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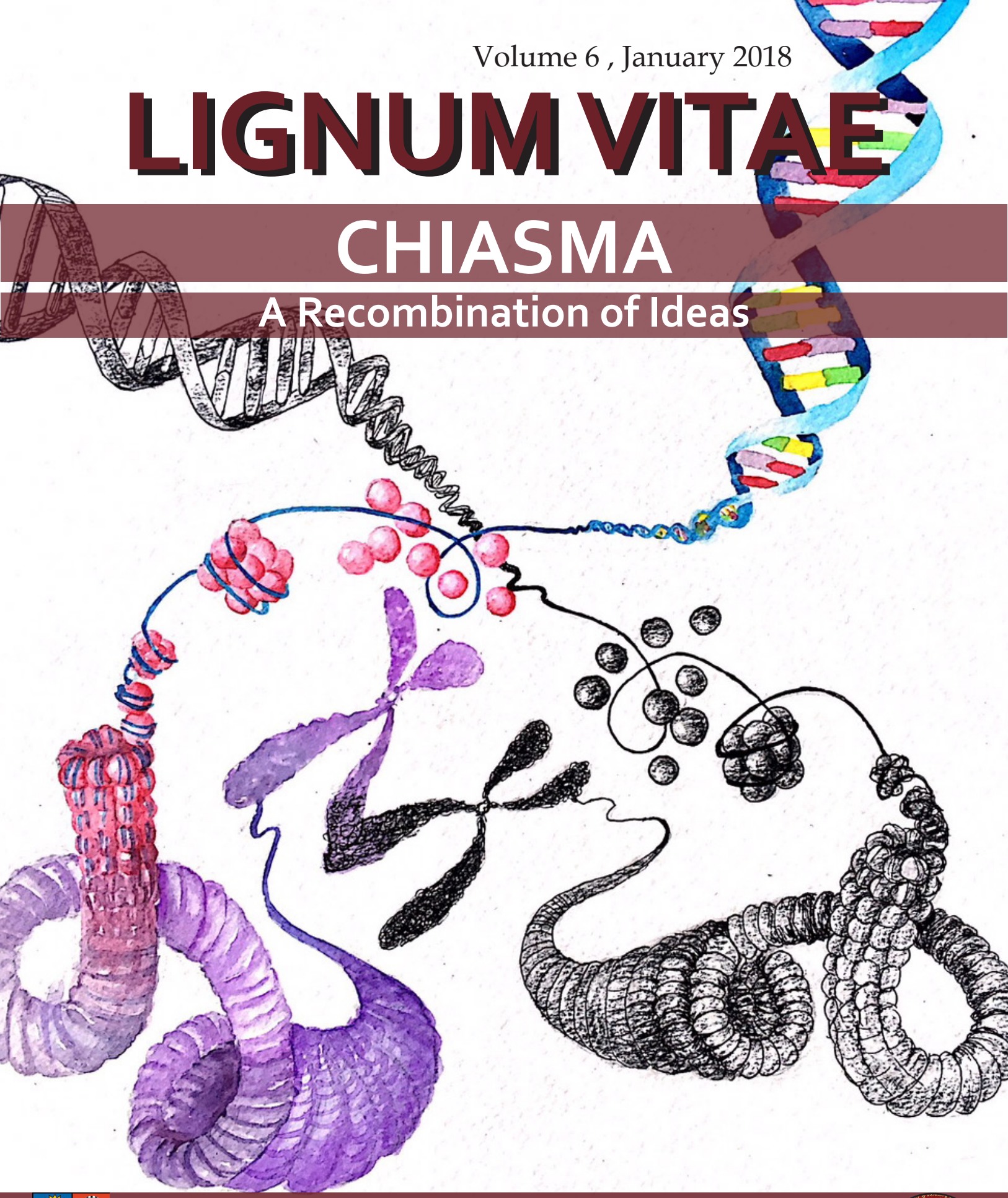
LIGNUM VITAE

CHIASMA

A Recombination of Ideas



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EDITORIAL

The academic climate is different today, as we see the world shifting from a singular, traditional approach to an interdisciplinary, multifaceted one. This revised way of thinking is the future – encouraging us to probe deeper into the mysteries that surround us and focus on ideas that lie outside the realm of conventional thinking. Nothing can be studied in absolute isolation, and exploring the areas of overlap between various fields of study is absolutely critical in order for progress in this dynamic world.

Today, we are witness to groundbreaking research that transcends the boundaries established by traditional fields of study – we see Physicists and Engineers working towards curing Cancer, Geneticists and Archaeologists collaborating to trace the evolution of mankind, and Neuroscientists applying biological principles to marketing research in Neuromarketing; studying consumers' sensorimotor and cognitive responses to marketing stimuli.

We present this year's issue of Lignum Vitae, "Chiasma: A Recombination of Ideas", in this very light of revised thought process – embarking on a quest to inquire into phenomena concerned with multiple disciplines. Thus, this year's edition attempts to explore the areas of overlap and interrelation between numerous disciplines; proving that intellectual exchange is imperative for greater variation in innovation, just as the formation of a Chiasma between sister chromatids during Meiosis is critical in the transfer of genetic material that facilitates genetic diversity within a species.

In the words of John Seeley Brown, "Instead of pouring knowledge into people's heads, we need to help them grind a new set of glasses, so they can see the world in a new way."

EDITORIAL TEAM

MAIN AISA KYUN HOON?

SOM BANERJEE, TYBSC

"And as I had my father's kind of mind-which was also his mother's-I learned that the mind is not sex-typed" –Margaret Read

While I do agree with Ms. Read from an anthropological perspective, a purer biological analysis compels me to disagree: human brain is indeed "sex-typed".

An elementary Biology class would profess that it is the sex chromosome contributed by the father which determines the phenotypic sex of the offspring. A further in-depth analysis would reveal a well-established fact that, in the early stages of development, the gonads are bipotential i.e. they can develop into either male or female reproductive system, regulated by gene expression. It is the expression of the sex-determining region of the Y chromosome (SRY gene product is a transcription factor which upregulates the expression of other transcription factors like SOX 9 and hormones like Anti-Mullerian hormone) that causes regression of the Mullerian duct system (female) and progression of the Wollffian duct system (male). Hence, a chromosomally male fetus (i.e. XY), which is mutated at the SRY of the Y chromosome such that the SRY gene is either absent or non-functional, would develop into a phenotypic female, while a chromosomally female fetus (i.e. XX), which contains the SRY gene due to a rare translocation event, would develop into a phenotypic male. It is, therefore, not the entire Y chromosome, but a certain region located on the 'p' arm at position 11.2 of the chromosome which is responsible for manifestation of the sex of the fetus.

At this point, an important distinction must be drawn between 'phenotypic sex' and 'gender': while the former is determined merely by the presence of specific kinds of reproductive organs, the latter refers to an individual's subjective perception of their sex, and is often dictated by social, cultural and religious norms. Thus gender identity i.e. "the conviction of belonging to the male or female gender" or not conforming to a binary gender system, involves a certain amount of cognitive response and is a result of the sexual differentiation of the brain directed by exposure of steroid hormones, testosterone and estrogen. Unlike sex determination, which takes place between 6-8 weeks of gestation, sexual dimorphism of the brain happens at a much later stage of development. The developing fetal brain, irrespective of its sex, is protected against high levels of estrogen secreted by the maternal ovary and placenta, due to the interfering activity of α-fetoprotein, which has a high affinity for estrogen and binds to the same. In the phenotypic male fetus, once Leydigs cells have differentiated, they start to secrete testosterone and the level of this hormone reaches a maximum in two stages of development: between 12-18 weeks and between 34-41 weeks of gestation. The male brain has numerous receptors of testosterone, and the two testosterone surges are responsible for masculinization of the brain. Ironically, the brain contains an enzyme called the aromatase, which converts testosterone to 17-β-estradiol, an estrogen, which governs neuronal development in brains. However, since females do not produce any testosterone, the female brain is not exposed to any kind of hormonal surge which then drives the process of feminization of the brain. When I talk about the masculinization or feminization of the fetal brain, I talk of the differences in development of the neural structures which control the gonads and external genitalia and thereby mediate sex-specific functions post puberty. One well-studied example is the development of a group of hypothalamic cells called AVPV which undergo apoptosis under the influence of testosterone surge in the male fetus, but are extremely well-developed in females, and at puberty, induce systemic release of gonadotropin-releasing hormone and prolactin, thereby regulating cyclic ovulation only in females.

An interesting research led by D.F. Swaab at The Netherlands Institute for Neuroscience contests that since sexual differentiation of the genitals and that of the brain are two events temporally well-separated in the developmental stages of the mammalian fetus, 'these two processes can be influenced independently, which may result in transsexuality'. Transgenders are those individuals "whose identity, expression, behaviour, or general sense of self does not conform to their assigned sex", and when such individuals seek medical assistance such as hormonal therapy or sex reassignment surgery to transition from one sex to the other, they are called transsexuals. In biological terms, a transgender would be an individual with male genitals who feels like a woman due to feminization of the brain, and vice versa. For the purpose of this study, the two terms: transgender and transsexual have been used interchangeably. It is established in scientific literature that the interstitial nuclei of the anterior hypothalamus (INAH3) is 1.9 times larger in males as compared to females, and contains 2.3 times as many neurons. Swaab's study revealed that male to female (MtF) transsexuals do possess a female INAH3. During gestation, well-defined neuronal circuits are established which in adulthood translate into an individual's gender identity. This internal programming is irreversible, and is not only guided by hormones, but also by gene regulation, a process still not well-studied.

While sexual dimorphism among humans, in terms of anatomy and physiology, is a biological reality, whether these differences are equally well-pronounced in behaviour and psyche is still debated upon. A 2005 study by J. S. Hyde from University of Wisconsin-Madison, aimed at testing the 'Gender Similarity Hypothesis' focused on several cognitive parameters (comprehension, analytic skills), communication (talkativeness), personality (aggression, jealousy), and motor behaviors, showed that 78% of gender differences were insignificant. This led Hyde to look down upon gender stereotypes, and she concluded that claims of gender differences are often "overinflated" and "cause harm in numerous realms, including women's opportunities in the workplace, couple conflict, analyses of self-esteem problems among adolescents." Males, Females and other non-conforming genders show some amount of behavioral disparity, but the problem with stereotypes (such as, men don't cry, or women don't smoke or drink liquor, and the list is endless!) is that they are, more often than not, without conclusive biological basis, and they not only limit individuals from expressing themselves freely, but also breed inequality, shame, disrespect and ridicule, and act as torch-bearers for patriarchy.

FOETAL SURGERY: LIFE OR FATAL

KENNITH CASTELINO
FYBSc

Saving a life has always been quite a remarkable achiev ment, but can you imagine saving a life even before it is born? Foetal surgery is one of the most innovative and evolving fields in medcine. It involves surgical intervention in order to save the foetus' life and/or im prove the quality of its life. This field is so new, complex and important that its dynamics are ever-changing. New methods of treatment are being discovered and their significance is far-reaching. Despite its significance, the ethical issues faced by the fields of foetal surgery and maternal-foetal medicine are some of the most complex set ethical conundrums that humanity has encountered.

