillfully presented their ideas on this year’s theme and we are more than thankful to them.

I would like to thank every member of the team for their wonderful contribution and the never-ending support. The Teachers of the Department of Life Sciences and Biochemistry for the guidance without whom pulling it off would have been very difficult and anyone who was even remotely involved with the Magazine. Thank you so much.

We aspired to inspire young minds to accept change in the field of Science and otherwise, along with the challenges associated with it. We hope we have been able to deliver the same.

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#ThanosDidEverythingWrong

-Noel.Q.S.Gonsalves
SYBSc, Life science

In Marvel's 'Avengers: Infinity War', possibly the biggest comic-adapted movie in history, the star antagonist, the 'Mad Titan' Thanos, believed it to be his destiny to collect the Infinity Stones, extremely powerful artefacts that supernaturally control every aspect of the universe, and use their combined power to wipe out half the life in the universe; you know, basic supervillain stuff. Why? Because he believed that the only way to cure overpopulation in the universe is to dramatically reduce the number of living individuals. And I emphasise on dramatically, as the final chapter of the movie shows Thanos sweep away half the characters like literal dust in the wind just by snapping his fingers. His reasons for this may seem justified on the surface; cruel but necessary. However on closer inspection, Thanos's plan falls apart quicker than Spider-Man in Tony Stark's arms (ouch).

For those who haven't watched the movie (why?), here's a quick plot summary: Thanos hails from a planet whose inhabitants were suffering because there were too many mouths and not enough food to feed them. He suggested impartial genocide as a remedy, but his people (understandably) did not heed his advice and eventually all but he perished. Hence, Thanos took it upon himself to go around the universe "saving" other civilisations by decimating them. Eventually he realised that a faster way to do this was to defeat the universe's heroes, collect all six of the Infinity Stones and wipe out half the life in the universe with a snap of his fingers. This snap now set the entire universe in disarray, eliminating a random half of every living species; animal or plant, earthly or alien. What would an event of such magnitude mean for life on Earth? What would destruction on this scale mean for the biosphere?

Firstly, let us consider the human casualties. In addition to the 50% that already disappeared, what about

the wave of deaths caused by disappearing doctors, evaporating engineers and perished pilots? The approximately 3.8 billion people vanished will doom a thousand others as planes suddenly fall from the sky and patients are left unattended in hospitals. We would put other species in danger by suddenly deserting factories or losing control of machines in forests. Millions of children, pets and the elderly would be left uncared for. Human society would reach a level of panic never seen before, leading to riots and mass migrations, crippling state systems that are already short-staffed. The immense pressure on medical facilities and relief organisations would simply break them, resulting in even more lost lives.

However, humans account for only 0.01% of the biomass on Earth (as per "The biomass distribution on Earth", Yinon M. Bar-On, Rob Phillips, and Ron Milo, 2018). On the whole, farm animals outmass humans 10:1, and the snap affecting them would mean severe food shortage across the world. The disappearance of wild mammals, fish, reptiles and birds would wreak havoc on natural biomes, already in delicate balance because of human activity. Pollinators, scavengers and predators play a pivotal role in maintaining the natural order and if they were reduced, ecosystems would be completely shaken. The vanishing of bacteria, protists and viruses will rattle every ecosystem on Earth. The obligatory relationships that every higher organism has with microorganisms will be cut and almost every affected animal,

plant and fungus will die if its microbiome is damaged. The dematerialization of fungi, even more numerous than animals, will greatly impact plants as most of them are mutualists with fungi. Forests and grasslands influence everything from biosynthesis to the weather, so the loss of plants will unimaginably damage the planet

as a whole. Life on Earth is intimately connected and the loss of any one component can spell disaster for the others.

And the worst part is, all this loss will be for nothing. Thanos's plan to relieve the universe of overpopulation is destined to fail, and he isn't the first to suggest it either. Thomas Malthus, in 1798, wrote that populations have a troubling tendency to overwhelm resources, and that "premature death" is necessary to keep the world in balance. In 1968, Paul Ehrlich published a book titled 'The Population Bomb' in which he argued that without a dramatic decrease in the global population, mass starvation would irreparably increase. Their predictions turned out to be wrong; the population did not explode as much and global starvation is at an all-time low. The apocalyptic scenario of people suffocating the planet is far-fetched, because with an increase in population an increase in innovation follows, and the overall quality of life improves. Population stabilises at an optimum relative to the resources obtainable, by balancing fertility and mortality rates, which means that "overpopula-

tion" has less to do with how many people there are and more to do with how those people behave. In nature, a population hit by a calamity shows a high tendency to bounce back. A population suddenly cut in half will surely suffer another smaller dip; however, the world will eventually get back on its feet, the population will grow even faster as a natural response to the humongous loss of its species until it reaches equilibrium and maintains itself.

The aftermath of the cataclysmic snap can be predicted, and it's more disappointing than Hawkeye's absence in the movie. It's clear that drastic reduction is not the solution to overpopulation and the futility of such a plan should discourage any sensible supervillain from ever attempting one, but Thanos did it anyway, and that may severely affect his shot at the title of greatest Marvel villain of all time. Perhaps if he had attended a course in population dynamics, or learnt a little more biology, he would have found a better way to use the nigh-omnipotent power of the Infinity Stones and actually help the universe. But then that would make him the hero and we can't have that now, can we?



DID YOU KNOW?

Our Taste Buds Grow Up With Us?

Ever wondered why spinach became easier to eat as you grew older? Or maybe it was anchovies or olives. Whatever it might be, a new survey has some insights as to why this might be. The reason? Each person is born with approximately 10,000 taste buds that are replaced around every two weeks. However, as get older and time progresses, these taste cells aren't replaced, and those numbers start to decrease. This causes flavors that were too intense when you were younger to become more palatable as you age.



Dr. Schrödinger, MBBS

Pooja Mehta
FYBSc

While it might be strange to see an article about quantum mechanics in this magazine, what is even stranger are the fundamental principles of quantum physics that are strangely observed to most efficiently work at the miniscule level of cells and complex biomolecules. But what is Quantum mechanics? In simplistic terms it is the study of subatomic particles; the way they move, their energy conversions and effectively how they exist in the universe.

Why, most of you would wonder, should biochemists and life science enthusiasts care about this? There are a lot of reasons why but before I get to that I think it is fundamental to be able to comprehend and appreciate the weirdness of this entire science.

There have been many experiments conducted that prove that not only light, but particles like electrons and some very light atoms too behave as waves. One of the biggest mysteries in quantum mechanics is an experiment that proves that the behaviour of certain subatomic particles depends on whether the phenomenon is being detected/observed or not. When particles such as electrons are passed through two narrow slits in an otherwise impenetrable barrier one would expect two heaps of electrons corresponding to the slits to form on the photographic plate (just like sand particles being poured through two slits would form two heaps of sand). But while this is seen for some large molecules, electrons do not form such a pattern. Instead, they form several bands on the screen which are the result of interference of waves of the passing electrons. The significant oddity is that when a detector is placed near the two slits to determine exactly how many electrons pass through which slit in a given time, the interference patterns disappears and instead just two bands corresponding to the two slits are observed. When the detector is turned off, the interference pattern reappears! So, somehow the electrons know whether their motion is being detected or not (almost like humans somehow knowing when they are being spied on!)

This iconic experiment led scientists to believe that a wave is in fact the probability function that defines what particular position in space a particle occupies and that a particle occupies all its probable positions at once. Further, it continues to exist in all its possible positions until it is forced to make a decision (as in the case when a detector is placed, the electron chooses one particular path instead of following all its probable paths and hence ceases to be a wave). This multi-existence is called superposition. Now, this might seem very abstract but you can think of it as you entering a shop to buy a dress and until you decide on the dress you like, you have the potential of buying any and every dress that's present in the shop. But once you buy one dress and pay the bill, you cannot buy any other dress. When this happens in the case of subatomic particles, it is called a "wave function collapse" for obvious reasons.

But then why, one would ask, is this phenomenon observed only at such a small scale? One of the possible explanations is 'decoherence' which is essentially the

inability of an object made up of trillions of molecules to show significant quantum effect due to the jumbling up of waves of the trillions of electrons and particles in that object.

Now, we finally come to how this affects life. There are several phenomena in the natural world that can be explained using quantum mechanics, but one of the most widely accepted phenomenon is photosynthesis. It is likely that coherent quantum superposition of energy states can be sustained and created in all photosynthetic organisms including bacteria, algae and even plants. Photosynthesis starts when a chlorophyll pigment absorbs a photon of light and that energy is then transmitted through a forest of pigment molecules before it reaches the reaction complex where it excites an electron that cascades down an electron transfer chain and finally splits a water molecule which in turn produces the energy storing molecules of the cell. Originally, it was thought that the photon just hops randomly over several chlorophyll pigment molecules before it finds the reaction complex, but that would be inefficient and result in huge losses of energy into heat. According to the quantum theory though, this photon moves as a coherent wave traversing all the possible paths to the reaction centre. Thus, it explores all possible paths in one go! It is needless to say why this process is absolutely essential for life to exist on our planet as it does.

Another biological area where quantum mechanics is commonly found to play a role is in the DNA. Certain particles with very low masses are also believed to show quantum tunnelling, an effect owing to which these particles pass through an energy barrier that they cannot traditionally surmount. It can be thought in terms of the particle having even a small probability to be present on the other side of an energy barrier. (As a simple analogy: to pluck an apple from a tree you would ideally require some energy, but if quantum tunnelling occurred the apple would simply vanish from the tree and appear onto your hand.)

In the DNA, the nitrogenous bases are held together by hydrogen bonds. The proton in this bond tends to lie closer to one of the two nitrogenous bases. In a double bond the protons of the two bonds are at two opposite ends and tend to replace each other due to quantum tunnelling (without external energy) and do so frequently. While replication or transcription occurs, if owing to quantum tunnelling, the proton happens to be closer to

the wrong nitrogenous base it gets carried off with the base, resulting in a faulty nitrogenous base on both the separating strands. This is what very often causes the 'mutation'.

Some other very fascinating living organisms believed to work on the principles of quantum mechanics are Robins and sparrows. It's long been known that these birds navigate through an internal, chemical compass that interacts with the Earth's magnetic field. But the magnetic field of the earth is very weak, so how does this happen?

The answer is quantum entanglement. It is a phenomenon where somehow the spins of two electrons depend on each other no matter how far apart. As a result of this delicate interaction, if one changes its spin, the other does so simultaneously almost as if the one electron somehow communicated to the other one that it was going to change its spin. But how this happens was a mystery to even Albert Einstein who called it "spooky action at a distance"!

In one study published in the journal *Nature*, Oxford University researchers worked with the European Robin and what they found was that within the retina of these birds was photosensitive protein called cryptochrome. Within this molecule there are a pair of electrons that are quantum entangled and their delicate dance or co-ordinated motion determines the orientation and movement of the bird. This subtle use of quantum mechanics that birds have naturally evolved is one of the most extraordinary examples of quantum biology at play.

Biologists and the world at large are still sceptical (and justifiably so) of the relevance of quantum mechanics in biology and the life sciences, but like any other new scientific discovery, the mysteries relating to this topic will take decades to unravel. Meanwhile, all we as biologists can do is appreciate how quantum effects that physicists demonstrate with great difficulty using high end, expensive equipment, unnaturally low temperatures and isolated environments have been occurring so effortlessly and gracefully in the warm, messy, chaotic and unpredictable biological environments such as the cells for aeons. It is quite a miracle.

Finally, as Niels Bohr, one of the founding scientists of the quantum theory once said "If quantum mechanics hasn't profoundly shocked you, you haven't understood it yet."

Imagine you are at a bakery and are offered a scrumptious looking cranberry cheesecake, which, according to the shopkeeper is a new flavour in the market. Your mouth is watering, every instinct in your body wants you to gorge on that creamy, crumbly heavenly delight and you extend your hand reaching for the pastry when you suddenly realise that you are on a diet and that a cheesecake loaded with fat and sugar would be a severe setback to your routine and despite the fight that all your senses put up, you politely decline the pastry. This simple yet quick and decisive act is actually a result of a complex neurological process called cognitive control. In scientific terms Cognitive Control (or Executive functions) refers to the set of processes that lend some amount of adaptability to information processing in order to be able to abide by some decisions made in the past. It is the process by which previous goals or plans made by the person influence their behaviour in the present or near future, and inhibit automatic responses. Cognitive control indicates a very high level of consciousness and willpower.

Executive functions are often invoked when the brain finds that prepotent responses (responses that have precedence over other responses and greatest immediately effective habit strength) have to be overridden.

Executive functions develop and change over the years for a particular person, and differ from one person to another. They are affected by both negative and positive experiences that someone gathers over the years. Neuropsychological tests (such as the Stroop test where one is told to identify the colour of the font in which the name of another colour is written) and other such rating scales can be used to measure executive functions. Es-

entially these scales test one's ability to resist a lapse in cognition due to interference of two conflicting pieces of information.

A few research studies conducted in this field demonstrate that cognitive control is a better predictor of physical and financial health than IQ tests and basic assumptions such as social status. One such study popularly known amongst psychologists as the 'marshmallow experiment' conducted on about a 1000 children between the age of 4 and 8 in New Zealand in the 1960s was a strong indicator of the importance of delayed gratification which is one important

dimension of the set of skills collectively known as cognitive control. In this experiment, researchers placed one marshmallow in front of each child and promised to give them another one only if the children waited for the researchers to return before eating the first marshmallow. They then left the children alone with their marshmallows and observed that some children waited patiently in anticipation of a second, some paced around the room contemplating their options while a few were unable to resist the temptation and ate the marshmallow. The latter were found to demonstrate low levels of cognitive control.

All these children were systematically tracked and rigorously tested for cognitive control while they were in elementary school. Years down the line, the children who had patiently waited for the second marshmallow showed higher test scores and lower risk to drug abuse and obesity. They were tracked until they reached their mid 30's and even then those who as children had showed a higher degree of cognitive control were financially and mentally more fit than the rest. However, this is not to say that those poor

COGNITIVE CONTROL

-Vishaka Singh
FYBSc

children who decided to eat their marshmallow were doomed for life. In fact those children whose cognitive control improved over their childhood fared as well as those who had had high levels all along. Hence, this experiment, though not entirely faultless was a good initiator for a beginning in hard core research in this field. As technology evolved, so did methods of research and identification of the centres in the brain responsible for such functions. Neuroimaging of various neurological diseases and injury models confirmed that executive functions are primarily supported by the prefrontal regions of the frontal lobe, with neuronal connections to some cortical, subcortical and brainstem regions. The prefrontal cortex is not completely myelinated till a person reaches their 30's, which is why executive functions reach their maturity very late.

In the early years of a person's life, the basic executive functions are memory and inhibitory control (a cognitive process that permits an individual to inhibit their natural and dominant responses to stimuli in order to select a more appropriate behaviour that is consistent with completing their goals). They are the basis for development of more complex executive functions as the child grows. During the age of 3-5 years goal-directed behaviour develops. Preadolescent children continue to exhibit certain growth spurts in executive functions, suggesting that this development does not necessarily occur in a linear manner, and during this period children develop a better functioning verbal memory as well as goal oriented behaviour, organizational skills, strategic planning and selective attention.

Additionally, between the ages of 8-10 cognitive flexi-

bility(the mental ability to switch between and simultaneously think about multiple concepts) begins to match adult levels.

At adolescence the distinct brain systems become more integrated and due to this executive functions such as inhibitory control, goal directed behaviour, memory and attention control also become more advanced.

During adulthood, there is constant myelination of neurons in the prefrontal cortex. So, between ages 20-29 executive functioning skills are at its peak. This encourages people at this age to take up more challenging mental tasks. But these skills begin to decline in later adulthood. Working memory and spatial span are two areas where decline is most readily noted during adulthood. Cognitive flexibility though only starts to decline after the age of 70 in most adults. Impaired executive functioning is one of the best predictors of functional decline in the elderly.

In the present, advances in neuroimaging techniques have led to studies that link genetics to executive functions and its deterioration. Neuroimages are also being used as endophenotypes for discovering the genetic causes of decline in cognitive function. But every human brain is far too complex and versatile and scientific research has still not reached the point to be able to fully explain the different components at play for the normal functioning of the brain. Hence, only further research can improve our understanding of executive functions to the extent that we can relate to it in our day to day activities.

MYTH BUSTERS

Glass is a high-viscosity liquid

Obviously glass isn't like water or even like molasses, but could it be characterized as having super high viscosity such that it is an ultra-slow flowing liquid? Well, no. This myth arises from the fact that window glass in older buildings is typically thicker at the base. Supposedly, the glass was evenly thick but gradually "sagged" over time, thickening the base. In reality, glass is categorized as a solid, but in "olden days" it was difficult to get a perfectly even pane of glass using old fashioned methods. When a craftsman made a reasonably flat piece of glass, he would then cut the glass to size, and if one side was thicker than the other, he'd put that side at the bottom for stability. Not everything sags with age.



As Time Goes By

Umm-E-Salama Udaipurwala
TYBSc, Life science- Biochemistry

Everything comes to an end. Religion says so, physics says so, and so does our biology. Insects have a lifespan of a few weeks to as little as a few hours. Mammals, including us humans, tend to have longer lifespans that extend to years. History is witness to humanity's fascination with this end of life. Alchemists fervently searched for the elixir of life, a mysterious substance that they believed had the illusive power of making its consumer immortal. Although no such elixir has been found, biologists have begun to discover certain mysteries of biological ageing and inevitable death.

Ageing is defined as “the time-related deterioration of the physiological functions necessary for survival and fertility”. Ageing and death have been seen as an eventuality predicted by entropy. A host of environmental factors in congruence with biological factors such as mutations and epigenetic factors have been shown to play a part in ageing.

In a landmark study performed by Cynthia Kenyon and colleagues, they uncovered a gene that played a key role in ageing. They used *C. elegans* for their investigation and found that a single gene called *daf-2* was linked to the nematode's lifespan. They found that mutations in the *daf-2* gene extended the worm's lifespan significantly. These results caused a paradigm shift in our understanding of how ageing works in the body and led to further investigations on the previously held notion that ageing and death were a by-product of ‘wear and tear’ of tissues. Even among those scientists who believed ageing to be under genetic regulation it was monumental that a single gene could be responsible for such a drastic change in the lifespan of an organism.

Daf-2 is a transmembrane receptor that was found to

function like the insulin receptors in mammals. Mutations in *Daf-2* prevent a signalling pathway that normally leads to the inhibition of the transcriptional factor *Daf-16* (Forkhead transcription factors, FOXO, in mammals) from functioning. *Daf-16* when inhibited through phosphorylation causes the expression of certain genes (such as yolk proteins and *INS-7* an insulin-like protein) that further bind to *Daf-2* and cause a positive feedback loop which has been shown to contribute to the ageing process. In mutated *Daf-2*, *Daf-16* is not inhibited by phosphorylation and causes the gene expression of certain other proteins that protect the cell from oxidative damage such as heat shock proteins, DNA damage repair proteins and antioxidant enzymes which were shown to lead to an increase in lifespan.

Unfortunately, the more complex an organism is, the less straightforward answers become. In simple organisms like *C.elegans*, there is only a single receptor that carries out this pathway. The same cannot be said for more complex organisms. As mentioned earlier, *Daf-2* is similar in function and form to insulin growth factor-1/insulin receptors. These proteins play a role in metabolism, cell growth, cell proliferation, and cell migration. A mutation in its receptor could cause diabetes and insulin resistance. A mutation in IGF-1 has shown to cause degradation of muscular tissue. With that being said, if the mutation is tissue-specific, it has shown to increase the life-expectancy in mice.

In various model organisms, scientists have found that certain mutations in certain genes in particular pathways increase the lifespan significantly in those organisms. In mammals, proteins that affect, either directly or indirectly, the Insulin/insulin-like growth factor signalling pathway, IIS, (as discussed with respect to *Daf-2*), a

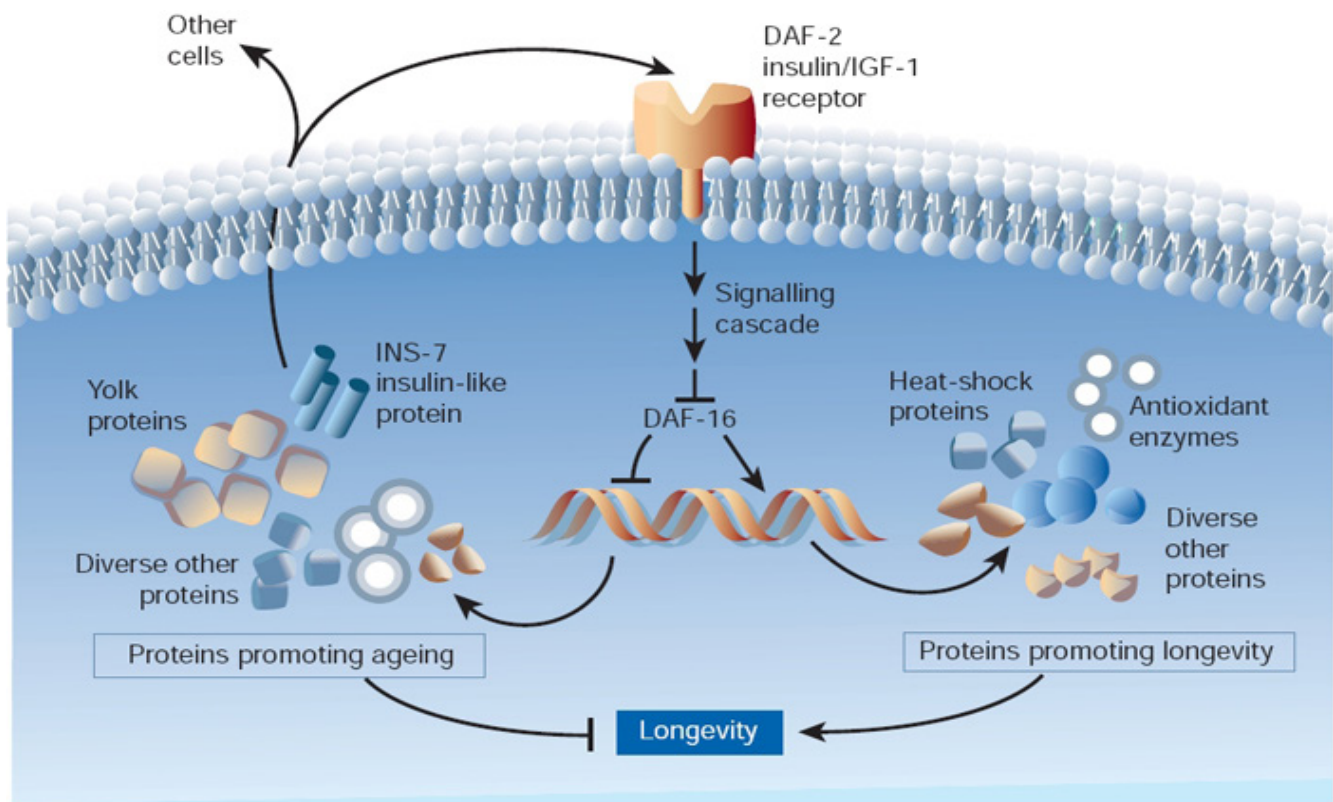
target of rapamycin (TOR) pathway and mitochondrial pathway have been shown to affect ageing and senescence. These genes are found to be linked with metabolism, nutrition sensing, cell growth and reproduction. The complexity of ageing and retarding is evident by the interaction between FOXO proteins and SIR proteins. FOXO proteins are transcription factors that induce the gene expression of proteins that cause apoptosis to take place, but at the same time increase resistance against oxidative stress and enhance DNA repair. SIR proteins are enzymes that constitute the class III histone deacetylases and these can inhibit or activate FOXO proteins from causing apoptosis and increases the cell's capacity to deal with oxidative and DNA damage. Up-regulation of SIR proteins works to increase lifespan in nematodes, yeast and flies but it poses a problem in humans. Apoptosis is a crucial mechanism to ensure that the DNA damage doesn't cause the rise of cancerous cells. That is not a problem in nematodes and flies as their adult forms are largely made of post-mitotic somatic cells.