Foetal surgery of all kinds is considered to be highly invasive as the mother has to undergo the surgery in order to treat the foetus. Foetal surgery is mainly classified into three types. The first is the most invasive kind, called a hysterotomy.Hysterotomy involves the opening of the abdominal and uterine walls so that direct contact can be made with the foetus for its treatment. It is mostly performed for the excision of tumours and to fix congenital heart diseases. A hysterotomy is the most radical kind of foetal surgery, as chances of pre-term labour and the inability to carry future pregnancies to term are quite high.

The second kind is called fetoscopy and is comparatively less invasive. A fetoscopy is an endoscopic procedure in which tiny incisions are made in the foetal wall through which endoscopes are inserted. The endoscopes are then manoeuvred with surgical instruments to carry out the procedure. It is used to sever the connections of amniotic bands that obstruct the circulation of the foetus, among other procedures. The third kind is a percutaneous catheter procedure in which a catheter (a thin wire-like tube) is manoeuvred to treat conditions related to blood circulation, such as blood transfusions. Both fetoscopy and catheter procedures largely reduce the risk of uterine wall rupture and preterm labour compared to a hysterotomy.

It is often the principles of non-maleficence (do no harm) and beneficence (for the benefit of) that are in conflict with each other when it comes to the regard of both the mother and the foetus. In the event of a complication, a procedure that may benefit the life and/or the quality of life of the foetus may pose a great threat to the life of the mother and vice versa. Therefore, post-natal treatment is always preferred over foetal surgery. The decision to undergo foetal surgery is only taken when there is no other way of prolonging the pregnancy to full term without losing the growing foetus.

In case the need for a foetal surgery arises, physicians are duty bound to explain the problem in place, the invasiveness of the procedure and the risks involved for both, the mother and the foetus. Most of the recommendations made are dependent on the chances of survival of the mother and foetus, as well as the possibility of the uterus being viable for further pregnancies. The reason behind this being that if the odds of the survival of the foetus are slim to none, and the procedure would render the uterus non-functional for future pregnancies, most physicians would often recommend termination. This rule is not taken lightly, especially in countries where termination of pregnancy with parents' consent is considered illegal, as termination of pregnancy is always considered to be the last resort when the mother's life is at risk.

The above arguments beg the question of whether it right to terminate a pregnancy without trying to save the foetus if there is any possibility of survival? Even this argument has many hoops to jump through.

As bizarre as it may sound, a foetus is not considered a child until its birth. Nonetheless, over the years, foetuses have gained rights and the severity of these rights have increased as the gestation progresses. An early embryonic foetus that poses a threat to the mother is more likely to be terminated if there is no way of treating the condition. But, a foetus that is near the end of the gestation period would have a much greater chance of survival. In this case, the parents and physicians concerned are likely to opt for a foetal surgery. In any scenario, the mother's safety, rights and opinions have more value than the rights and opinions of any other individual.

In a fairly large number of cases, parents are most likely to choose to save the foetus, even when the procedure poses a great risk – unless the physician deems the task impossible. On the contrary, in rare cases parents have requested termination of pregnancy after a diagnosis of abnormalities, even if the foetus is in the late gestation period with good odds of survival. This could be due to the parents' personal beliefs, or the possibility of expensive medical care post birth. In such instances, judicial cases have been fought for the protection of the foetus and many have even been won in favour of the foetus due to the increasing strength of foetal rights.

In the end, a life, whether born or unborn, is a life at stake. Even with all the ethical complications we face in our society, we have managed to prioritize what's paramount for life to the best of our abilities with growing knowledge and leaping advances in medicine.

THE SCIENCE OF SYMPHONY

Sharmistha Muralidharan, TYBSc

Music has existed in the world since before man himself, and ever since man has been exposed to music, he has connected with it emotionally. But the existence of this connection itself has raised countless questions, like why do some mixtures of sounds in nature sound consonant, while others sound dissonant? Some more basic questions have been answered, with many of the answers finding roots in biology.

One such question is the existence of a small number of scales out of the myriad possibilities, and how they elicit different responses in different people. Biology explains this as the recognition of tonal sounds that are produced and recognized by humans. Tonality then evolves from these periodic pressure changes that are received at the ear, and induces behavioural responses in the person. Dale Purves, a neurobiologist who has intensively studied biomusicology, believes that the major and minor scales are either happy or sad because they imitate the diminished and excited states of these emotions. Moreover, the Western and most other scales share great similarity to the human voice bandwidth, thereby explaining the few scales we use out of a billion.

We have all been guilty of using music to influence or equilibrate with our moods, but music can do so much more; in fact, it can actually help improve various health conditions. Not just that, it can actually improve the performance of your brain! The classic example of this is what most believe to be the answer for the following question: Mozart or Beethoven – who is the better composer? In 1993, Rauscher and Shaw, two researchers proposed the "Mozart Effect," where they observed that among non-musicians, those who listened to Mozart's sonata for two pianos K.448 for ten minutes, had improved spatial-temporal reasoning, as compared to those who listened to verbal relaxation instructions or just silence. The spatial IQ scores tested were 8 to 9 points more for music than the other two categories. Beyond 10 to 15 minutes of exposure, there was no enhanced effect.

But if music is relaxing, then why just Mozart? Was it the happy and enjoyable tones of the music that resulted in this enhanced reasoning? An experiment on rats with the same music, when compared to Philip Glass' minimalistic music, white noise and silence, still showed greater efficiency of reasoning, and hence the enjoyment aspect of the music was ruled out. But further study using scanning methods to map out parts of the brain showed that the parts of the brain involved in music, such as the processing of pitch, melody and timbre overlap with the areas localized for spatial and temporal processing. A hypothesis suggests that the music can help prime the parts of the brain for a corresponding to spatial reasoning. In fact, on using an Electroencephalogram (device used to measure electrical activity in brains) it was found that listening to 10 minutes of Mozart can cause firing up of neurons in right frontal and left temporoparietal parts of the brain for about 12 minutes!

John Logan once said that "Music is the medicine of the brain." Perhaps this wasn't just a metaphor, for some of the most groundbreaking effects of the Mozart sonata have been observed on epilepsy patients. One such extremely effective case was that of an 8-year-old suffering from Lennox-Gastaut syndrome. The sonata was played for 10 minutes per hour of every day and caused a drop of 9 clinical seizures in the first four hours to one per hour. There have been many other cases of drastic as well as gradual effects due to the mechanism causing decrease in epileptoform activity of the neurons.

But what is it about Mozart's music that stimulates spatiotemporal reasoning? More experiments determine that it is the long-term periodicity, and owing to Mozart's, ranging especially between 10 to 60s. Similar characteristics were found in J. S. Bach and J. C. Bach, as well as Yanni's music. Using old pop music and minimalist Philip Glass music, the effect of median periodicity music was negated. What sets Mozart and the two Bachs apart from other composers like Beethoven is the presence of these long-term periodicities, which have been estimated to resonate within the cortex of the cerebrum, as well as aid in the processing of the brain and in decreasing epileptic seizures. Modern pop, rock music and other genres seem to carry a trend of shorter periodicities.

The short-term effects of Mozart and other composers have been replicated a few times, but more long-term effects indicate that children who listened to the same composers for a 6-month period during keyboard lessons performed 30% better than those who did not. However, short-term effects were not seen in musicians, owing to their developed use of both cerebral hemispheres in terms of music appreciation. This includes areas that are involved in processing melody, rhythm, pitch and metre.

Although the effect of Mozart's music has not found many practical applications in human beings yet, it definitely does describe the literal influence music can have on the mind of a person to some extent. There is no debate on whether or not an individual should be exposed in early life at all, for as Oliver Sacks once said, "In terms of brain development, musical performance is every bit as important educationally as reading or writing."

Did you know ? The speed of an incoming brain impulse is about 400 km/h.

GENE PLAY

-ZUBIA SHAIKH-
SYBSC

In Elbert Hubbard's felicitous words, *"One machine can do the work of fifty ordinary men. No machine can do the work of one extraordinary man."*

Humans have been engineering life for ages. Selective Breeding has equipped us to fortify certain beneficial traits in other organisms. We excelled at this, but could not comprehend its mechanism until the code of life - DNA was discovered. This complex molecule governs the growth, development, function and reproduction of every living thing on this planet. A mere four nucleotides couple to make up a macromolecule that codes for all of life's instructions. Any revamp in these instructions results in a transmutation in the organism carrying it. Several endeavours to change the genetic code have culminated in fruitful results, which include genetically modified mice- a model organism for research. The first food modified in the lab – the Flavr savr tomato – was engineered to have longer shelf life. This was done by inserting a gene that inhibited the activity of an enzyme that induced the rotting of the fruit.

Until recently, genetic editing was expensive, complicated and lengthy. But, the early 1980s witnessed the discovery of strange repeating segments of DNA in the workhorse of laboratories- E.coli. Throughout the '80s and '90s, similar repeating segments were found in the genome of many other bacteria. Yoshizumi Ishino is credited for the discovery of the CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) Gene. Its appearance is appositely portrayed in the name of the revolutionary technology - CRISPR-Cas9.

Overnight, the costs of genetic engineering shrunk by 99 percent, a relatively shorter span is required making in making it accessible. A glance at history reveals the competition between Bacteria and Viruses since the dawn of life. These bacteriophages kill nearly 40 percent of the bacteria in the oceans daily. The bacteriophages insert their genetic code into the bacteria and take over the bacteria to use as factories for the production of more viruses. But, bacteria have come up with ingenious methods to fight of a viral invasion, one of which is CRISPR-Cas9. They save a portion of the viral DNA in their own genetic code, in a DNA archive called CRISPR. When the virus attacks again, the bacteria instantaneously makes a RNA copy from the DNA archive and arms itself with a secret weapon- the protein called Cas9(CRISPR-associated enzyme). Cas9 scans the bacterium for the signs for viruses by examining every bit of DNA it encounters with a sample from the archive. When it finds a cent percent match, it chops up the viral DNA making it useless, thereby safeguarding the bacteria from the attack.

The revolution began when scientists realized that the CRISPR-Cas9 System is programmable. Numerous alterations to the system have been made, changing it from a defensive bacterial weapon to a precise scientific tool. One can just give it a copy of DNA that has to be modified and put the system into a living cell where it works like a GPS, honing in at the target DNA. It gives scientists the ability to edit live cells, to switch genes on and off, and study the purpose specific DNA sequences. It works for all kinds of cells, including human. In 2015, scientists used CRISPR to cut off the HIV virus in the lab. A year later they injected CRISPR into rats and were able to remove almost half of the virus from their body. In a few decades, CRISPR-Cas9 Therapy might cure HIV and Cancer. CRISPR-Cas9 gives us the ability to edit immune cells and make them better cancer cell hunters. Clinical trials of CRISPR-Cas9 have been approved in the early 2016.

The means to edit the genome of an early embryo is also possible. Research under this is in its infancy and has its ethical challenges. Regardless of one's personal take on genetic engineering, it will affect individuals. Modified humans could alter the genomes of the entire species because their engineered traits would be passed on to their offspring and could spread in generations, gradually modifying the whole gene pool of humanity. As the proficiency in genetic modification augments, our temptation will grow. If one can make their progeny immune to Alzheimer's, then we can also "give" them an enhanced metabolism. Why not throw in perfect eyesight? How about a tall, muscular structure with a high IQ? Huge changes would be made as a result of personal decisions of millions of individuals that accumulate. This ethical dilemma of the relative "good" (eradicating genetic diseases) versus "bad" (cloning or genetically modified organism) use of CRIPR makes it misunderstood in the general public. What most people fail to grasp is that though this technology, theoretically, can modify humans, it is still far from being able to achieve this.