'Intrinsic ageing' is the accumulation of somatic cell

damage. It is caused by various factors including ROS (reactive oxidative species), reducing sugars that cause AGEs (advanced glycation end-products). AGEs bind to structural proteins (such as collagen) which causes the stiffness of blood vessels, joints, bladder and impairment of various organs. Unfortunately for scientists, some of these damaging molecules are important for the normal function of cells - glucose for metabolism and ROS for certain signalling pathways.

Chance though still plays a role in ageing. Epigenetic drift is the change in the epigenetic profile of DNA as organisms age. There is an increase in DNA methylation of the promoter of the oestrogen receptor gene in females. This methylation leads to inactivation of a gene resulting in the inability of certain tissues to respond to the signals of oestrogen, which can lead to atherosclerosis.

There is still a long way to go in decoding ageing as a biological function. Physics would argue that entropy clearly explains why life must end. But, the very fact that there appear to be genes with a direct effect on lifespans points to a more promising story of ageing.



The intracellular signaling pathways that are regulated by daf-2 receptor activation

[SOURCE: <https://www.nature.com/scitable/topicpage/genetic-control-of-aging-and-life-span-847>]



Divide & Rule: The Immortal Cells- HeLa

-Josette Misqitta
SYBSc Life Science

A cell is the smallest part of an animal or plant that is able to function independently. We have all been under the assumption that all living creatures are immortal. On the contrary, here are cells that appear to be mortal and have been extensively used in medical research-the HeLa cells.

It all began with a poor African-American woman named Henrietta Lacks who suffered from cervical cancer. She went through treatment at the John Hopkins Hospital located in Baltimore, USA. A cell sample was derived from her tumour for the purpose of scientific research. Dr. George Gey a well-known scientist helped culture the first human cell line. He found out that the cells were prolific dividers in vitro (in test tube) conditions. When individual cells died, generation of copies took their place leading to an ever growing cell line. He used the first two letters of the patient's name (He) and surname (La), hence the name HeLa. The cells were taken from her without her consent. Henrietta Lacks died on October 4th, 1951 due to aggressive cervical cancer, totally oblivious to the fact that she had made one of the greatest contributions that would become a breakthrough in medical history.

HeLa cells are no ordinary cells. They can easily contaminate cell lines. They have a total of 70 to 90 chromosomes, which is different from the normal human number- 46 chromosomes. During the process of cell division in these cells, the enzyme called telomerase a ribonucleoprotein prevents the shortening of the telomere (the ending portion of a chromosome). This gives them the ability to be immortal and forever dividing. Normal human somatic cells in culture show a limited dividing potential, as the telomere is shortened with each cell division. When the critical length of the telomere is reached the cell enters senescence (ageing). Telomerase

is also found in the stem cells which causes the cell to divide continuously. The HeLa cells can travel on almost any surface and can invade other cells in a lab setting. It is estimated that there are 50 million metric tons of these cells have been grown and used.

The cells have been a boon in biomedical science and research all over the world. The cells have been monumental in the development of vaccines, especially the Polio vaccine developed by Jonas Salk. As these cells can be cultured under lab conditions, there can be multiple clinical trials done to test different drugs. Cell death and cell migration can also be studied with the help of these cells. HeLa cells give researchers a way to conduct experiments on human cells without actually testing it directly on them. Improved cell culture techniques have been used to culture HeLa cells. They are widely used to grow viruses and in tests for anti-tumour medicines. These cells have even been exposed to nuclear testing, toxins and space environments. They are used in cancer research till date. There are 25 derivatives of the HeLa cell line. HeLa cells also helped studying diseases like measles, mumps and Ebola. These cells have also found to be helpful in chromosome counting and staining techniques.

Coming back to Henrietta, her cells were found to be infected with the HVP-18 (human papilloma virus), thus causing cervical cancer. This was discovered by Harald Zur Hausen who won a Nobel Prize for linking HPV and cervical cancer. And hence, we now have a vaccine that reduces the chances of getting cervical cancer by 70%.

The HeLa cells have revolutionized the way medical science is today. It has helped save millions of lives and has given us a better understanding in the fields of cancer, virology and genetics. Even though Henrietta died 60 years back, a part of her still lives till date.

The Eternal Glow Below

Bhumi Davda
FYBSc

Immortality, though a fascinating subject for many, is generally considered as only a fictitious idea or hot topic for fantasy movies. It is considered that Death – the permanent ending of the vital processes of a living organism is common to all the living organisms on earth. But is it really?

There are many species like the ever growing lobsters, turtles or even huge whales that have the potential to be immortal. They have exceptionally long life spans and most of the times they die only because of attacks by predators. Then there are species such as the Planarian flatworms that avoid ageing and can regenerate into entirely new and independent worms from split pieces of the original worm! However, this ability is possessed by the cells only for a few years.

There is however one organism that outshines all these organisms in terms of immortality. This hero of sorts is a jellyfish, *Turritopsis dohrnii* which is popularly called (can you guess it?) ‘The Immortal Jellyfish’. And this folks, is no pseudo immortal fish that has managed to achieve its glorious title by virtue of a longer than usual life span. It has actually been deemed as immortal by scientists who seem to have developed a valid explanation for this incredible phenomenon.

To be able to believe this rather inconceivable notion it is first important to understand the life cycle of an ordinary jelly fish. Jellyfish are sexually reproducing animals. The fertilization of an egg cell by a male sperm cell leads to the formation of a zygote which after its embryonic development turns into a free swimming larvae called ‘planula’. This larva initially floats on the surface and then drops down to a solid substrate and develops into a “polyp” (a stalk like cylindrical structure) and sometimes even polyp colonies. The trunk of this polyp, after reaching a certain size buds off and forms baby jellyfish which further develop to become the bell shaped, translucent beauties we know. These mature jellyfish are called medusas (the name is probably derived from the fact that it is characterized by its arm like protrusions). They produce eggs and sperms and the cycle goes on. Death occurs to these jelly fish

by changes in environment, ageing or by some sort of physical assault.

But during such hostile conditions the *Turritopsis dohrnii* does something quite amazing. It reverts back to its polyp stage from the mature medusa state. Medusa cells undergo transdifferentiation (the process by which one mature somatic cell transforms into another somatic cell without undergoing an intermediate pluripotent stage) and form polyp cells. Theoretically this process can go on indefinitely. This transformation demonstrated by this fish is unique to only this species of the animal kingdom and thus it is known to be the only existing immortal species in the entire animal kingdom. Therefore, scientists have been unable to establish the average lifespan of these creatures.

Despite their immortal status these creatures can and do die. Being only around 4-5 mm in length they are eaten by predators. They can also succumb to disease before they even reach maturity. Initially belonging only to the Mediterranean Sea, these creatures are now seen throughout the world. Their invasion has been “silent” because of their small size and innocuity. It is very difficult to culture these tiny creatures. Currently only one scientist, Shin Kubota from Kyoto University has managed to keep them under captivity for a prolonged period of time.

As with any moderately studied scientific phenomenon, there are many critics who oppose this phenomenon of biological immortality as well. Some argue that these species are actually cloning themselves and not entirely reverting their life cycles. These clones become “tired” with time and produce more fragile populations which are not healthy and eventually their tendency to respond to environmental stresses reduces. This in a way is somewhat comparable to ageing in other unicellular organisms. However, there has been no definite research carried out to prove this premise. Scientists are now trying to apply the phenomenon exhibited by these jellyfish to human cells and see if they can reverse the process of ageing. This might be improbable in the near future because the process of ageing in humans is not

as simple as it is in a jellyfish. Firstly, humans are not quite near 4 mm in size and secondly ageing in humans is not dictated by genes alone. Rather, little things start breaking all over, cells stop dividing and those that do, accumulate mutations. This is why getting older is often accompanied by all sorts of biological issues. The truth is, accumulating mutations and cell gunk isn't some-

thing exclusive to ageing human beings. Clone lines of *E. coli* bacteria and many other organisms too accumulate harmful cellular products over time. This is just the cost of being alive! However, research is being done in this field and the probable success of these endeavours is still subject to controversy.



The Final Frontier

Anshit Singh
SYBSc, Microbiology

Ageing has always been the topic of many research studies, discussions and controversies. It still remains to be the highest contributing factor for most diseases and roughly 60-70% of all deaths in the world are due to age-related factors or diseases. These figures alone would prompt urgent, novel research in technologies and methods to prevent ageing. But before we attempt to stop or possibly reverse ageing, we first need to understand what causes one to age.

To that end, several theories have been proposed in an endeavour to explain this seemingly inescapable end. One of the common themes in most current theories is the concept of damage, where an accumulation of external and internal injuries renders the body more prone to diseases. One such theory would be the DNA oxidation

theory which can be explained as follows:

DNA Oxidation Theory

Reactive oxygen species (these are chemically reactive compounds containing oxygen such as hydroxides, superoxides, oxygen radicals, etc.) are both beneficial (important physiological regulator in intracellular signalling) and detrimental to the cell. Modification (by reactive oxygen) of cellular biomolecules and their accumulation has been pinned to several diseases.

The modifications in DNA get the most attention. The oxidative modification of Guanine (one of four nitrogenous bases in DNA) giving rise to 7,8-dihydro-8-oxo-2'-deoxyguanosine (8-OH-dG) is seen more often compared to other nitrogenous bases in DNA.

These modified bases are called lesions. Over a quarter of a century of studies have correlated an increase in the number of oxidative lesions with the incidence of disease, but there still remain vast gaps in our understanding of the exact pathways through which they act. It is possible that these correlations are mere coincidences, but an overwhelming amount of evidence would suggest that the presence of 8-OH-dG is linked to the development of diseases.

A few other theories propose the concept of 'Programmed ageing' whereby genetic factors determine the death of an organism. This theory is supported by various examples such as the male Argiope spider whose heartbeat stops in a programmed fashion right after copulation to be eaten by the female or even the plants which die shortly after flowering. This concept pulls away from the notion that wear and tear is the only cause of death. In humans, DNA methylation could explain this theory of ageing.

DNA Methylation

DNA methylation refers to the addition of methyl groups to the nitrogenous bases of DNA (Adenine, Guanine, Thymine and Cytosine). Methylation of DNA can change the activity of the DNA segment without changing the sequence. It is very commonly observed in the suppression of gene transcription by altering the promoter. However, only Adenine and Cytosine have been observed to undergo methylation.