The technology is indeed daunting but we have miles to go. CRISPR can make agriculture more humane, by impeding culling of animals like less meat producing female cattle or male chicks from elite egg laying breeds. Basic Neuroscience could also consolidate from the availability of new animal models. Genetic engineering might be just a step in the natural evolution of intelligent species in the universe. We might end disease, we could increase our life expectancy by centuries and travel to the stars.

Did you know ? Your skin's outer layer sheds every 2-4 weeks, amounting to roughly 0.7 kg of dead skin in a year.

Nature's Six-legged Arks

Amartya Mitra - S.Y.B.Sc.

Imagine being stuck in a flood; sitting on the only accessible patch of dry land, waiting to be rescued, when suddenly you notice a flotilla of venomous killer-ants towards you! Don't be deceived, for this isn't the premise for a B – grade horror movie. In fact, it's already happened to a few people, most recently during Hurricane Harvey. What people assumed to be scum floating on the floodwater was, in some cases, actually a raft made of live fire ants, an invasive species in many parts of North America, Australia and China.

Fire ants are native to South American rainforests and wetlands, which is far from an ideal habitat for flightless insects that live in mounds of soil. These environments experience periodic floods where water levels can rise over 10 feet! But fire ants have not only evolved traits to help them survive these floods, they even benefit from them. During a flood, the ants conglomerate to form clumps or rafts which float and drift across the water until they find dry ground to build a new nest. These forced journeys help the ants to migrate to new resource-rich areas and establish new colonies, adding to their genetic diversity and spread.

Studies have shown that these ant rafts can float for up to 12 days without breaking apart. The way they carry out this ingenious feat is truly fascinating. When the nest starts to get waterlogged, the ants assemble at the highest available point with their queen and her brood. The workers then begin to stick to each other using adhesive pads present on their appendages to form a firm, layered structure. Simply put, the colony uses surface tension to build a sturdy raft. Coupled with the presence of air pockets within the layers, the hydrophobicity of the ants exponentially enhances the buoyancy of the raft. The ants forming the upper layer of the raft stay dry while the ones forming the lower layer stay submerged. The critters have a waxy, water repellant coating on their bodies, as well as microscopic hairs known as setae, which trap tiny air bubbles, providing a breathing medium to the submerged ants. The layer of air thus formed is known as a 'plastron', and is the fire ant equivalent of a diving helmet. Ants also take turns by cycling between the two layers. . While larval forms are located on the bottom surface of the raft, the queen and her eggs hold special importance and are hence kept dry at all times, within the central portion of the raft on the upper side. Every member of the colony, including the larvae, which have curved and forked setae that help to trap air bubbles effectively, does its bit to keep the raft afloat.

This begs the question; what does one do when there's a flotilla of ants drifting in their direction? There's no chance that they'll be friendly; they're called fire ants for a reason. Fire ants derived their name from the nature of the nasty alkaloid they inject into victims' bodies, which, according to the testimonies of some victims, feels like fire. Individuals allergic to the compound may even die of anaphylactic shock. What's more? Floating ants, being vulnerable to predators, are even more aggressive than usual and inject higher amounts of venom. Poking the raft with anything like a stick is not only ineffective, but also dangerous. The ant-raft is extremely hydrophobic and won't sink if one attempts to push it down. In fact, the water under the raft will get pushed down along with the raft, rather then submerging it. If one does somehow manage to push the raft underwater, the ants will still have tiny air bubbles on them and will not drown – they'll float back up at the first opportunity they get. All of this will happen as the very hostile ants, (which have finally found a dry object) climb up the stick, onto you and inflict some serious damage. But fear not! The ant army can still be defeated. Like kryptonite is to Superman, soap is to a fire ant raft. When dissolved in water, soap breaks the surface tension of water and also negates the adhesive properties of the ant appendages, thus preventing them from grabbing onto one another. Moreover, it also interferes with the waxy water-repellant coating on the ant's bodies and prevents the formation of the plastron when the ants are submerged. Putting some liquid soap in the path of the flotilla will cause it to break apart and sink and the ants will drown Unfortunately, though, not everyone roams around with dish soap in their pockets! So if you ever come across one of these flotillas, it's best to leave them alone.

Or you might just want to add dish soap to your survival kit! Whatever floats your (fire ant) boat.

PUMP IT UP

VARUN SANE SYBSc

Our world is just another ball of metal and gas and dust revolving around a star, in some galaxy in an unending universe, with billions of galaxies containing billions of stars with planets revolving around those stars. Yet, despite this apparent monotony of the universe, we still call Earth unique because we have what no other planet has: LIFE. About 8.7 million species of living organisms call Earth their home; and most of these living species are living because of the presence of a brain.

The brain is the seat of the nervous system, responsible for coordinating various body functions. Ever wondered how the brain knows when to do what, or, how it sends and receives signals? This is where physics comes in. A large part of the transmission of signals in the brain is carried out by virtue of the difference in electric potential between two points.

Neurons are responsible for transmission of nerve impulses through the body, by a process similar to that of flow of current in a simple cell. Neurons are associated with many ions around their membranes. K^+ and organic anions have a high concentration inside the cell whereas Na^+ and Cl^- are abundant outside the cell. The movement of these ions across the cell membrane is by passage through specialised, hydrophobic, highly specific channel proteins, since the ions are hydrated and cannot simply diffuse across the hydrophobic regions of the membrane. The unequal distribution of charged particles on either side of the Neuron membrane results in the generation of a concentration gradients for various ions, and hence a potential called a Resting Membrane Potential (RMP). When the membrane potential is more positive or more negative than the RMP, the membrane is said to be either depolarized, or hyperpolarized, respectively.

Neuron membranes are permeable to Sodium, Potassium and Chloride ions. There is an abundance of K^+ ions inside the cell membrane, causing a tendency of efflux of K^+ ions along their concentration gradient. Conversely, Na^+ ions are more abundant on the outer surface of the membrane, causing a tendency for inward movement. In this process, the outer and inner walls develop relatively positive and negative charges, respectively, thus generating a potential. Eventually, when enough potential is generated, the net movement of ions across the cell membrane ceases. This potential is called the Equilibrium Potential.

The Na^+ and K^+ ion concentration gradients across the cell membrane are maintained by the activity of a protein called Na^+K^+ pump, which actively transports the ions against their concentration gradients, using energy derived from hydrolysis of. Every ATP molecule hydrolysed causes influx of two K+ ions are efflux of $3Na^+$ ions. The net effect of such a movement of ions is that the resting membrane potential becomes slightly more negative than it would otherwise be.

The simple movement of charges from a region higher electric potential to lower electric potential helps in responding to various stimuli. Our nervous system is a complex web of neurons transmitting electric signals via constant cycles of depolarization, repolarization and hyperpolarization. It is mesmerizing how such a complex functioning system employs such a simple mechanism to carry out its functions.

TO ETERNITY AND BEYOND.....

MUSKAN MISRA
FYBSC

The only greatness for man is immortality.

-James Dean

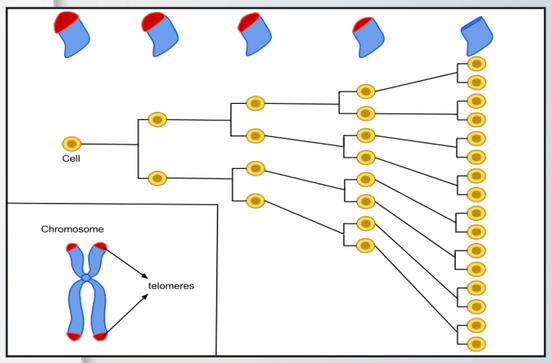
If you are reading this, congratulations for having achieved the goal with which we begin each day- you have avoided being a mere mortal. We all love to read about immortal heroes and characters like the ones in DC and Marvel Comics. Deep within our hearts, don't we all want to be immortal be it in our deeds, our words, inanimate statue or in our physical selves? Ponce de Leon's exploration for the fountain of youth is the stuff that we all assumed to be of legends, but in the contemporary world anti-aging techniques are a reality, with cutting edge technologies, we may soon find the phenomenon of aging to be a thing of the past. Thus, the clock will stop ticking.

Many of us are not able to comprehend the process of aging. As logic says, the building blocks of our body are cells, which are being formed at a constant rate. Yes, our cells have the power to regenerate themselves. But then why do we grow old? Numerous theories have been proposed to explain this highly complex and multifactorial process of aging; the most robust of these are probably the telomerase shortening and free radical theories.

Scientists for years now have experimented to achieve the successful restoration of vitality in the human body. One of the main reasons why our cells age is the shortening of the telomerase. In a cell's nucleus, our genes are arranged in molecules of DNA known as chromosomes. At the ends of the chromosomes are present telomeres (stretches of DNA), which protect our genetic data.

Yet, time and again when a cell divides, the telomeres becomes shorter. And when the telomere becomes too short, the cell can no longer divide and

dies therefore, a little part of that cell's information on rebuilding or regeneration is lost over time. Unlike other cells, stem cells are immortal as they have the ability to multiply and so can the fatal cancer cells. Telomerase enzyme rebuilds the telomerase in stem and cancer cells, which makes them immortal. But no experiment has proved the possibility of the telomerase being used in somatic cells to prevent the aging of the tissues.



Silicon Valley is the mecca for the scientific achievement and advancements in the field of immortality. The Calico Labs, created by Google in partnership with pharmaceutical giant AbbVie; are trying to create age- defying drugs. The labs are rumoured to have built a drug that mimics foxo3 (a gene associated with extraordinary life span). The reason behind the involvement of the Silicon Valley is that technology and anti-aging medicines have the potential to be one of the largest industries that is ever known to exist.

Scientists at UC Berkeley have discovered a drug called the Alk5 kinase inhibitor. The drug helps humans in restoring brain and muscle tissues (through stem cells) back to the youth phase. It restricts a chemical that stops stem cells from repairing our bodies. It is in trial phase as of now.

Furthermore, technological advancements in various fields like nanotechnology, microbiology, regenerative medicine et cetera, have seen an upward spiral in the past decade as scientists have been forever trying to cheat death by building cyborgs, 3D printing of organs, etc. But these do not necessarily focus on the anti-aging factor.

The Free Radical Theory was first proposed in the 1950s by Denham Harman and it states that the innate process of aging of organisms is caused by the cumulative oxidative damage to cells by free radicals (a free radical is an atom that contains an unpaired electron in the outer most shell and is highly reactive) produced during the process of aerobic respiration.

To gain stability they react with surrounding molecules. Thus, giving rise to free radical chain reactions. It is used to explain the process of aging including the formation of age pigments, lipid peroxidation of membranes, cross linkage of proteins and DNA damage. Our mitochondria 'the powerhouse of the cell' weakens. It also causes severe damage to the cell and ultimately the cell dies. Therefore, it means the body undergoes oxidative stress.

Antioxidants found in various colourful fruits and vegetables seems to be the only way out to prevent our biological systems from oxidative damage.

While we humans try to conquer immortality, there are many organisms who have already achieved the impossible and are said to be immortal. Bristlecone pines are potentially immortal. They are the oldest known living specimen (over 5000 years old.) Pithovirus sibericum, a virus has been preserved for the last 30,000 years in Siberian permafrost. Scientists revived this virus by letting the virus thaw. The Turritopsis dohrnii (immortal jellyfish) lives its life cycle in a reverse mode. An adult jellyfish, through transdifferentiation ultimately turns into its juvenile form.

We don't know yet what promise the future holds, we can only gaze at the crystal ball. But one thing is sure that as and when immortality is possible, it will bring many tough choices and questions along with it like do we all really want immortality? Whatever said, every scientist is trying to defy Shelley's OZYMANDIAS (Remember, the Egyptian king who tried to immortalise himself by building his statue which finally decayed after a few years), with the ultimate

Did you know ? A human sneeze can travel about 100 mph or more.

ALL FOR NOTHING?

-SAMYUKTHA RAJAN

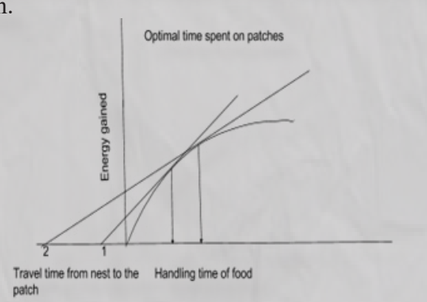
TYBSC

How much time would you spend in a supermarket given that you only live a few blocks away? Would you be more likely to frequent the store if you lived closer to or farther away? If you see a kilo of okra for Rs.100 versus half a kilo of okra on sale for Rs 40, which purchase are you most likely to make? Welcome to Optimal Foraging Theory (OFT) 101.

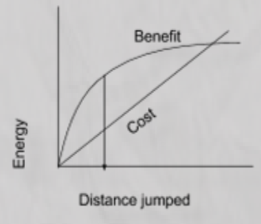
Look into your wallet and check how many ten rupee notes you have in your possession. The likelihood that change is present in your wallet is small since demonetization has made having change a limiting factor. If you are an animal, it is very important to identify these constraints in order to analyse the currency that you want to maximize on.

Time, in a fast paced world, turns out to be one of the most crucial limiting factors. As a forager you would probably want to minimise the time spent travelling to a patch, searching and then handling the food in order to progress onto achieving more scintillating tasks, like finding a potential mate or protecting the progeny born from that fortuitous match. Animals that employ such strategies are called time minimizers as their reproductive fitness does not increase after a certain gain of energy, and the currency that they optimise is the benefit energy or handling time. This is a subset of the OFT called the Marginal Value Theorem.

This theorem predicts the amount of time that a forager spends in a patch before moving onto the next one, or returning back to its territory. As can be seen from the diagram, foragers having a shorter transit time also spend lesser time on the patch (1), as compared to foragers who live further away (2). This can be seen in birds like Starlings who try and maximise the rate of returns of leatherjackets (larvae of Crane flies) to their offspring. The curve is one of diminishing returns as greater the time spent on the patch the less that is available for consumption. So here is proof #1, that even though you may increase the hard work performed, the benefits may not increase in proportion.



On the other hand, some animals are more relaxed and passing time seems of little importance to them. The foraging lapwing, whose biggest obstacle is calculating the optimum distance that he has to jump, is one such animal. A lapwing jumps, pauses, and to surveys his surroundings for prey. Now he, much like Goldilocks, requires the circumstances to be just right. If the jump is too small, then the chances of finding new prey are relatively low. If the jump is too big, then his chances start to equalise. Then, once again, the curve becomes one of diminishing returns where the benefit does not increase in proportion to the cost of energy spent in taking that giant leap. Here we have proof #2. Much like the lapwing, the needs jump to cover just the 'optimum' distance to accrue the most benefit.



While both these examples dealt with birds trying to maximise their own reproductive fitness we shall now consider the peculiar case of the foraging worker bee. Our buzzing friends have long confused and perplexed evolutionary biologists as being the most convincing proof of the existence of Multi-Level Selection, which Dawkin's has very kindly referred to as a "poorly defined and incoherent view of evolution that biologists with non-analytical minds warm up to". The worker bee, on account of her sterility, has no reproductive fitness for herself to maximise. Au contraire, she tries to maximise the fitness of the entire colony. The honey that the worker bee collects goes into the rearing of young worker bees and ultimately, the reproductive success of the colony as a whole

.

Time does not seem to be the crucial limiting factor, nor does the availability of nectar. What currency is the bee is trying to optimise instead? It turns out to be net benefit energy or net cost energy. This means that the bee is maximising efficiency. Why this such a pivotal aspect of its behaviour as opposed to that of other animals?

Studies have shown that larger the load that the honeybee carries from the patch to the hive, the shorter her lifespan is. So with the benefit of foraging a greater load of honey for the survival of her colony, she must pay the cost of a decreased lifespan. This challenges what common sense would dictate, especially since a large amount of energy is spent nurturing the young. This is why optimisation models on the worker bee focus on minimisation of cost. Hence, she should not carry the maximum load, rather an optimal one in order to maximise efficiency and balance out the decrease in her lifespan.

So in summary, there's nothing like hard work to reap the rich dividends of imminent death, is there? So long as that hard work uses optimal energy, a calculated use of time and precise leaps towards achieving the goal at hand.

**Cautionary warning: Easily impressionable people must read this under parental supervision, only.*

Did you know ? Nails that are soft and brittle, with no moon, could indicate an overactive thyroid

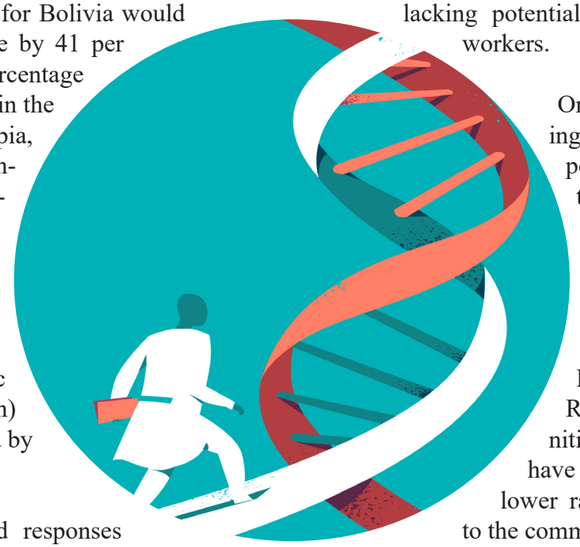
DIVERSITY IN DEVELOPMENT

MICHELE MARY BERNADINE,
TYBA

Diversity has often been cited as a factor impacting the socio-economic development of a region, with one section of academia and popular opinion supporting the need for diversity to make the best of the myriad cognitive abilities and styles at the disposal of the nation, while the other settles for homogeneity or similarity as being optimal to the progress of a nation.

Genetic diversity, in the context of economic development has gained prominence in the recent past with discourse on the same being prompted largely by the work of Quamrul Ashraf and Oded Galor, which stated the existence of an optimum level of genetic diversity in a country aiding economic development. According to the study, an extensive level of genetic diversity would lead to lack of cooperation among members of society. Conversely, a lack of genetic diversity would result in a static production possibility frontier in the economy, as it limits cognitive diversity and hence restricts innovation. A study was done by the aforementioned scientists based on the Founder's Effect, a hypothesis stating that countries closer to Africa and the Middle East would have greater genetic diversity, by virtue of their proximity to Africa, the place of origin human ancestors.

The Founder's Effect primarily outlines the effect that occurs when a few members of the original population start a new colony. This process may result in reduced genetic diversity in the new colony as well as a more or less homogenous sample of the genes in the original population. The scientists' analysis of 53 ethnic groups across the world proved the hump-shaped hypothesis of an optimal level of heterozygosity. Employing the econometric tool of regression, analysis of the genetic diversity and economic development advocate the proposed theory of the relationship between the two variables. Countries with very high genetic diversity such as Ethiopia and very low genetic diversity such as Bolivia exhibited a highly elastic relationship between the two factors. The effect of genetic diversity on economic development is such that a 1 percentage point increase in diversity for Bolivia would increase per capita income by 41 per cent. Conversely, a 1 percentage point decrease in diversity in the most diverse society, Ethiopia, would increase per capita income by 21 per cent. In corroboration with their hypothesis, the rate of change at the optimal level shows very little variance around the mean, with a 1 percentage point change in genetic diversity (in either direction) lowering income per capita by 1.9 percent.



The study drew varied responses with a concern being that it would provide states with a justification to implement arbitrary immigration levels contributing to the anti immigration rhetoric that has started slowly but gradually sweeping the western countries with USA, UK, Austria and several other nations seeing right wing extremists take centre stage in the policy making sphere of these countries. On the other hand, it also added weight to the claims of economists like Robert Gordon, who associate increased skilled, and in a provocative recommendation, unskilled immigration to be a boon to economies like the US, where growth has been stagnant over the past few decades. The argument that immigrants will only enter a country for the purpose of employment when the economy is experiencing a boom, although may seem like a flawed justification to some, is the basis of this recommendation. Migrant workers, both skilled and unskilled contribute substantially to the US economy. According to OECD research, since 2000/01,

31% of the increase in the labour force of highly skilled sectors is accounted for by migrant workers. Sectors like IT, academics and finance among other sectors have seen a rising presence of migrants enter the fray. A quarter (approximately 28%) of the entrants in strongly declining professions in the US is also accounted for by migrant workers. Through their participation in these professions (mostly unskilled such as production, installation, maintenance and repair), they are able to fill the gap in the labour market by taking up jobs which are seen as lacking potential or prospects by native workers.

On the other hand, according to some researchers, the possible lack of cooperation among the genetically diverse communities would be a hindrance to the peace and prosperity of the country. As per research conducted by Harvard political scientist Robert Putnam, communities with greater diversity have lower voting turnouts, lower rates of voluntary service to the community and participation in public life. Homogenous communities on the other hand had more robust statistics when it came to civic participation. The results of this research were interpreted by some academicians as a testament to the concept of a diversity paradox, the positive effects of diversity on civic life will wane if a limit is not established. On the other hand some conservative groups began using it as justification to not establish stronger limitations on immigration levels.

The above two arguments primarily outline the rationale for the arguments supporting and disputing the need for genetic diversity and its contribution to the socio political and economic development of a country. With the rising xenophobia and anti-immigration sentiment across the globe at a time when refugee crises and mass deportations are threatening the sustainability of many communities across the world (Rohingyas, Middle Eastern war torn nation's refugees), this research could indeed make a strong case for genetic diversity and permitting higher immigration rates by having the advantages outweigh the possible drawbacks of the same.

The Data Problem

Jigyasa Dayal
TYBSC

We live in a world where everything has been digitalized and since then we have generated massive amounts of data. In the past 2 years, we have generated 98% of all the data that ever existed. The problem now arises – where does one store this data?

From the floppy disk - that could store about 1.5MB to CDs and hard drives - that store 1 TB (equal to 100000 MB), all these methods of data storage cater to individual needs. The latest in data storage are clouds. Contrary to popular belief, clouds are actual physical locations that store and process a ginormous amount of data. According to estimates (as the actual figures are not disclosed) Google alone could store up to 15 Exabyte or more (1 Exabyte equals 1 million TB) and Google does not even own the largest cloud databases.