Methylation of Cytosine occurs at its 5' position, forming 5-methylcytosine. This spontaneous deamination gives rise to Thymine which results in a G:T mismatch. There are repair mechanisms in place which convert the T back to C, or alternatively converting the G to an A. This turns the original G:C pair to an A:T pair, hence introducing a mutation. If this conversion of C to T were to occur during DNA replication, it wouldn't be repaired owing to the fact that T is a DNA base (in contrast to its RNA analogue - Uracil) and hence the mu-

tation would be made permanent in the daughter cells. In ageing, DNA methylation can be used as a highly accurate molecular biomarker and is popularly known as a Horvath ageing clock. It is observed that loss of methylation is directly associated with chronological age. In fact, diseases such as Progeria which induce rapid ageing, have been known to show mismatches in the epigenetic and chronological ages).

End Replication Problem

One more model of ageing is the End Replication Problem which is known to commonly occur during eukaryotic DNA replication. During eukaryotic DNA replication, the two strands of DNA are replicated in slightly different fashions. The leading strand undergoes continuous replication, whereas the lagging strand undergoes semi-discontinuous replication. Consequently, the lagging strand (5'-3') requires multiple primers for its replication. Due to this requirement for multiple primers on the lagging strand, some bases are left un-replicated at the 3' end leading to an overhang.

The ends of the chromosome are called telomeres and it is generally here that the problem occurs. Some cells, such as the germ line cells show telomerase activity which is absent in somatic cells. When telomerase activity is absent, the telomeres keep decreasing in length every generation until senescence occurs. This rate is doubled when the overhanging regions are degraded. But in cells which show telomerase activity, the enzyme elongates the telomeres which allow for attachment of primer and hence this problem is avoided. Over-expression of telomerase is often seen in malignant tumour cells essentially making them immortal eukaryotic cells.

As our understanding of these natural time-bombs improves, we may be able to develop techniques or enzymes which are able to reverse or even eliminate ageing altogether. Death need not be the necessary end to our lives.

DID YOU KNOW?

Einstein's Stolen Brain

After Albert Einstein's death in 1955, pathologist Thomas Harvey at Princeton Hospital conducted an autopsy in which he removed Albert Einstein's brain. Rather than putting the brain back in the body, Harvey decided to keep it for study. Harvey did not have permission to keep Einstein's brain, but days later, he convinced Einstein's son that it would help science.(
WHATTTT?!)



(F)lights, Camera & Action!

Aditya Sane
TYBSc, Physics

Technology has been of the greatest assistance to science research since the very beginning. Advancement and development of technology has gone hand in hand with leaps in science research. Scientists have found use of seemingly useless inventions like the LASER, which has now become an indispensable tool that scientists have their hands on. Technology has had an even greater role to play when it comes to studying the smallest of organisms or movements that have time scales much shorter than the blink of an eye. Studying insects for this reason is all the more difficult given that the problem is compounded. One of the most fascinating things about most insects is their ability of flight.

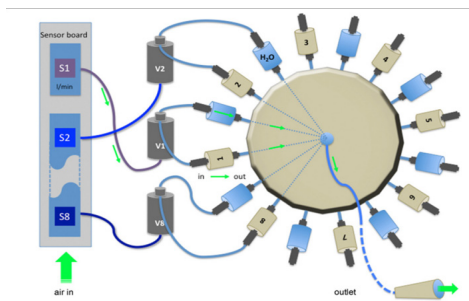
To study insect flight, a common house fly is taken as one of the key models. Insect flight patterns are altered by visual and olfactory stimuli and also the direction of wind. To study insect flight, there are two broad methods, either by allowing the insect to fly in a contained environment or by tethering it and monitoring its wing movements. One of the tried and tested methods of providing stimuli (visual) has been the use of an array of LED lights. The fly is tethered and the LED display is kept in front in front of it (or sometimes it surrounds the fly), patterns are then displayed using the LED array and the fly's neural response as well as its wing motion is recorded. This sort of a set-up is used for various kinds of studies be it, behavioural, neural or mechanics of insects. This may seem like a very basic set-up,

however, it is still very much in use and very few alternatives were available to it up until the 21st century. With the development of virtual reality there was a shift in paradigm. Much like the VR headsets we use, special chambers are used to augment the fly's reality. One can control what the fly sees and can change the display to record the fly's response to the changed visuals. One can make it such that every time the fly turns to the left the display changes such that it corresponds to the direction opposite to what the fly had intended thus confusing it.

One could now control what the fly sees. For the olfactory response, wind tunnels were used. These were just transparent tunnels where some aero-dynamical specifications were taken care of. At one end of the tunnel were kept odour sources. The flies were introduced from the other end and the flies were studied on how they approach their odour sources. Here, the visual input cannot be controlled. The direction of odour plumes are also unidirectional. To introduce multiple odour plumes and also control the direction of these plumes recently a contraption was made which could do exactly that. In this multi-component system, one can control 8 different airstreams (the number can be increased) with different odour concentrations and therefore can control from which direction the fly is getting its olfactory stimuli. In this contraption, the fly is tethered in the centre with the jets all around the tethered fly. The odour and direction can be temporally and spatially activated thus giving a high degree of control over the fly. With this, we now have control over the olfactory stimuli of the fly.

With this development we separately had control over the visual and olfactory stimulus of the fly. A good set up is one where we can independently control all the variables and can therefore have more accurate results concerning the dependence of a certain process on these variables.

An Indian team of scientists are trying to integrate both



Multi-component system to give 8 different air streams (S.B. Olsson et al. / Journal of Neuroscience Methods 195 (2011) 1–9)

these developments into a single system. With the use of jet streams and virtual reality to study the flight patterns of flies and high speed cameras to capture the wing motion, this would be a one of its kind system and would in many ways revolutionise how we have been studying insect flight. We can study how flies forage for food and their reflexes on spotting a predator. It would also allow scientists to study which stimulus visual or olfactory holds a higher precedence under dif-

ferent circumstances. This could then be extrapolated to different researches across various domains not just insects. No one would have thought that virtual reality would have such a huge impact on insect research or something similar to an air blower could be mechanised to give olfactory stimulus to insects. Application of such simple ideas often lead to major breakthroughs and push frontiers in science.

Psyched Yet?

Austin Varghese
FYBSc

The pre - enlightenment era treatment practices were famous for their inhumane and almost animal like treatment of patients with mental disorders. The doctors believed the patients to be possessed by demons and cursed by gods or to have been inflicted with 'impurity by Satan'. Quite many museums around the world exhibit how the patients were treated or more literally tortured. There have been documented cases where the patients were fed nails, screws and sharp objects to 'rid their bodies of impurities'. Patients were isolated, beaten, tortured to be "exorcised of the demons that have possessed them". There have been cases where women suffering from post-partum stress disorders had their teeth and nails pulled out as it was believed by practitioners of the time that these contained 'impurities' that affected the state of mind of person and caused them to be in mental distress.

Fortunately, things changed when the enlightenment era started. Many reformers changed this abomination of a field into a boon for mankind. One of these reformers was Philippe Pinel, father of modern psychiatry. He was the first physician to adopt a method of treatment known as moral treatment. Moral treatment is an approach where the patient is treated in a more humane way and in accordance with the moral discipline expected of a human being.

He started the use of straitjackets and solitude as methods of punishment, for negative reinforcement of humane behavior and to control and manage the patients as opposed to the use of force and torture. He used showers and baths, opium, camphor and other

common antispasmodics in cases of patients that were considered untreatable to control nervous excitement and relapse in behavior. He seldom employed laxatives for this purpose too. Though rudimentary and crude in appearance, these practices were the seed to a field that has improved quite a lot of lives today.

Another important point in history was development of a subfield —and eventually a separate field of psychiatry- biological psychiatry. Most of what we see and know today as psychiatry was developed under the purview of this field. Biological psychiatry simply attempts to understand the biological fault behind a mental disorder and attempts to treat it. Development of this field led to an exponential increase in the understanding of mental disorders. It led to classification of diseases upon the various areas of our body that they affect. And the development of quite a lot of drugs that if not treat, at least, help in controlling and managing a wide spectrum of diseases.

As millions and billions of mutations come together to give rise to a new species, a new organism, the small and almost insignificant changes come together to produce the greatest developments. For instance, if Philippe Pinel had not adopted moral treatment, may be today, we still would have treated the insane as abominations rather than equal humans.

The methodology of treatment of the insane is not ideal and free of faults, and remains a developing field. It's composed of small differences in decisions and is a constant journey toward change.

TURNING TO THE LEAF

Zubia Shaikh

TYBSC-Life Science -Biochemistry

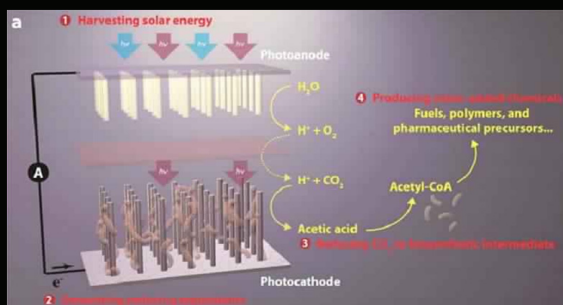
Increasingly igniting fossil fuels, cutting trees and manning the most irresponsible attitude in this Anthropocene era, has caused potential harm. Ecosystems are losing their natural ability to mop up the massive carbon emissions and our very survival is in peril. The cry of our mother Earth and its clarion call to steer these emissions down, reflects the gravitas and urgency looming large.

Atmospheric carbon dioxide is now at its highest level in at least three million years. As trees are chopped down to make way for our luxuries, fossil fuels are burnt-the increasing emissions of greenhouse gases trap heat in the atmosphere that was on its way out to space, causing Earth's greenhouse effect to grow more intense. Our gray surroundings-the asphalt and concrete buildings tend to hold onto more heat than forests and fields. It is up to us then to offset the addition of gases into the atmosphere. If we wait too long humankind will become a passenger on a one-way street to dangerous climate change.

It is amusing to learn how brilliant researchers from the

Lawrence Berkeley National Laboratory have endeavored to mimic Nature's expertise and developed a progressive technology that converts carbon dioxide into biofuels. Yes! They turned to the leaf and learnt from the ubiquitous process occurring in all plants-Photosynthesis.

The essence of photosynthesis is its water splitting reaction. The carbon dioxide (CO_2) absorbed from the atmosphere and water (H_2O) imbibed through their roots, collide with each other in the chloroplast seated deep inside the leaves. Here, the water molecules split into a hydrogen molecule (H_2) and an oxygen molecule (O_2). Being endothermic in nature this reaction gets the optimal energy when from the sunlight trapped by the chloroplasts. The hydrogen reacts with CO_2 to create sugars ($(\text{CH}_2\text{O})_n$) that serve as the basic energy unit for plants (the oxygen eventually finds its way to our lungs). Plants achieve the conversion of solar to chemical energy cleanly without the use of fossil fuels! The reaction is enhanced by chlorophylls with magnesium clusters and various enzymes which serve as pho-



This break-through Artificial Photosynthesis system has four general components:

- (1) harvesting solar energy,
- (2) generating reducing equivalents,
- (3) reducing CO_2 to biosynthetic intermediates, and
- (4) producing value-added chemicals.

[SOURCE: <https://www.sciencedaily.com/releases/2015/04/150416132638.htm>]

tocatalysts.