There are a few drawbacks, though, to this fantastically efficient system. First, they require physical space. One of Facebooks' data center in Oregon is spread over a whopping 1 million square feet and requires a staff of 165 to run it daily and it is just one of the many. Secondly, all personal data storage devices can last a maximum of a few decades before they are no longer usable. Finally, these methods are subject to damage by physical factors such as fire and water. How then, can this data be stored long term?

Cells can hold a massive amount of information as DNA in the form of efficiently packaged chromosomes. For example, the human chromosome 1, the largest human chromosome, is approximately 5µm when condensed and spans 249 million base pairs. This makes DNA not only a highly efficient way to store data but also highly durable as the half-life of DNA is about 500 years. If stored under cool and dark conditions it can last for thousands of years - the oldest mitochondrial DNA extracted from a human is 65,000 years old.

The first time DNA was used to code information was in 1999, when scientists assigned a specific number, letter or a grammar symbol to each of the 64 possible codons of the DNA creating a 'DNA alphabet' (e.g. AAA = 0, AAC = 1 and, so on). They then generated a 22-character sentence in terms of these codons, which they flanked on both sides with marker sequences. This DNA was put on a typewritten letter and mailed back to themselves. They were able to identify and extract the DNA based on the marker sequences. On sequencing the strand, they were successfully able to decrypt their message.

This made way for using DNA to encode digital data. All digital devices use binary code since it is electronically feasible to have only two states - on and off or 1 and 0. All data to be stored can be converted into binary code by assigning each base a binary value (A=00, T=01, G=10, C=11). Therefore, a synthetic DNA strand could be generated to store any form of data. This was first demonstrated by George Church and his colleagues in 2012, when they were able encode 739KB of data into DNA including all of Shakespeare's 154 sonnets. In 2016, Microsoft was able to encode 200MB of data onto synthetic DNA. They did this by converting binary to ternary (uses 0, 1 and 2) and then to nucleotide base pairs.

The current limitation is the cost; the whole process would have cost Microsoft approximately $800,000. The current available sequencing techniques are too expensive to make large scale DNA data storage viable. However, new technologies are coming up and costs are falling dramatically. The human genome project that concluded in 2003 cost $2.3 billion while whole genome sequencing today can be done for $1000 to $3000.

The other issue is of how slow the process is - 400 bytes per second. The required rate would be 100 megabytes per second to be viable. Despite DNA's stability, it is subject to degradation by radiation and heat. Robert Grass and colleagues encased DNA into a silica shell and found it to be stable even after weeks of exposure to 140°F temperatures. He stated that if DNA is stored at subzero temperatures it could last for millions of years. Scientists are also experimenting with synthetic DNA sequences that can self-replicate and inserting them into bacteria that are extremely hardy and can survive high dosages of radiation.

Current theoretical estimates suggest that each gram of DNA could hold about 455 Exabyte of data. Hence, all of the world's information from Plato until yesterday could be contained only in a few grams of DNA. All this may sound like science fiction but in reality, is completely possible. DNA may not entirely replace conventional data storage methods in the near future, but has the potential as a specialized storage solution.

It is completely possible that in the future all of this storage could involve the use of genetically engineered bacteria, biological computers and varied applications of synthetic biology to encode and retrieve data. Synthetic circuits in E. coli have been demonstrated to perform basic logical operations: the AND, OR and NOT gates. This makes it possible to carry out both digital and analog computation in living cells. A group of researchers from MIT and Boston University demonstrated in 2016 that using principles of computer engineering, one could automate digital circuit designs in bacterial cells. This could revolutionize data storage, protein and drug designing, biosensors and even space exploration - proving we might just be standing at the threshold of turning sci-fi into reality.

Did you Know ?

The heart can keep beating even outside the body if it continues to be supplied with oxygen, since the SA node can generate its own electrical impulse.

CHROMATOGRAPHY

A poem by Yohaann Jafrani(TYBSc)

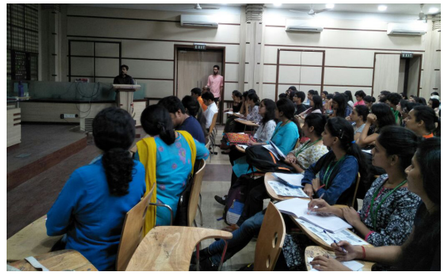
Note: To be sung to the tune of "Bare Necessities" from The Jungle book movie

Well it is chromatography, yes it is chromatography,
Where solutes choose the stationary life.
A part of downstream processing,
A subject that is worth learning.
And did you know that there are different types.
There is size exclusion,
And adsorption.
There is ion exchange,
And partition.
And partition we divide into two sub types.
If the mobile phase is less polar than,
The stationary phase then its normal.
And the opposite is called reverse.
Yes chromatography is really easy to learn.
Adsorption chromatography
Is a liquid chromatography.
Where solutes adsorb on underivitised solid particles.
And we have already dealt with it,
Separating lipids on silica gel.
Cause lipids and the gypsum on the gel can bind.
Then there's affinity that's really simple
It helps in separating charged particles.
Partition chromatography is really nice,
It separates the solutes based on their size.
Well it is chromatography, yes it is chromatography,
Where solutes choose the stationary life.
A part of downstream processing,
A subject that is worth learning.
And now we have learnt all the different types.

DEPARTMENT ACTIVITIES

FY ORIENTATION BY SYs AND TYs

CAREER GUIDANCE TO THE TYs



KHANDALA SEMINAR

NUTRITION WORKSHOP FOR NON TEACHING STAFF

SOCIAL OUTREACH BY THE SYs

ON THE ANVIL

1. 'Know Better Do Better' - An Awareness Camp on Developmental Disabilities; January 20th , 2018.
2. 'Biowaves - Developmental Disabilities and You' - A conference on January 22nd, 2018.
A collaborative initiative of the Department of Life Science and Biochemistry, The Caius Research Laboratory and The Veruschka Foundation.
Venue : St. Xavier's College Autonomous Mumbai

LIGHT IT UP

- Taneya Singh Samant

FYBSc

Bioluminescence refers to the production and emission of light by a living organism. It is witnessed widely among animals, especially in the open sea, including fish, jellyfish, comb jellies, crustaceans, and cephalopod molluscs; in some fungi and bacteria; as well as in various terrestrial invertebrates including insects. Non-marine bioluminescence is less widely distributed, the two best-known cases being fireflies and glow worms.

Bioluminescence occurs as a result of a chemical reaction that yields light energy within an organism's body. For this reaction to occur, the species must contain luciferin - a molecule which produces light upon reaction with Oxygen. There are different types of luciferin, classified according to the animal hosting the reaction. Many bioluminescent organisms produce luciferase, which catalyses the light-producing reaction. In Firefly luminescence, the substance Adenosine triphosphate (ATP) initially reacts with Firefly luciferase, ionic magnesium, and Firefly luciferin to form a luciferase-luciferyl-adenylate complex and pyrophosphate. The complex then reacts with molecular Oxygen to emit light; the last step of the reaction liberates energy adequate to convert the electronic configuration of the complex from a low-energy ground state to a high-energy excited state. The high-energy complex then loses energy by radiating a photon of visible light and returns to the ground state, thereby producing light.

In bacteria, the expression of genes related to bioluminescence is controlled by an operon called the Lux operon. Most of the bioluminescence produced in the ocean is in the form of blue-green light. This is because these which can travel through (and thus be seen) in both shallow and deep water, by virtue of their short wavelengths. Light of longer wavelengths travelling from the sun—such as red light—doesn't reach the deep sea. In many marine animals, including several squid species, bacterial bioluminescence is used for camouflage by counterillumination, in which the animal matches the overhead environmental light. In these animals, photoreceptors control the illumination to match the brightness of the background. These light organs are usually separate from the tissue containing the bioluminescent bacteria.

While fireflies use bioluminescence to attract mates, many animals use this light as a defence against predators and as a means of communication between other members of the species. The functional role of bioluminescence in lower organisms such as bacteria, dinoflagellates, and fungi is difficult to discern. Partly because the glow of luminous bacteria is extinguished when oxygen is removed, it has been suggested that the bioluminescent reaction was originally used to remove oxygen toxic to primitive types of bacteria that developed when oxygen was absent or very rare in Earth's atmosphere.

Bioluminescent organisms are a target for many areas of research. That assay method has been widely used in medical and biological research to determine the amount of ATP present in extracts of cells and tissues. The study of reactions involving ATP has led to a detailed understanding of the mechanisms of energy conversion in cells. Edith Widder, a scientist who specializes in bioluminescence, was with a group attempting to film the giant squid for the first time. She suspected that the squid would be lured to a bioluminescent light attached to a fake squid—not because it wanted to eat the small fake squid, but because it's flashing light "burglar alarm" could mean that there was larger prey in the vicinity. Her theory proved right. A live giant squid was captured for the first time on film in 2012.

The beautiful colours and light that are produced by bioluminescence can be works of art. A temporary exhibit at the National Museum of Natural History in 2012 explored these links between art and science. Artist Shih Chieh Huang created hanging installations in the dark space of the museum that lit up and looked as if they were floating in the deep-sea. Some artists use the bacteria itself to create line drawings or entire exhibits with petri dishes full of the glowing single-celled organisms.

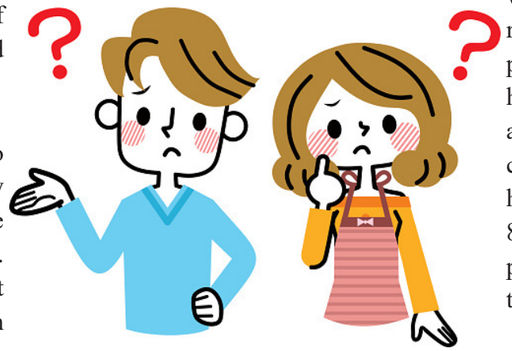
"In the ocean, [bioluminescence] is the rule rather than the exception" -Edith Widder

The Way **YOU** Turned Out

Malavika Selvaraj, SYJC Arts

In the Instagram age, most people have at least one anatomical feature which offends their aesthetic sensibilities. It is a truth universally acknowledged that where there is a pair of caterpillar eyebrows or gigantic front teeth, there is also a close relative to blame. It's not just one's superficial packaging either; your genes determine who you are to a large extent. They could be responsible for a propensity towards diabetes, certain cancers, and a variety of mental disorders.

Another well-known factoid is that the food a pregnant woman consumes affects the baby she is carrying. The condition of pregnancy invites advice ranging from the helpful - "avoid uncooked seafood", to the ridiculous - "eat peeled almonds so that your babies will turn out nice and pale". Soon-to-be fathers, on the other hand, are generally excluded from the frenzied bombardment of advice on what they can and cannot eat.



However, it has come to light that men's diets also play an extremely influential role in an infant's development. In 2012, Margaret Morris at the University of New South Wales in Sydney published a study attempting to determine whether the father's diet would affect his offspring. She divided male rats into two groups. The control group ate a normal rodent diet, while the variable group was fed a high-fat diet (HFD). Both groups mated with genetically identical female rats that had been raised on a normal rodent diet.