Evolution has greatly refined an extremely complex pathway to split water and make sugar. This very concept was remodeled to use solar energy to split water in the presence of a catalyst, then collect the hydrogen product as fuel, either in pure form or as part of an organic molecule (like the sugar in the plant). Finding a cheap method to do this could provide clean hydrogen fuel as the basis for a future, fossil-fuel-free economy. So how have we fared so far to imitate this natural feat? The difficulty in engineering photosynthesis led researchers to enlist some help in the form of bacteria. Combining materials science and living organisms allows for the best of both worlds. Researchers used an amalgamation of powerful light absorption tools and the natural synthetic capabilities of the cell. They relied on nanowires made of silicon and titanium dioxide to capture light. The wires absorb light and channel the electrons to a bacteria- *Sporomusa ovata*, which acts as a workhorse to reduce the carbon dioxide into acetate. *S. ovata* is a kind of acetogenic bacteria and hence it can produce acetate from carbon dioxide in anaerobic conditions. Various other engineered organisms can come into play to convert acetate into Acetyl-CoA. This can further be processed to synthesize any number of valuable chemicals.

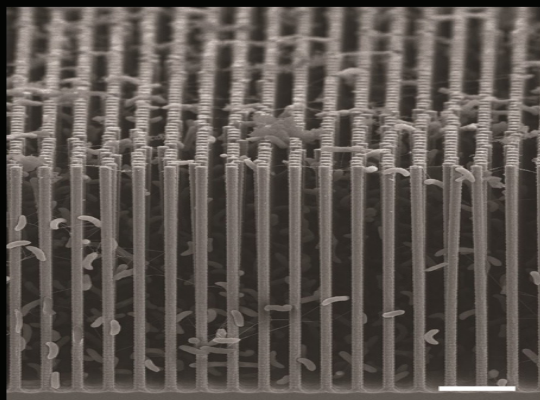
Artificial water-splitting devices are electrical wires that are twisted and coiled like tentacles. These are unsurpassable compared to the flexible green organic material responsible for photosynthesis in plants. But the core

chemistry remains the same, and we are just beginning to match the sophistication of Nature's million-year-old machinery. As a pilot project, scientists were able to produce acetate at a 0.38% efficiency simply with water, carbon dioxide and sunlight as the energy source, for about 200 hours under simulated sunlight, which is about the same as that of a leaf.

With the acetogenic bacteria and other engineered bacteria, they produced n-butanol, a biofuel comparable to gasoline with 26% efficiency, 25-percent for amorphadiene, a precursor to the antimalaria drug artemisinin and the renewable biodegradable plastic-polyhydroxybutyrate (PHB) with 52% efficiency.

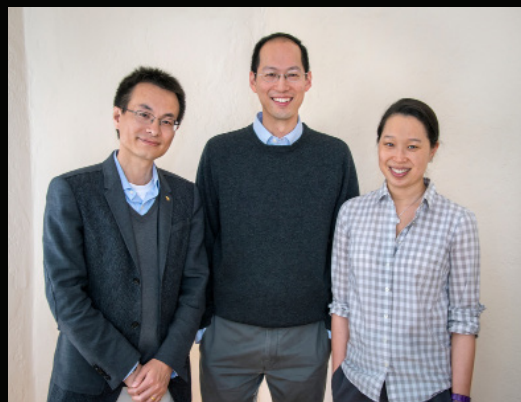
Quoting the research team- "We are currently working on our second generation system which has a solar-to-chemical conversion efficiency of three-percent, once we can reach a conversion efficiency of 10-percent in a cost effective manner, the technology should be commercially viable."

This prodigious hybrid technology though right now in the labs, is a massive step in the right direction. Transforming detrimental greenhouse gasses to prized chemicals both reduces emissions and provides necessary products at ostensibly no cost to the environment. It may appear that the efficiency of reducing carbon dioxide is low, but this is still a novel technology with plenty of room to increase its efficacy. Bringing artificial photosynthesis closer to a practical reality will set the ball rolling on new ways to undo the harm we've already done.



Cross-sectional SEM image of the nanowire/bacteria hybrid array used in a revolutionary new artificial photosynthesis system

[SOURCE: <https://mcb.berkeley.edu/news-and-events/departments-news/major-advance-artificial-photosynthesis>]



(From left) Peidong Yang, Christopher Chang and Michelle Chang led the development of an artificial photosynthesis system that can convert CO₂ into valuable chemical products using only water and sunlight.



Delivery Despair, No More!

By Kareena Gala
FYBSC

“The merest school girl, when she falls in love, has Shakespeare or Keats to speak to her mind for, but let a sufferer try to describe a pain to a doctor, and language at once runs dry.”

-Virginia Wolf

The quest of motherhood is deep rooted within every woman. While a baby opens up in an exciting world, the excruciating pains dauntingly mar the process of motherhood. Therefore, alleviations of labour pain have been the focus of humans for a very long time. Primitive attempts to help relieve pain were based on suggestion and distraction techniques in the ancient civilizations of Babylon, Egypt, China and Palestine. Suggestion methods involved use of rings, necklaces, amulets and other magical charms while distraction methods involved counter-stimulation i.e. the infliction of a painful stimulus which is sufficient to distract women from labour pain. Herbal concoctions based on extract of poppy, mandragora, henbane and hemp were introduced in the middle ages. At the beginning of the 19th century, remedies like vigorous exercise, bloodletting and a variety of medications were designed to induce vomiting to distract women from their pain. A few used physiotherapy techniques like massages, breathing techniques while a few practiced acupuncture and hypnosis. In the middle of the 19th century, successful use of ether and chloroform in about 2000 deliveries was reported (Emma, wife of Charles Darwin in 1847 and Queen Victoria in 1853, were delivered using chloroform). In the early 20th century, opioids like morphine, scopolamine was used to produce ‘twilight sleep’ and by 1924 barbiturates (diazepam) were advocated to produce sedation in labour.

But increased use of heavy sedation during labour was accompanied by increased and sometimes harmful obstetrics intervention and fetal distress. To avoid the side effect of sedative drugs, different types of nerve blocks were tried to relieve labor pain. Epidural analgesia turned out to be the most effective. In 1961, Bromage, a famous anesthesiologist and pain specialist, quoted on modern epidural technique for pain relief in labour. “In child birth this sort of analgesic capability opens the door to revolutionary changes in obstetrics practice. No longer were centrally depressant analgesic and anesthetics required and labour could

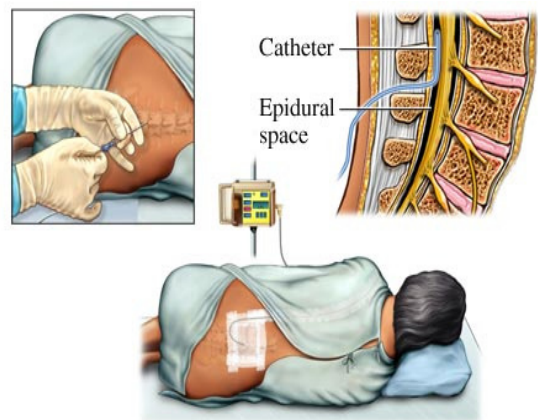
be pain free from the beginning to the end without the need for any pharmacological depression of the fetus.” Analgesia during labour is practiced only in few centers in India, and is likely to gain more and more momentum during the coming years. There are three widely practice methods of labour analgesia- Inhalation of gas mixture (Entonox), injectable narcotics and Regional Analgesia. Entonox is a mixture of Nitrous Oxide and Oxygen, inhaled through a facemask during painful contractions. This can be done by the patient herself and is safe for the baby. Narcotic drugs like Morphine or Pethidine injected during the first stage give fair but not complete analgesia. Any attempt to improve results by increasing the dose will result in somnolence and consequent lack of cooperation from the parturient. A close watch is kept on the respiration of mother as well as the new born as respiratory depression may occur, though rarely, will necessitate antidote. These methods and the use of TENS (Transcutaneous electrical nerve stimulation) is prevalent in some places. TENS covers the complete range of transcutaneously applied currents used for nerve excitation or namely to describe the kind of pulses produced by portable stimulators used to treat pain.

The last and most important process is regional analgesia. Out of all different nerve blocks, Epidural analgesia is the most effective, advantageous and satisfactory method in labour pain relief. Epidural space is a space just outside the spinal canal where all the nerve fibers are separately placed. During labour pain, the head of the fetus is fixed to the pelvis and the cervix is dilated up to 3-4cm. Then, one fine catheter or tube is inserted just outside the spinal cord where the specific nerves are situated which carry the pain sensation from the uterus, cervix and vagina to the brain. By giving continuous analgesic drugs through this catheter on those nerves, labour pain can be relieved from the beginning to the end. There are three advantages – (1) Labour pain can be relieved from start to end, (2) if at any point, a caesarean section is required due to non-progress or fe-

tal distress high titrated epidural anesthesia is sufficient for the C-section, and (3) After C-section, post-operative pain can be relieved by the same epidural route till discharge. Epidural doesn't help deliver normally, it just relieves intolerable pain to make one comfortable, cooperative so that doctors can provide a proper trial to reduce unindicated caesarean sections. In cases where the mother is hypotensive or has a cardiac disease, diabetic mothers and mothers with asthma or COPD, an epidural is compulsorily required. Along with these advantages, there may be some contraindications like when the mother is unwilling or during local sepsis, bleeding disorders or low blood pressure.

With the advancements in the field of medicine and biology, where areas like cancer and genetics are gaining momentum, I chose this topic as it is still obscure to general population in India. Labour pain is one of the most terrifying and unbearable pain and has been the scariest part of the entire term of pregnancy. Women have suffered silently over ages. It is time we come out of this cocoon. Hoping that this article would spread awareness to those still in the dark, I would like to conclude by quoting Dayden's words,

“For all the happiness mankind can gain is not in pleasure, but rest from pain”



DID YOU KNOW?

The largest organism in the world is a specific honey fungus measuring 2.4 miles (3.8 km) across in the Blue Mountains in Oregon

DEPARTMENT

NATIONAL CONFERENCE : BIOWAVES



NATIONAL CAMP : 'KNOW BETTER, DO BETTER'



ACTIVITIES

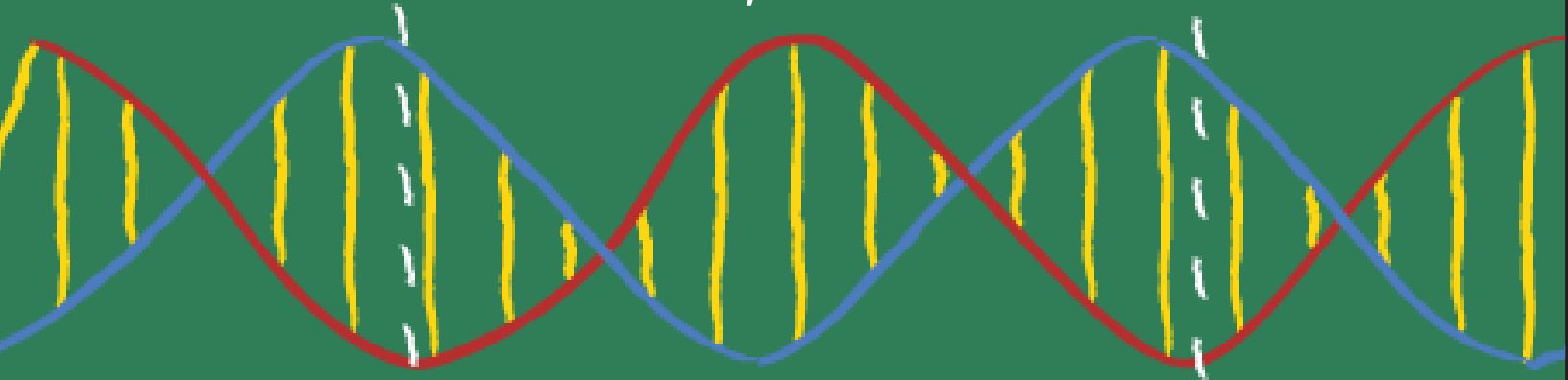
KHANDALA SEMINAR



SOCIAL OUTREACH BY THE SY's



NATURE V/S NURTURE



Aryaa Apotikar
FYBSc

Imagine meeting James and Oliver Phelps, the twins who played Fred and George Weasley in the Harry Potter series one fine day. How uncanny would that be. Curious thing is, despite being identical twins people can still tell them apart because of minor physical traits. Why is this? Shouldn't twins be the same in all aspects. Atleast thats what one would expect. They both posses the same DNA sequence given down from their parents, they cannot but be be similar in all areas. Funny part is, one can tell apart identical twins. You start to notice a bunch of dissimilarities between the two. An important process is at play here. This process plays such a crucial role, It'd be impossible to imagine life without it. It's called epigenetics.