The female offspring of the variable group showed signs of becoming diabetic in the future. A reduction in tolerance to glucose was observed, caused due to impairment of the pancreatic insulin secretion. These defects were seen to worsen over time. The obese rats of the variable group created sperm cells with different methyl markers on their DNA. Their daughter rats inherited these changes, including hundreds of abnormal genes linked with diabetes and metabolism – and thus also their health problems.

Although the male offspring of the variable group did not develop any obvious glucose metabolism defects in this study, a growth deficit phenotype was observed from their birth to the age of six months. Male offspring from HFD rats had lower birth weights compared with those of the control group, followed by reduced post-weaning growth. There was a reduction in body weight by ten percent at six months. The rats had significantly smaller fat pads and skeletal muscles. Reduced circulating levels of growth hormone (GH) were detected at 8 weeks, which the researchers proposed may have resulted in the smaller bodies of the rats.

Reproductive biologist Sarah Kimmins approached the same question from a different angle. She put a variable group of male mice on a diet which had fifteen percent less than the recommended amount of vitamin B9 or folate. The three control groups – one set of male mice and two sets of female mice used for breeding - were fed normal, well-balanced diets. Folate is known to directly influence the body's ability to produce epigenetic markers which "switch" genes on and off in response to the environment and diet throughout foetal development. The foetuses of folate-deficient women had defects in their neural tubes - the structure which develops into the brain and spinal cord in adults. Fertility problems are common among folate-deficient men and the male rats also suffered from the same. But, Kimmins discovered that there was also a strong correlation between deficiency of folate and serious birth defects in the offspring.

While both these studies were conducted on rodents, the research is likely to hold good for humans, too. Of mice and men, one thing is true: both are genetically and epigenetically very similar. It takes human males about three months to produce fully grown sperm from stem cells. Kimmins speculates that even if a man temporarily follows a healthy diet, it could lead to him producing healthier offspring. When children are born with birth defects that are not genetic, it is generally blamed on something that the mother did (or didn't do) during pregnancy. Evidently, it's time to cast this outdated notion aside and embrace that both your parents may be equally responsible for the way you turned out.

Why Schrödinger's cat matters

Anshit Singh

FYBSc

Besides the gargantuan amount of cute videos and hours of Nyan cat, cats have given us something much greater, 'Quantum Mechanics'. Schrödinger used the analogy of a cat in a box to explain different states of the system under consideration which was that at any given point of time, the cat inside the box can either be dead or alive, given that there are no external observers. As soon as an observation is made, the system 'collapses' its different states into one, dead or alive. Before any observation has been made, the system is theoretically in every possible state simultaneously.

As perplexing as this may sound, it has been able to explain many natural phenomena, such as the electron. None of the previous atomic models (including Bohr's) could explain all the properties of an atom. However, the quantum mechanical model did. Theories such as Heisenberg's duality, Pauli's exclusion, etc., were able to explain some of the more unusual properties displayed by fundamental particles. Quantum Mechanics has given us information worth its weight in gold. But how do abstract theories apply the comparatively macro world of biology? The answer to that is Photosynthesis.

Photosynthesis is the conversion of energy in the form of electromagnetic radiation (sunlight) to chemical energy in the form of carbohydrates (glucose), simply put. The process, however, is a cascade of complex steps, beginning with the capture of sunlight and its transportation it to the reaction sites for further processing.

The basics of the capture involve photoreceptors such as chlorophyll that are present near reaction sites and are directly exposed to the photons (the smallest amount of discrete electromagnetic energy) which are absorbed by them. This absorbed energy is enough to create a separation of charge which manifests itself as an electron excitation.

Now, this excited electron must be transported to a reaction site before the energy is lost as fluorescence. Multiple structures (complexes) are involved in the transport of this electron such as the FMO complex in green sulphur bacteria. The efficiency of this transfer is close to 99% which is not possible as per the laws governing classical physical models. This is where quantum physical models come into play.

Studies conducted in 2007 (GS, et al. 2007) and 2010 (Mohan, et al. 2010) claim to have identified the quantum coherence that allows the transport of electrons in such an efficient manner. Quantum coherence is the addition of the intensities of the two 'waves'. These waves are also called electrons. But, matter at microscopic levels is easily interchangeable from its particle form to its waveform as explained by a phenomenon called "duality of matter". We know that there is either matter (particle) or wave, but this view was challenged and in its place, it was proposed that matter and waveforms are interchangeable. Theoretically, even you are a wave, only the wavelength is just too short to be detectable. This distinction between the two forms is blurred at the scale of an electron.

As with all theoretical sciences, we have to theorise how is the excitation of an electron transported and converted into chemical energy. One such proposal has electron tunnelling (another great well to dive into) and quantum coherence, creating energy sinks for the excitation to travel to. Another such proposal claims that the complex feels the environmental noise, and the electron is moved to the reaction site due to quantum coherence in conjunction with thermal noise, i.e. the complex analyses heat from the environment and tries to make sure the electron is coherent with this electromagnetic wave. But these proposals fall into an extremely theoretical realm, the scope of which is beyond this article.

So we just learned about how Quantum Mechanics, a field widely considered to be only studied by Physicists, can be applied to completely biological phenomenon. This might just be the next step towards Unification; another inch towards a universal theory which can explain everything in the Universe.

Did you know ? Our ears keep on growing throughout our lives with almost unbelievable speed — a quarter of a millimeter per year!

A(i)nt You Attracted ?

-Aditya Sane
S.Y.BSc.

Insects are the most abundant creatures on the planet. Ranging from 0.5 mm to 10 cm in length, they are also one of the most successful creatures through evolution and the finest aeronauts to have inhabited Earth.

Have you ever noticed that ants do not go near a cockroach while it is living but as soon as it dies, within minutes one sees ants crawling all over and around it? How does the ant know when the cockroach is dead? How does it locate it? These are interesting questions. Such questions can even be raised when we talk of insect-plant interactions. For example, why is it that a particular insect goes only to a specific flower and not to others? What guides them while they are at it? Do they do it consciously or are they somehow 'manipulated' by the plants?

Most interactions that happen in nature are facilitated by chemicals. Most insect-plant interactions depend on the quantity and composition of plant volatiles that are released.

Megha Shenoy, in her paper 'Composition of Extrafloral Nectar Influences Interactions between the Myrmecophyte Humboldtia brunonis and its Ant Associates (Shenoy M. et al, Journal of Chemical Ecology, 2012)', discusses how ant- plant interactions and ant footfall is affected by the composition of the plant's Extra Floral Nectar (EFN). Her study investigated the correlation between the EFN composition of the myrmecophytic ant-plant Humboldtia brunonis (Fabaceae) and the number and species of ants visiting EFN. The ant visitation to various plant organs which have different amounts of EFN such as the young leaf and the floral bud was also studied. The EFN is rich in sugar and contains small quantities of essential amino acids. They scientists studied three dominant EFN feeding ants- Crematogaster dohrni (northern study site), Myrmicaria brunnea (middle study site), Technomyrmex albipes (southern study site). The team regulated the sugar-amino acid ratio in the mimics to see the change in footfall of these ants. Crematogaster dohrni was the least selective and did not portray any feeding preferences. On the other hand, the other two preferred sucrose over glucose and fructose. T. albipes consumed the young leaf mimic to a greater extent than the floral bud mimic. The young leaf mimic was rich in essential amino acids and had low sucrose concentration and the lowest viscosity. The varied response by these dominant ants to the composition of the EFN suggests that plants can regulate interactions with the local ants by varying the quality of the EFN.

A similar study was conducted by Dong H. Cha and Shannon Olsson- Identification of Host Fruit Volatiles from Snowberry (Symphoricarpos albus), Attractive to Rhagoletis zephyria Flies from the Western United States (Cha D.H. et al, Journal of Chemical Ecology, 2017)- in which they identified a particular blend of plant volatiles that was more attractive to the Rhagoletis zephyria flies. Their results show that the Rhagoletis flies are attracted to a unique blend of plant volatiles, specific to the host plant. Furthermore, behavioural changes of flies specific to host fruit odour seems to be a vital adaptation for sympatric host plant shifts leading to host specific mating and prezygotic reproductive isolation.

We can also look at which chemicals regulate the emission of these plant volatiles. Jasmonates are known for their effect on plant senescence, development, flowering and in the production of Extra Floral Nectar (used as a indirect plant defence mechanism). The paper, Role of jasmonates in Nectar secretion (Radhika Venkatesan et al, PLOS one, 2010), explores the role of jasmonates in the secretion of nectar. In her study, she compared Jasmonic acid (JA) levels at various plant flowering stages, and studied the effect of applying JA mimics to see the change in nectar production along with looking at the effect of damage to the leaves (which produces ENF also stimulated by JA) to the nectar production. She found that the JA levels were highest just before the flower was fully opened (nectar secretion maximum). Applying JA mimics also quantitatively increased nectar production but had no effect on the quality or composition of the nectar. Surprisingly, there was no change in nectar production both qualitatively and quantitatively when the leaf was damaged. The JA levels inducing ENF production did not affect nectar production at all. Thus, along with playing an important role in the defence and development of the plant, it was concluded that jasmonates also play a vital role in the production of nectar, which is essential for pollination.

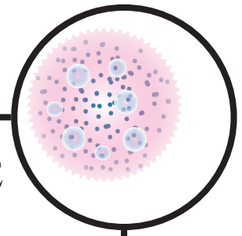
We see that plants use a variety of chemical stimuli to facilitate their survival and growth. Scientists can use this to their advantage by identifying chemicals and their use to the plant. This knowledge can be used to regulate various natural interactions, both in plants and in animals, to benefit man.

CURRENT RESEARCH

GREEN SYNTHESIS OF SILVER NANOPARTICLES AND ITS CHARACTERIZATION

Devashri A. Kadam, Sweta Chalwadi, Dr. Priya Sundaranjan

Nanomaterials are at the leading edge of the rapidly developing field of nanotechnology. Their unique size-dependent properties make these materials superior and indispensable in many areas of human activity. The unique properties displayed by the metal nanoparticles arise from their high surface/volume ratio. Silver nanoparticles have unique optical, electrical, and thermal properties and are being incorporated into products that range from photovoltaics to biological and chemical sensors. Synthesis of nanoparticles is carried out by chemical, physical and biological methods. Our study focuses on biological synthesis or green synthesis of silver nanoparticles and their characterization. It is carried out with the help of various plant sources and AgNO3 as a metal precursor. Silver Nanoparticles which are formed are further characterized using UV-VIS Spectroscopy, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), X-ray diffractometry (XRD). Further, they are checked for antibacterial activity and their application in various fields such as health industry, food storage, textile coatings and environmental applications such as water purification.



ISOLATION AND CHARACTERIZATION OF LIPASE FROM LIPASE PRODUCING BACTERIA

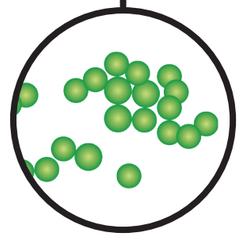
Dorothy Bodhak, Dr. Priya Sundarrajan

Abstract: Lipases catalyze the hydrolysis and synthesis of esters formed from glycerol and long-chain fatty acids. They have several biotechnological applications such as with food technology, leather, cosmetics, detergents, textiles, oleochemicals, pharmaceuticals and industrial waste, etc. Lipases occur widely in nature in plant, animal and microbial sources, however, microbial lipases are commercially significant due to the ease of production. The aim of this project is to isolate lipase producing bacteria from various sources like soil etc. The isolates will be screened on Tributyrin agar medium, and the positive isolates would be used for further study. Growth parameters of the isolates, the like ability to tolerate varied temperature and pH, will be determined so that they could have potential industrial applications. The enzyme activity for lipase will be determined by the p-nitro phenyl palmitate (pNPP) assay. Various enzyme parameter would be determined for the lipases produced from the isolate and tests would be carried out to show the use of lipase in detergents to remove oil stains as a potential application of the enzyme.