One would expect that changes, only in the DNA sequence would allow for such phenotypic changes. Interestingly, this is not the case. The genes present on the DNA which are allowed to be expressed to give the basic phenotype or external traits to an individual can be controlled without changing the sequence of the DNA genome.

In an electric circuit where the blue switch allows a bulb to switch on and a red switch to allow the fan to be switched on, it is the switches which allow for control over the devices. Turn one on and it results in the conduction of the message to operate to the device. Similarly, in the interior of the nucleus in a cell, the basis of the function of certain molecules allow a genetic sequence to be switched on and off or activated and inactivated.

The genome is just a helix of two strands of continu-

ous molecules. It's important components are nucleotides which can be classified into 4 (A,T,G,C). One common epigenetic control is through methylation, i.e. addition of methyl groups to the nucleotide C of the DNA in CpG islands(groups). This silences parts of the genome containing the methyl groups and doesn't allow for their expression. For example, if the gene controlling freckles were allowed to be methylated in your genome, you would not possess any freckles even if you had the gene for the same. This is also how all the cells in an individual are genetically identical but different in how they behave and function, due to silencing of some genes and activation of others. The molecules which create such epigenetic changes are the chemical tags present on the genome. And all the different chemical tags together form the epigenome of an individual. These tags can attach to either the DNA or the proteins which hold the DNA together. Histones are the proteins which hold the DNA together. They are made up of 8 units forming an octamer. The DNA coils around this structure. Attachment of chemical groups like methyl, acetyl, phosphate to this octamer can lead to either activation or silencing of genes present on the DNA, depending on whether their attachment leads to loosening or tightening the wrapping of DNA around the histone. Loosening allows the genes present on the DNA to be easily accessible and proceed with transcription and later translation(processes which lead to production of proteins) which creates the traits that are visible changes in an organism.

Another very important epigenetic process and one

which is easily understood is X chromosome inactivation. In all placental female mammals, in addition to the 22 autosomal chromosomes there are two extra sex chromosomes, both of which are X chromosomes. In a male, this X chromosome is present singly and allows for gene products of only that one X chromosome. An organism cannot allow for twice the number of gene products in their body, which is why in a female one of the X chromosome is packaged in such a way that it remains transcriptionally inactive to form a heterochromatin structure(tightly packaged structure). Here, an entire chromosome be it from the paternal or maternal side is entirely inactivated at a random. This is the process which explains why females have 50 % chance of garnering a X chromosome linked disease due to its inactivation epigenetic process. Since no such mechanism occurs in males, their probability of procuring the same disease shoots to a 100%. An important example of this genetic phenomenon is the colouration of calico cats, where the orange, white and black coloration in kittens can only be seen in females.

In the most basic process in biology, reproduction, It should ideally be the case that the new genome which is created should be without any epigenetic tags passed from the parents in order for a new organism to reprogram itself to a new individual. This is required so that new cells and tissue can originate from a basic template

and continue further specialization. New research studies suggest that in mammals about 1% of the genes survive gene reprogramming in a process called imprinting. This explains a lot about the inheritance of certain traits from parents to offspring which couldn't be based earlier on purely recombination of the maternal and paternal genome. This opens up ideas about individuals being affected even through the environment and passing on acquired traits to the next generation. These are now core ideas around the process of epigenetics. Case studies of people having suffered from disorders during the time of the Dutch famine in 1944-45 and their children show a trend with regards to their physical traits. This may have been due to the inheritance of changes in their epigenome during this dreadful time and the passing on of the same genes to their offspring. Audrey Hepburn, famous for her elegant and fragile bone structure, was one of the inhabitants in Netherlands during this time when she was 16. The effects of the famine stayed with her even after the end of the famine and continued to effect her physical health.

There's still a lot more to epigenetics than what I've covered here and what researchers have found till now. The quest continues to unravel the biggest mysteries of the genome and allow for us, as a human race to broaden our perspective on the spectrum of life.

MYTH BUSTERS

Lightning never strikes the same place twice .

This myth is not only wrong, it's dangerously wrong. Lightning often strikes the same place twice, at least within a close vicinity. If you find yourself standing around outdoors during a lightning storm, there is no outdoorsman or forecaster who'd recommend you go stand where lightning has already struck as if you are somehow protected at that spot. Instead, you need to find shelter, stay away from windows and avoid touching anything metal or electrical. And it's always a good idea to suspend your golf game or kite-flying till the storm passes.

Down The Memory Lane

In keeping with our theme 'A Constant Journey Towards Change' and in honor of the 150th anniversary of St. Xavier's College (Autonomous), Mumbai, we interviewed two of our Alumni about their experience being associated with the College.

Dr. Samuel B. Namdas has been associated with Xavier's for more than 30 years. He joined in the year 1979 as a Professor and served as an HOD to the Department of Life Sciences and Biochemistry from 2001 to 2005.

Dr. Vishwas Sarangdhar was a part of the very first batch of Life Science and Biochemistry at St. Xavier's College. He went on to do his MSc in Biochemistry and got his PhD from Tata Institute of Fundamental Research (TIFR), Mumbai. He has served as a Biotechnology consultant to various industries and is also an active member of The Caius Research Laboratory, St. Xavier's College (Autonomous), Mumbai.

Dr. Vishwas Sarangdhar



What inspired you to pursue a career in Science and Research?

I have always been curious about the way things work. Ever since school days, I had made up my mind that I'd take up Science to obtain insights into the mechanisms of natural phenomenon. I disliked Mathematics so I was sure that I wanted to study different aspects of biology, especially at the molecular level.

What are some of your fondest memories being associated with the Life Science Department?

We were the first batch of Life Science-Biochemistry and there was a lot of excitement among the teachers to teach the first batch. The first two years, teachers from Botany, Microbiology and Zoology Departments would take our lectures and conduct some of the practicals. By the time we were in TYBSc, the Department had full complement of the Faculty. Happy memories during all those years include the Khandala Seminars, where we bonded as a group, students and teachers together. Practical were a lot of fun, thanks to our very enthusiastic teachers like Sam Waugh, Alex from Life Science, and Sheela Joseph from Zoology. There was open exchange of ideas in the class and we could argue with the teachers about a an array of topics. Lectures too were never boring because our teachers always treated us like their friends.

What changes do you see in Xavier's and the Department of Life Science over the years?

The major change I notice in the Department over the years is the number of students. Back in the 1980s, batch majoring in Life Science had only 25 students while the Biochemistry Department had 40 students in all. The increased student number makes a very large demand on the resources of the Department and on the teachers' time. This seems to make personal attention to individual student more difficult.

How has autonomy changed the College?

Autonomy was to enable Xavier's to have a curriculum better than that of Mumbai University and to allow teachers to evaluate students in ways that are not limited to just the books. The inadvertent consequence of autonomy that I notice is that the teaching has decreased, and the tests and exams in a semester have become the

focal point of the departments.

Autonomy has also increased demand on teachers' time in activities not directly related to the teaching of the subject. For example, the teachers have to devote a lot of time to maintain various types of records, attend/conduct seminars not related to the subject, and organize activities for the student's to undertake so that the number of Credits required by the students other than the Subject Credits are achieved.

What changes have you observed in the way of teaching in the Department and the College?

From the days of 'Chalk-and-Talk', I have seen the logical progression to transparencies, to PowerPoint presentations being employed by teachers. However, the major difference I notice is in the effort taken by the teachers to find new teaching material so that they can achieve effective transfer of concepts.

The drawback I have noticed is that the students have the reading material distributed to them through electronic modes, which makes them unattentive in class, because they know that they have the access to the material any way. The other difference seen due to the autonomy and the semester system is that the students have very little time to properly assimilate the topics they learn. This is exacerbated by the involvement of the students in extra-curricular and Social Involvement Program which are mandatory.

How has research in India changed? Do you see any changes in opportunities in this field, especially for women?

The research in the field of biology has undergone a massive expansion due to far better availability of funding from various government agencies. There are special avenues opened for women scientists to pursue research careers, even if they take a break from academics due to personal reasons. The emphasis is on encouraging a larger number of women to take up the research path. It seems to be bearing fruit given the number of women scientist who have earned various prestigious awards in recent times. Two of our own Alumni, Shubha Tole and Vidita Vaidya, have been conferred The Bhatnagar Award.

Dr. Samuel Namdas



What changes do you see in Xavier's and the Department of Life Science over the years that you've been associated with the department as it's HOD?

I joined Xavier's in 1979 and was assigned the task of setting up the Biochem lab and start the interdisciplinary Three Units Biochemistry course in which students from Botany, Life Science, Microbiology and Zoology could enrol. There was a tremendous response from all the students and we had to put a limit to number of students for each combination that could be enrolled. The first year University result was outstanding with record number of students getting first class with Distinction and above. We increased the intake from 40+ to 60 running three batches of practical in a week. The late Dr Dorothy Hakim was heading the combined Department of Life Science and Biochemistry at that time.

What changes have you observed in the way of teaching over the years?

I think we always ventured in trying out something new and believing that nothing is impossible and sky is the limit. We encouraged students to explore and learn from each other which include the teachers as well. The restriction of sticking to the syllabus was never practiced. Teaching and learning was a fun and I assume that still continues.

How has autonomy changed the college?

Before the autonomy there was a new initiative i.e. introduction of an autonomous, self funded Honours Programme- a 'brain child' of Professor Jangu Mistry and some other like minded young teachers. This programme was a success right from its inception and I think is still continuing in some form or other.

The success of this programme, ultimately lead to autonomy. I am sure the autonomy has opened up many new options including flexibility and freedom to design new course combinations and opportunities for students to stretch their limits.

There could be some downside of getting caught with examination duty and related paper work which earlier was mostly carried out by the University with the help of teachers from the affiliated colleges. Now it seems autonomous status has become a norm mainly because of competition, globalisation, new way of learning, acquiring skills and emphasis on adaptation to the rapidly changing world. I am sure the college and our students are well equipped to face these challenges.

What are some of your fondest memories as HOD of The Department of Life Science and Biochemistry?

I always believed in working as a team and learning from each other. The working environment was cordial and supportive. It was like home away from home. We used to look forward to our frequent 'pot lucks' with everyone enthusiastically showing their expertise. The Department was well known in the College for this enviable and desirable distraction.

What inspired you to pursue a career in Science and Research?

Science encourages you to ask questions and think logically. I think human being is a curious creation questioning his or her own existence and trying to resolve the mystery of this observable or known universe- the answer to which may never be found but that doesn't discourage us from trying with our limited knowledge of Science!

How has research in India changed? Do you see any changes in opportunities in this field especially for women?

There is a tremendous hidden talent and potential which needs to be awakened and encouraged specially for women. Our mind set and outlook towards women particularly in rural India needs to change.

Do you have a message for the youth pursuing Science and Research today?