ISOLATION AND CHARACTERIZATION OF PROTEASES FROM BACTERIA ISOLATED FROM VARIOUS SOURCES

Dean D'Souza and Dr. Priya Sundarrajan

Proteases are hydrolytic enzymes which break the peptide bonds within proteins and thereby causing their breakdown. Protease distribution generates a market of about 1 billion dollars worldwide and 70% of total enzyme distribution in the world is attributed to proteases. This project is (aims a better word) to test the activity of proteolytic enzymes produced by five different strains of bacteria obtained from soil and other sources (Isolated by Ms Rupal Solanki). The protease producers were screened and isolated on Skimmed milk agar plates which have casein as a substrate and on 24 hours incubation the formation of clear zones results in confirmation following which proteolytic assays testing the activity of the enzyme at different pH and temperatures will be carried out. Various other enzyme parameters would also be studied. Attempts would be made to semi purify the proteases.



FITNESS TRADE-OFFS OF MUTANT PDR5 ALLELE IN CLINICAL STRAINS OF YEAST

Aysis Maria Koshy, Sylvester Parkhey, Dr. Maya Murdeshwar

Saccharomyces cerevisiae has long been used to carry out bread and wine fermentations as also industrial fermentations of several products. S *cerevisiae* is Generally Recognized as Safe (GRAS) for humans. However, over the past few decades, there has been a rise in the occurrence of yeast infections in humans. Some strains were observed to be clinically significant and to counteract these, several anti-fungal drugs were developed. For example, ergosterol inhibitors and echinocandins are antifungals that target the unique components of the cell wall and membrane of the yeast. However, parallel to the growing use of antifungals, there has also been a subsequent increase in resistance mechanisms by yeast. One such mechanism is the use of drug efflux pumps that expel the drug soon as it enters the cell. PDR5 gene codes for the Pdr5p (Pleiotropic drug resistance 5 protein), one such Multiple Drug Resistance (MDR) efflux pump. PDR5 is highly up-regulated in a variety of stress conditions. When comparing a lab strain (non-pathogenic) versus a clinical strain (pathogenic) of yeast, it is assumed that the latter will demonstrate a better resistance mechanism and therefore a more efficient Pdr5p, because it has been subjected to several stresses within the human body. However, literature indicates that clinical strains possess a 'weaker' mutant Pdr5p as compared to the WT gene found in lab strains. This counter-intuitive observation led us to ask the burning question as to why would a clinical strain acquire and retain this weak defense mechanism?

A proposed hypothesis, is that there probably are 'fitness trade-offs' that the mutant PDR allele bestows on the survival of the clinical strains under stress conditions. To determine where the benefit lies, our group aims to perform a meta-analysis using bioinformatics tools followed by experimental work of growing these clinical strains in nutritive, oxidative, temperature and salt stress conditions that pathogenic yeast normally face in the human host. We hope to generate interaction maps of the various pathways, proteins and genes expressed in each of these stress conditions and to correlate them to observed levels of the mutant PDR5 allele, with the aim to understand if a weaker PDR5 provides a beneficial trade-off in the aforementioned stress conditions.

STUDY OF THE EFFECT OF STRESSORS AND PROTECTIVE AGENTS ON CHIRONIMOUS RIPARIUS.

Annachris Thankachen, Urvi Brahmbhatt, Prachi Chavan, Snehal Joseph, Dr. Nandita B. Mangalore,

Dr. Radiya Pacha-Gupta and Dr. Manasi K. Kanuga

Chironomus larvae are used as model organisms particularly for toxicological studies due to their wide distribution in aquatic environments and because they are prone to pollution induced stress. This study investigates the stress induced by incense smoke on *Chironomus* larvae and the efficacy of known antioxidants such as tea (green and black), *Aloe Vera* and Turmeric in alleviating the stress through pre-exposure or post-exposure to stress and subsequent recovery.

EFFECT OF BPA AND 17β-ESTRADIOL ON ZEBRAFISH FIN REGENERATION

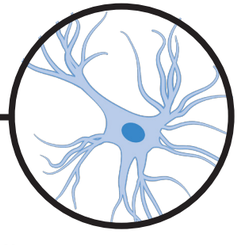
Farha Ansari, Naythan D'cunha, M Priyanka Gomes, Sakina Garothwala, Dr. Radhika Tendulkar

The steroid hormone 17β-estradiol mediates its effect on biological systems via estrogen receptors while its structural analogs such as BPA (bisphenol A), antagonize Estradiol action through molecular, cellular, and functional pathways linked to various other receptors. Estrogens and their structural analogs are widespread in the aquatic environment and often cause alterations in normal development, reproductive physiology, and health. Hence, toxicological studies are carried out on teleost like zebrafish and its embryo, a model system, to investigate the potential effects of these hormones on humans. The purpose of our study is to understand the pattern of proliferation, and migration of cells involved in the regeneration of the zebrafish tail and fins, which occurs proportionate to their body size, throughout their life; while also studying if these hormones have any effect on the regenerative capacity of the zebrafish.

EFFECT OF ZINC TOXICITY ON THE NERVOUS SYSTEM: AN IN VITRO AND IN VIVO ANALYSIS

Merlyn Cherusserikkaran, Maithili Joshi, Priyanka Kislai and Dr. Bhaskar Saha

Zinc is a vital micronutrient and plays an important role in the proper functioning of the nervous system. Several studies have indicated that zinc deficiency leads to several neurological dysfunctions. In contrast, studies on zinc toxicity are scarce. The aim of this project is to study how excessive zinc exposure affects the nervous system. We plan to use *Caenorhabditis elegans* as a model organism to study how excess zinc accumulation changes certain behavioral pattern in these animals. A second axis of the project is to analyze the differential toxic effect of zinc on neuronal (Neuro2A) and glial cells by probing cell proliferation, survival, mitochondrial dysfunction and other physiological parameters. Outcome of our study will be able to provide a possible toxicological role of zinc on adult neurogenesis and its related behavioral processes.



ISOLATION OF FRESHWATER MICROALGAE AND EVALUATING ITS POTENTIAL FOR GREYWATER TREATMENT AND PRODUCTION OF ANTIMICROBIALS

Pratik Acharekar ,Sabanaz Sayid and Dr. Binoj Kutty

Bio-treatment of waste water with microalgae is particularly attractive because of their photosynthetic capabilities, converting solar energy into useful biomasses and incorporating nutrients such as nitrogen and phosphorus decreasing eutrophication. Besides, waste treatment research is being done towards algal production of high-value natural or genetically engineered products such as pharmaceuticals including antimicrobial, anticancer among others. As compared to sewage (containing fecal matter, and often called blackwater), domestic wastewater generated activities such as bathing and washing is called greywater. Phycoremediation of greywater is emerging as one of the leading contenders in obtaining reusable fresh water and reducing the load on sewage treatment plants. The project plan was to isolate microalgae from freshwater, identify these and study their growth kinetics in different algal growth media and explore their commercial importance with respect to antimicrobial activity and greywater treatment capabilities. Water samples were collected from freshwater ponds brought to the lab and observed microscopically to note the diversity of the algal population. The samples were inoculated to algal growth medium (for example Chu's and Khul's) for enrichment. After 2 to 3 weeks of enrichment they were subcultured in liquid media or streaked on to solid media to obtain a pure culture. Once pure cultures are obtained, they will be evaluated for their ability to phycoremediate greywater and screened for presence of antimicrobial activity against common laboratory microorganisms.

Experience a glimpse into the life of Dr.Vidita Vaidya - A neuroscientist working to understand how Neurocircuitry of emotions, it's alterations and modulations occur and also using animal models in her lab to study the molecular, cellular and epigenetic changes that contribute to long term behaviour at the NCBS of TIFR.

With a Bachelor's from St. Xaviers College, a Doctorate from Yale University and a Post Doctorate from Karolinska Institute and The University of Oxford she is the recipient of The National Bioscientist Award(2012) and The Shanti Swarup Bhatnagar Award in Medical Sciences(2015). Join her as she talks about her award-winning work on the identification of receptors, her educational journey from St. Xaviers to Yale University, her current lab work and her message to young science aspirants.

Q: What prompted you to choose the field of neuroscience to do your masters?

A: I did my bachelors and then went straight for my PhD. So, I don't have my masters in the middle. I finished my three years in life sciences from Xaviers and even before that I was interested in the brain. I loved my neuroscience course which was, at the time taught by Dr Sheila Donde. I really enjoyed neuroscience, and I had a particular interest in wanting to study what regulates and controls behaviour.

Q: You did your PhD from Yale University. How is studying and researching abroad different from studying and researching in India?

A: At the level of research and the way it is done in research labs, I would say that it is not very different. But, at the level of an education system, there are some clear differences. We are a culture that is more oriented towards homogeneity. This leaves much less no room for innovation, difference, variance and in particular for failure. Failure is an essential recipe for success in science. Our systems tend to make us risk averse. That, for me, is the biggest difference. In the first six months of graduate school, I became free of marks. It was the most freeing experience ever.

Q: You spoke about how you became acquainted with failure. Could you recount any particular instance?

A: I can say so many. It was the first time I was working at a bench and so everything was new. Some of those failures were actually very useful to my learning process. I can recount one event which while not failure per se was a rather funny event.

During my PhD, I remember having to catch a bus once and I was running a gel. I went to look at the gel and it hadn't separated enough so I needed to run the gel longer for better separation. A while later I went to take out the gel and I realized that instead of putting the gel in I put the Polaroid I had taken of the gel inside the tank. So the entire tank was now just floating with photographic emulsion. A silly mistake but one you could laugh at. However, it made me realise that you need to look at your stumbles with a sense of humour. They are inevitable in science.

Q: Could you tell us more about the work that obtained you the Bhatnagar award - identification of receptors for antidepressants?

A: What we were interested in was how new neurons get born in the adult brain and is there a way we can understand the mechanisms that control it. People had already shown that stress, process of aging, animal models of depression, etc. cause a decline in the birth of new neurons in the hippocampus and all of these conditions all reduce norepinephrine and serotonin. On the other side, exercise increases norepinephrine and so do antidepressants and also enhance new neuron production in the hippocampus. We showed that by 2002, that norepinephrine clearly regulates the birth of new neurons. But, if that is the case, and antidepressants increase the production of norepinephrine pretty fast, why then is the effect of antidepressants on the production of new neurons slow – about 3 weeks. So why is there this delay?

So, what we showed over a period of time was that one set of receptors for norepinephrine, the alpha 2 receptors, actually reduce the birth of new neurons and the beta 3 receptors increase the birth. It is almost like a check and balance system for the same neurotransmitter working on new neuron generation – one set of norepinepinephrine receptors drive cell division of new neuron progenitors and the other actually shuts this down.