There is no substitute for hard work. Endeavour to be the best at whatever you do. Don't leave a single stone unturned in pursuit of your scientific inquiry. The secret of success is what Thomas Edison said "99% perspiration and 1% inspiration"



The Perfect GIFT!

with Dr. Indira Hinduja

Dr. Indira Hinduja M.D., Ph.D. is an Indian gynaecologist, obstetrician and infertility specialist based in Mumbai. She has obtained a PhD degree for her thesis entitled 'Human In Vitro Fertilization and Embryo Transfer' from the Bombay University. She was responsible for the first baby born by In Vitro Fertilisation (IVF) in India and also pioneered the Gamete intrafallopian transfer (GIFT) technique resulting in the birth of India's first GIFT baby. She is also credited for developing an oocyte donation technique for menopausal and premature ovarian failure patients.

What inspired you to pursue studying IVF after gynaecology?

Maybe I didn't want to be a routine gynaecologist. I was starting my career around the same time as the birth of the first IVF baby in the world and so I wondered if it would be possible for me to divert into that. Whenever we think of development, we always tend to disregard it and think we don't have enough infrastructure. But I used to read a lot and collect all relevant literature. On my way back home there used to be an institute called Institute of Research in Reproduction (now National Institute for Research in Reproductive Health) and my bus stop happened to be right opposite this institute. I kept thinking to myself, "What must they be doing there?". One day I finally gathered the courage to enter. I found a scientist, Dr. Peter there who was working on hamster eggs and that really encouraged me. He was about to go for tea to 'Sahyadri' hotel. I introduced myself to him as a doctor from KEM hospital and requested him to sit and have a discussion with me. And over the cup of tea we discussed his work and I asked him why we couldn't do it on humans. He seemed excited by the idea and that further encouraged me.

I used to collect fluid from women who used to come for laparoscopic sterilization (tubal ligation). So if I saw a follicle in the fluid I used to aspirate it and give it to Dr. Peter. I had never before seen what an egg looked like and one fine afternoon he (Dr. Peter) found an egg! That again gave us the motivation to go on. So, in this way, little by little we got success.

What are your memories of your early work in IVF and embryology?

After registering myself for a PhD it took me a long time, a REALLY long time to get a hang of things. It literally took me days and nights to handle all that I had to handle because I did not previously know anything about em-

bryology. Sometimes, I used to get very frustrated and even cry because I wasn't able to identify the eggs. I kept books around for reference and sometimes suddenly I would just go "ha mila!". And so, without any infrastructure, this is how we succeeded.

When you first pioneered IVF in India, what were the societal reactions you faced? Was the idea readily accepted?

No, not at all. They did not accept it. People thought it would be an abnormal baby. They thought that the whole baby would grow inside a test tube and some even asked me to show them the test tube! People were actually very curious. They wanted to know whether they could go and buy such a baby in the market. There were lots of myths and misbeliefs about the entire concept. Everybody wanted to come and see the baby and find out if it was abnormal or like a jackal. Even the commissioner wanted to see the baby.

Even after the birth, people did not accept it. They believed the baby would not grow well. Some thought it was only a fluke and that the baby had already been conceived before the procedure. There was a lot of criticism and a lot of comments being passed that I was cooking up stories etc; so much so that once I even wondered why the hell I did do it. A lot of people doubted me and questioned how I did the IVF because we didn't have such sophisticated equipment back then. Even the institute and hospital staff were commenting.

How did you deal with all this criticism and negativity?

You have to just wait and watch. You can't convince everybody and anyway in a short while I got the second baby and then the third. Gradually, people have to believe you. Still, jealousy was bound to be there because I became popular overnight. You just have to bear it. Gradually, reproducibility of my work helped me build my reputation.

Did you ever imagine that IVF would become so big in India?

No, never. That time you are not working for your name and fame. You are just working to achieve what you have set out to achieve.

Making IVF a reality was a major milestone in embryology in your times. For our generation, what according to you what will the next big development be? What should students interested in embryology today focus on?

Embryology is a major branch by itself. There are a lot of avenues for future research because after all you are handling a human egg. So, it's a good field, provided you are interested. There are a lot of recent developments like prevention of birth defects, formation of stem cells, preventing particular conditions in the baby that have been found in the family...there are so many things. Maybe one day we will even have made to order babies!

How is infrastructure for IVF and embryology different today from back when you did it for the first time?

Everything now is available ready made. All you need is a little skill. Back then we had to do everything ourselves: distil the water, prepare a media for the cells, ensure proper proportions of substances had gone in the media. Then we had to test the media in animals. Now everything is already checked. Embryo tested media for different stages of the procedure is also readily available. Back then we didn't even know that different media were required for the various stages.

I have not had any formal training abroad. Many people go for training and in 6 to 7 months become IVF specialists. I did not have the opportunity for such training. I learnt myself with my own two hands. I learnt from my errors, mistakes and experiences. After I made mistakes I would analyse where I might have gone wrong. Many times I had to beg other scientists for certain resources! I have begged like hell.

We have a lot of biology students in our college and at least some of us my go into embryology. Do you have any message or advice for us?

First, you have to develop your interest. Everything depends on your interest. Once you find what interests you, guiding centres and training centres for what you want to do are always there. Prepare your literature, do your research about your field of study properly and then for the final learning there are so many educational institutions for every field now. In my case, I was willing to go to extent to study and understand the specifics of IVF. I have slept many nights in the laboratory and on the writing table to follow the progress of my work. You have to be prepared for that sort of hard work. And if you are prepared for that, I don't think any obstacle can stop you. You have to have that...desire to do it! The zeal to succeed! You have to have what we call 'junoon' to succeed. But this zeal and one pointed focus should be at your own cost and never at someone else's. You will never succeed if you try to make progress at someone else's cost.

BEST REGARDS, HEMANT MODI

PHONE- +919820219465



STUDENT ACHIEVEMENTS

COLLEGE TOPPERS(2017-2018)

Mr. Som Banerjee - 3U Life Science Topper

Ms. Mallika Pandya- 6U Life Science Topper

Ms. Farha Ansari- MSc Life Science Topper

Awards

Mr. Rohan Gupta and **Mr. Bivas Nag** (FYBSc) won the 1st prize in the science quiz event 'Brain Crunch' at Primers, the Fest of Elphinston College on 12th December 2018.

Mr. Arjun Udupa won 2nd Prize for the Poster Presentation at IIT Bombay on 12th January 2019

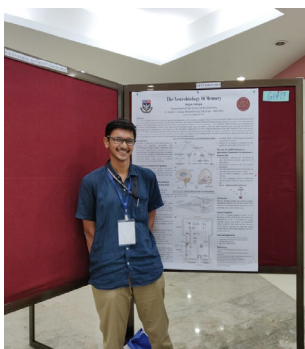
Ms. Muskan Misra and **Ms. Alisha Shah** (SYBSc) won the 1st Prize in the event 'Ethnic Funk' and **Mr. Noel Gonsalves** and **Ms. Taneya Samant** (SYBSc) won 3rd Prize in the event 'InQUIZitive' at Luminescence, the fest of Mithibai College on 8th August 2.

Ms. Assumpta Fernandes won 2nd Prize for the Poster Presentation at International Science Conference held at St.Xavier's College (Autonomous), Mumbai from 9th to 11th January 2019.



Mr. Noel Gonsalves and **Ms. Taneya Samant** 3rd Prize in the event 'InQUIZitive'

Ms. Muskan Misra and **Ms. Alisha Shah** won the 1st Prize in the event 'Ethnic Funk'
(L toR)



Mr. Arjun Udupa won 2nd Prize for the Poster Presentation



Mr. Rohan Gupta and **Mr. Bivas Nag** won the 1st prize in the science quiz event 'Brain Crunch'



Ms. Assumpta Fernandes won 2nd Prize for the Poster Presentation at the International Science Conference.

Ms. Jinali Mody (TYBSc) won the 1st prize as part of the team that represented St. Xavier's College (Autonomous), Mumbai, at the Milgrad School of Business, University of Tacoma, Washington, USA.

MSc I students **Ms. Lizanne Oliveira** and **Ms. Esha Shanbhag** bagged the 1st prize in the Science Quiz event 'Cerebrocracker' at Palindrome, the annual fest of the PG Dept. of Biotechnology at St. Xavier's College (Autonomous), Mumbai, on 20th Jan. 2018.

Ms. Kriti Rajda (TYBSc) won 2nd Prize at the Sweden India Nobel Memorial Quiz, Mumbai September 2018.

Ms. Zubia Shaikh (TYBSc) won 2nd Prize at the Primal.K.Shroff & Co. National level essay writing competition 'Politics Of Identity'

International Study Programmes& Scholarships (2017-2018)

Ms. Jinali Mody (TYBSc) was selected for a 5-day leadership development programme for young women held between 11th – 15th July 2017 at King's College and the colleges of Oxford University in association with the Mayor of London. The programme was organized by the Transcontinental School Innovation Alliance (TSIA).

TYBSc students **Ms. Ananya Agnihotri** (USA) and **Ms. Mallika Pandya** (Daegu Haany University, South Korea) returned with flying colours and high scores after completing their year-long foreign exchange program.

Ms. Surpreet Bhasin, Ms. Janvi Gandhi, Ms. Shivani Suresh (SYBSc) were selected for the HCAP program at Harvard University, USA, in Jan. 2018.

Ms. Asmita Dubey (TYBSc), Holland Scholarship at MSc in Environmental Biology at Utrecht, Netherlands.

Ms. Samyuktha Rajan (TYBSc), TROPIMUNDO scholarship for Erasmus Programme for Evolutionary Biology at the Groningen University, Netherlands.

Ms. Sharmistha Muralidharan (TYBSc), Neurasmus Programme at Vrije University, Netherlands

CURRENT RESEARCH



A SYSTEM FOR RAPID SCREENING OF THE ANTI-DIABETIC ACTIVITY OF PLANTS

Deepthi Nambiar, Sushmita Bose, Dr. Manasi Kanuga & Dr. Nandita Mangalore

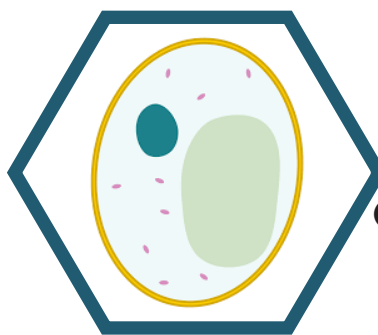
In recent years, diabetes, a chronic multifactorial disorder has proven to be a grave public health concern. Amongst various strategies designed for the management of the disorder, the most common approach has been the use of α -glucosidase inhibitors. Maltase, an alpha-glucosidase, aids the hydrolysis of maltose to glucose. Inhibition of this enzyme helps in retarding the glucose absorption thus reducing postprandial hyperglycaemia, a hallmark of diabetes. In this study, attempts are being made to lyophilise maltase and develop a rapid screening system for checking the α -glucosidase inhibition potential of plants. Plants known to have anti-diabetic properties will be screened using the developed method to check the efficiency of the same. This will further aid in screening a large number of plants, prioritise them based on the anti-diabetic activity before being tested in animal models.



IN VIVO AND IN VITRO STUDIES OF ZINC TOXICITY ON THE NERVOUS SYSTEM

Nathan Gonsalves and Dr. Bhaskar Saha

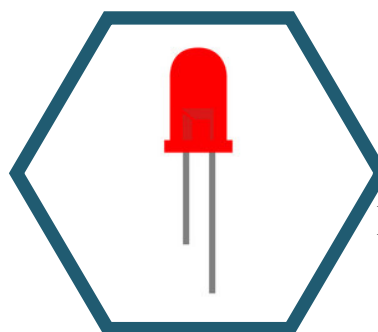
Zinc dyshomeostasis has been extensively studied in the recent past owing to the effect that excess zinc has on the nervous system as in conditions like brain ischemia, trauma and epileptic seizures. The elevated levels of free zinc in the body especially in the central nervous system leads to neurodegeneration, even though zinc is found to be neuroprotective in trace amounts. Zinc induces cell cytotoxicity causing a disruption in normal neuronal signalling and synaptogenesis. As the effects of zinc deficiency on the nervous system has been well characterized before, we hereby need to extensively study the effects of zinc toxicity on the nervous system. In order to study the effect of zinc toxicity on the nervous system, we chose to use *Caenorhabditis elegans* as a model organism for the in-vivo studies as well as C6 glioma cell line and N2a neuroblastoma cell line as a part of the in-vitro studies. A comparative analysis of the findings obtained from both studies would help understand the effect of toxic zinc doses on the nervous system, which would be important in designing strategies to prevent the ill-effects of zinc on humans who are at a higher risk of exposure to zinc.



CHARACTERIZATION AND IMMOBILIZATION OF YEAST FOR BIOETHANOL PRODUCTION

Rani Jain, Swapnali A. Shिवtarkar and Dr. Priya Sundarrajan

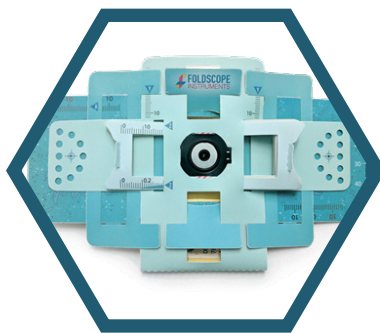
Fossil fuels are currently used as the world's main energy source with consumption increasing due to population demand. This has led to various environmental and global climate changes. Thus from economical and environmental point of view, there is a need to switch from non-renewable energy source to renewable energy source. Bioethanol is one of the most widely used renewable energy source so as to overcome various environmental problems. Bioethanol conversion from various agricultural wastes is mainly brought about by various yeasts that will help in the production of bioethanol. Yeast strains isolated from various sources are being used to study various parameters that will help to identify suitable ethanol producer. Study of growth parameters such as sugar utilization, pH, temperature and ethanol tolerance will be carried out to check which strain grows better in various stressful conditions for various industrial applications. Estimation of ethanol produced will be carried out to determine the amount of ethanol produced. Co-culture and cell immobilization technique will be carried out for better bioethanol productivity.



EFFECT OF LED ILLUMINATION ON ORGANISMS

Esha Shanbhag, Genevieve K. Karaila, Dr. Binoj C. Kutty

Artificial lighting systems have transitioned from incandescent light bulbs to compact fluorescent lamps (CFL) and now light-emitting diode (LED) bulbs. The use of LEDs has increased exponentially over the years as it is energy efficient, durable and cost effective. However, studies on the biological effects of LED exposure are limited. This project will study the effect of exposure to LED illumination on growth of bacteria (*Escherichia coli* and *Staphylococcus aureus*) and yeast (*Saccharomyces cerevisiae*). The effect of incandescent, CFL and LED exposure on the viability at similar intensities will be compared. Time response curve at a single intensity and Dose response curves of these cultures for LED exposure at increasing intensities will be generated. The growth curve of LED exposed and unexposed cultures will be compared. In an attempt to understand intracellular response to LED exposure, protein expression profiles will be compared after electrophoresis. To investigate if oxidative stress is responsible for the light induced effects, levels of oxidative stress response enzyme such as superoxide dismutase, catalase will be monitored. Our preliminary studies suggest that LED exposure at 2000 lux for 3hrs decreased the viability of *Escherichia coli* culture.



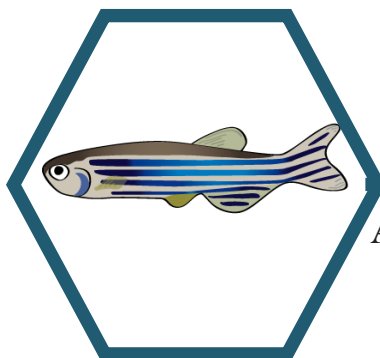
MAPPING MICROSCOPIC BIODIVERSITY IN SELECT ECOLOGICAL NICHES USING PAPER MICROSCOPE 'FOLDSCOPE'

Jennifer Tellis¹, Siddhi Parab¹, Dr. Maya Murdeshwar, Dr. Sujata Deshpande

To bring this idea to fruition, and to give the lay person a chance at scientific, exploratory research, the frugal scientific innovation of the paper microscope was brought into play. Devised by Dr. Manu Prakash, currently an Associate Professor of Bioengineering at Stanford University, USA, the 'Foldscope' is an inexpensive, portable, light-weight paper microscope, small enough to fit into a pocket, and amenable with on-site field studies. It is designed to make a microscope 'as common as a pencil', and to take expensive, fragile and normally inaccessible laboratory equipment to the common man.

The aim of the project is to explore the seasonal and climatic variation in ecological biodiversity of microflora and microfauna using the Foldscope. The changes in the type and abundance of these microorganisms will be investigated in soil, still and running water, leaf litter, tree bark, moss covered rocks and other microhabitats over a period of one year. The effect of human interference on these bionetworks will also be studied. The results will be systematically documented using scientific research methodology.

This project is funded by the Department of Biotechnology (DBT), Government of India, DBT-PrakashLab Research Grant 'for the use of Foldscope as a Research Tool' (Foldscope India Phase-I) of ₹8 lakhs to the guiding teachers for a period of one year.



A STUDY ON ZEBRAFISH LARVAL FIN REGENERATION UNDER THE INFLUENCE OF ESTRADIOL

Reanne Fronteiro, Lizanne Oliveira, Dr. Radhika Tendulkar

Zebrafish (*Danio rerio*), the teleost fish, displays a high potential for regeneration of organs like the retina, heart, caudal fin and spinal cord. Amongst these, caudal fin regeneration has been demonstrated in both adult and larval models of the zebrafish, with regeneration of the larval caudal fin being completed approximately three days after amputation.

17 β -estradiol (E2), a natural steroid hormone, has emerged as a contaminant of aquatic ecosystems. When present in large amounts, E2 exerts several effects on craniofacial cartilage development, reproduction, behaviour, etc. of zebrafish. The effect of E2 on fin regeneration has not been assessed. However, 17 α -ethinylestradiol (EE2), a synthetic estradiol elicits an inhibitory effect on fin regeneration in zebrafish larvae. This study, therefore aims to determine the effect of E2 on the regeneration of caudal fins of zebrafish larvae. Additionally, this study would

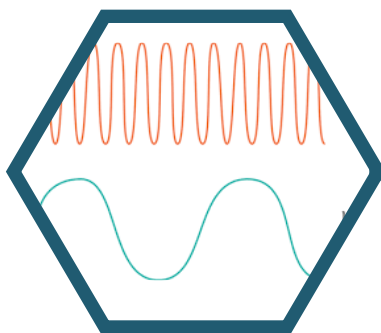
also help in understanding the effect of E2 on caudal fin development in zebrafish larvae, using bone and cartilage development, cell proliferation and cell death as parameters for analysis



EFFECT OF EXTRACTS FROM INDIAN MEDICINAL PLANTS ON LONGEVITY IN *C. elegans*

Anju Ashok, Avanti Mhatre and Vishakha Nate Dr. Seema Das and
Dr. Radiya Pacha Gupta

The nematode, *Caenorhabditis elegans* has been used as a principle model organism in longevity studies (Sutphin & Kaeberlein, 2009; Tissenbaum, 2014). In nematodes, lifespan can be defined as the number of days the worm is responsive to external stimuli. Studies have found that dietary restriction increases longevity in *C. elegans* and delays the onset of age-related phenotype. Longevity is independent of aging. However, lifespan is a single measurable parameter that defines the amount of time an organism is alive but does not give any indication of how an animal is actually aging (Tissenbaum, 2014). In normal aging of worms, typical age-related phenotypes like decline in the rate of various behavioural patterns are observed. In this study, we are employing bacterial deprivation as a mode of dietary restriction to observe its effect on the longevity of *C. elegans*. In previous studies conducted, an increase in the life span of *C. elegans* was observed when subjected to bacterial deprivation (Smith et al., 2008). We propose to study longevity and age-related phenotypes in *C. elegans* using extracts from Indian medicinal plants. Several plants are known to have bioactive components which have antioxidant and antidiabetic activity. The phytochemicals like polyphenols, terpenoids, alkaloids, tannins, resveratrol are some of the known bioactive molecules responsible for the medicinal properties of plants (Zhang et al., 2015). *Arthocarpus heterophyllus* contains a polyphenol, resveratrol that activates molecular pathways involved in life-span extension. Additionally, the plant is known to be an antioxidant (Shrikanta et al., 2015). *Cinnamomum verum* is an emerging potential therapeutic agent used for treatment of diabetes. It contains cinnamon polyphenols that exhibit insulin-like activity in cells, animals and humans with diabetes (Sangal, 2011). The aqueous extract of the plant is shown to improve insulin receptor function (Sangal, 2011). *Stevia rebaudiana* extracts are used as natural sweetener in many countries. The sweet active components present in the leaves are stevioside, rebaudiosides A, B, C, D, and E; dulcoside A, and steviolbioside. These phytochemicals possess upto 250 times the sweetness intensity of sucrose and are noncalorigenic (Kujur et al., 2010). *Tinospora cordifolia* is known to have antidiabetic and antioxidant properties. Recent studies have shown that antidiabetic drugs have an effect on many signalling pathways, targeting mainly the Insulin/Insulin-like growth factor signalling pathway (IIS pathway) and ROS pathway, which results in longevity of worms (Saha & Gosh, 2012). Upon aging, behavioural changes of *C. elegans* are known to have declined and various approaches have been employed to measure the same. In this study the selected parameters are pharyngeal pumping, co-ordinated body movement and chemotaxis as a measure of the aging-related behavioural changes. Studies have found that there is an increase in accumulation of fluorescent compounds and single stranded breaks in DNA upon aging in *C. elegans* (Pincus et al, 2016). Hence biochemical assays such as comet assay and lipofuscin accumulation will be performed to study longevity.



EFFECT OF ELF-EMF ON ZEBRAFISH (*Danio rerio*) DEVELOPMENT

Prof. Prashant Ratnaparkhi, Releestina Lopes, Vinita Lobo

Devices which run on electricity generate electromagnetic fields (EMF). The frequency of Extremely Low Frequency (ELF) EMF is 1–300 Hz, and the Earth's natural geomagnetic field strength varies from around 60 μ T (microtesla) at the magnetic poles to around 30 μ T at the equator. [WHO, 2007]. ELF EMF is produced by both natural and artificial sources. Naturally occurring ELF EMF is associated with atmospheric processes such as ionospheric currents, thunderstorms and lightning.

Artificial sources are dominant sources of ELF EMF and are usually associated with the generation, distribution and use of electricity at the frequency of 50 or 60 Hz.

Increase in EMF-producing equipment and environmental exposure might have biological effects on human and/or animal health. Many scientific studies have reported that ELF-EMF can influence the biological systems, and could be involved in leukaemia, brain tumours, genotoxic effects, neurological and neurodegenerative diseases, immune system deregulation, allergic and inflammatory responses, breast cancer, miscarriage and some cardiovascular effects. [Lennart H. et al 2007]

Usually, extremely low-frequency electromagnetic fields exposure is assumed to be harmless to the health of human beings because of their low-level energy exposition (magnitudes well below levels required to affect the metabolic rate of the human body) [Feychting M et al 2005].

Through our project, we are investigating the effect of ELF-EMF on the development of zebra fish, in a time/dose dependent manner.

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Image courtesy- Prof. Binoj Kutty

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2019

January

M	T	W	T	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
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February

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March

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May

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July

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August

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October

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November

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December

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LIGNUM VITAE 2019