This is interesting because there will always be heterogeneity in receptor expression/signaling from individual to individual. Turns out that stress actually increases the alpha 2 receptor family and thereby individuals that are severely depressed will have much more alpha 2 binding in the hippocampus. Until you down regulate the alpha 2, the beta 3 doesn't get unmasked - which is a slow process. What we were able to do was use antidepressants that increase norepinephrine and simultaneously block the alpha2 norepinephrine receptor and this led to much faster effects on new neuron formation and also sped up the behavioural effects of the antidepressant.

Q: What is some of the other work that your lab focuses on?

A: The rest of my lab looks at early life and how early life experiences in rodents shape the modulation of behaviour related circuitry. We have focussed on serotonin receptors and how they mediate these long-lasting scars of early trauma. Early trauma is short lived but the behavioural consequences often persist across the lifespan. We've shown that the 5-HT2A serotonin receptor function goes up significantly in animals that had early trauma and it is maintained for the rest of the life of the animal. That receptor signals through a signalling pathway that is a Gq related signalling pathway. We can manipulate that pathway and recreate the behavioural effect. We are interested in trying to figure out the nuts and bolts of the circuitry that eventually drives persistent behavioural alterations that arise from early trauma and stress.

Q: You are very vocal on social media and through public lectures on the importance of science communication. What improvements do you think should be made in bridging the gap between scientific community and the layperson?

A: There are multiple ways via which the scientific community can engage the public and it is vital that they do so. There is a minuscule interest in science and science stories in our media. It would be fantastic if we had a scientific communication that thought about targeted audiences of different ages, focussed on it and did something about it. With the internet, so many things have become possible. There is tons of space for this and there will be more space for this in the future because the rate at which scientific technology is moving it will be even more vital to communicate this scientific progress effectively. In India, we don't have a science communication focus in our scientific institutions and this needs to change. Science communication should become mandatory because our ability to do science is going to be at risk if we don't take on this challenge. If you don't communicate the excitement of your science, why should the taxpaying public be excited enough to contribute to science funding?

Q: What advice would you give to students who are currently pursuing a career in the sciences?

A: Don't hang out with anyone who is cynical. The defeatist dialogue is, in my opinion, anathema to doing science. Also remember everybody doesn't have to become a professor. That's one trajectory for a career in science – there are others and if you keep you mind open to those avenues there will be a correct niche in which you will excel and enjoy yourself. But the more important thing is that you are having fun. If you are not having fun, it is unlikely that you will be able to sustain that work in the long term.

CANCER RESEARCH IN INDIA

Dr. Amit Dutt

Meet Dr. Amit Dutt - Scientist, Geneticist and Principal Investigator at Advanced Centre for Treatment, Research and Education in Cancer of Tata Memorial Centre. He has completed his doctoral studies from ICGEB, Delhi and a Ph.D from University of Zurich. He is the recipient of Swiss National Science Foundation Postdoctoral Fellowship Award (2005), the Ramalingaswami Fellowship award (2010) and the Wellcome Trust Alliance Intermediate Fellowship(2012). His lab focuses on using advance genomic approaches to uncover the causes of human diseases particularly cancer and to develop novel computational approaches to analyse high cancer genome dataset as well as to study pathogens associated with human cancer.

Dive in to understand his revolutionary work on FGFR3 gene and TMC-SNPdb in the field of oncogenomics. While understanding the difficulties of Cancer research, setting up of a lab and his message for students in the field of science.

Q: What made you change your interests from botany and plant genetics to cancer research?

A: In 1998, the first genome for the model organism, C elegans, was sequenced. It was around that time that I had a change of interest to study human cancer by understanding key processes necessary for normal development and tissue homeostasis. In 2000 I moved to the University of Zurich, Switzerland, for my doctorate in developmental biology under the mentorship of Dr Alex Hajnal, to join a laboratory that was using C elegans to study pathways that were involved in human cancer. Then, I moved on to the Broad Institute of Harvard and MIT, USA, where I worked on the human system studying Ras/MAP kinase pathway in human lung and endometrial cancer. Here, my approach was to study the genome-wide alterations in the disease setting of cancer.

Q: What were some of the challenges you faced when you moved back to India to start your own lab?

A: There were several challenges. One of the basic challenges was the lack of infrastructure to establish a cutting-edge cancer genomics laboratory. It requires high-end technology to generate data and strong computational platforms to analyse the huge amount of data churned out.

Another major limitation was the lack of technical expertise. India is good at informatics, however, there is a huge vacuum in bioinformatics. Most of my initial hirees were all informatics people who didn't have a biology background. I trained them in biology and using their informatics skill, we were able to set up an infrastructure

for computational analysis of biological problems.

Q: Could you tell us about the discovery of FGFR3 mutation and the significance of that discovery on the cancer research landscape of India?

A: We started with profiling mutation in genes such as EGFR and KRAS in lung cancer among Indian patients. These mutations are known to vary by ethincity. We were the first ones to do more than 1000 odd samples and establish that among Indian lung cancer patients EGFR is mutated at a frequency of 23%, which is distinct from Caucasian and East Asian population. This has become a frequently cited paper and reproduced by several independent groups—as a standard in the field . I am emphasizing on this fact because such data forms the basis to rationalize targeted therapy among lung cancer patients in India.

Having established the groundwork we moved on to more sophisticated analysis, looking for alterations or mutations beyond EGFR and KRAS. Pratik Chandrani, a graduate student working with us, generated the first most comprehensive landscape of targetable mutations in Indian lung cancer patients. The finding were crucial because based on his analysis, now we have a whole map of mutations in Indian lung cancer patients at a very high resolution and, at the same time we came to know that genes that are known to be altered in the Western population appear to be similar in the Indian population, albeit at an altered frequency. His analysis also led to a surprise finding leading to the discovery of novel mutations in a therapeutically relevant gene specific to the Indian population: the fibroblast growth factor receptor 3, FGFR3,. These mutations were found to occur at a frequency of 5.5% in the Indian population, which is highly significant given the denominator of lung cancer patients in India, is huge.

Using functional approaches, we were able to determine that FGFR3 mutations were activating in mouse-related assays. Some inhibitors that are already in clinical trials were found to be effective in inhibiting the growth of these tumours in the mouse. This is significant because we can adopt a drug approved for some other disease for the 5.5% Indian population.

Another point of significance is that earlier we had thought that this mutation was Indian specific, but recently a South Korean population has published similar kinds of mutation. It appears that FGFR3 mutations could be Asian specific rather than Indian specific.

Q: Could you tell us about the significance of the TMC-SNPdb that your laboratory came up with.

A: Cancer is a somatic disease. Thus to establish an absolute somatic status of genetic alterations is critical to understand its causality. Unless a mutation is somatic, one would not be able to associate it with cancer. The standard way of doing so is to sequence a tumour as well as normal tissue such as blood from the same patient. The spectrum of variations in the blood would represent natural human genome variations that are known to occur in germline in any given population at a frequency greater than 1%, called as single nucleotide polymorphism pf SNPs. By comparing and removing the burden of SNPs from tumor cell genome allows a researcher to identify tumor specific mutations, i.e., somatic mutations. However, given the high throughput nature of data generated from a next generation sequencing platform, one need to compare and subtract SNPs also reported in reference SNP public database in addition to those found in paired normal from the same patient.

When we were starting in India, there was nothing known as an Indian germline variation database. This was a huge impediment as there was no way to remove Indian specific SNPs. They could be misconstrued as a somatic mutation, confounding cancer genome analysis of Indian patients. This was a major deficiency for cancer research in India. To address this issue, we went ahead and did a whole exome sequencing using a huge number of normal (nor cancerous) samples. We developed a repertoire of those polymorphisms that are exclusively present in the Indian populations, called as TMC-SNPdb. This was the first reference database of this kind in India. It has the implications beyond cancer research, in various other disease such as mendelian genetics to help researchers know that the variation that they have found is a population-specific polymorphism or if associated with the disease. Our database has now been accepted and integrated into the recent builds of dbSNP—the most comprehensive SNP database maintained by NCI, USA.

Q: Currently, cancer treatment is expensive and inaccessible to many in the country. What would need to be done to address this issue?

A: Majority of the treatments in India were originally designed for developed countries which made innovator compounds that are exhorbitant for the Indian population financially. Also, there is an immense lack of availability of these compounds in India.

In India, cancer researchers and the clinicians need to come together to understand the disease and then design a treatment that is relevant to the Indian population. This needs to be paired with the pharmaceutical industries to develop and prepare these compounds.

For example, diseases that are associated with tobacco is specific to the Indian population – 40% of the Indian cancers are associated with tobacco. Similarly, cervical cancer is one of the major forms of cancer among Indian women as opposed to developed countries where it is very low. Gall Bladder cancer occurs in northern India but is virtually non-existent elsewhere in the developed world. This implies that to understand the disease and to design therapies against it, the initiation must come from India. Only then could the cost of these diseases be brought down and be made affordable for the Indian population.

Q: What advice would you give students who aspire to have a scientific career?

A: Firstly, have clarity for field of research you want to pursue and then apply for labs where you are interested by choice rather than by just chance. For this, they need to be well informed about what they want to do. I would also suggest to students to allow themselves to "waste" some time, relax and think about what they really want to do. If you need to take a break after your degree before going ahead to pursue a Ph.D program, I would suggest you take it. It does not matter in the long run in what year or what stage of your life you started your next degree. Opting for research as a career need not be natural or default next step in career for students completing their Masters program. The decision should be organic and more driven by passion to pursue curiosity to understand the mechanism for several enigmatic processes one observes around in a systematic manner. Similarly, when students are just starting out in the field of research, they have to maintain a balance between scientific temperament and scientific career. In the rush to make a big scientific career, many tend to sacrifice the scientific temperament by opting for fields and technologies that may sound more fancy than being driven by biological question or curiosity that fascinates you the most. Lastly, research is one field where you have to express yourself to the scientific community. It is not the language that is important, but rather about representing yourself and your thought process well which is central to the overall development of a scientist. Honing communication skills (written and verbal) is highly recommended.

Did you know ?
The human head is a quarter of our total length at birth, but only an eighth of our total length by the time we reach adulthood

STUDENT ACHIEVEMENTS

Department & College Toppers (2016-17)

- Ms Mallika Talwar - 6U Life Science Topper; 2nd Rank in Science Stream
- Ms Hamsa Narsimhan - 3U Life Science and Biochemistry Topper; 2nd Rank in Science Stream
- Ms Janhavi Damani - Msc Life Science Topper; 1st Rank in Science Stream, Post-Graduate Section.

Scholarships

- Mr. Hisham Shaikh - Erasmus Mundus EU scholarship for the year 2016-17.
- Mr. Som Banerjee - Sreevrat Goenka Scholarship for a student of SYBSc.
- Ms. Mallika Vivek Talwar - The Department of Life Sciences Scholarship for highest in BSc in (6 Units).
- Ms. Hamsa Narasimhan - Dr. MP Sujayakumari and The Department of Life Sciences Scholarship in BSc (3 Units).
- Mr. Dean D'Souza and Ms. Farah Ansari (MSc-II) - Dr. MA Eswaran Scholarship for a deserving student of Life Science.
- Ms. Keya Pankaj Kulkarni (MSc-II) - Sreevrat Goenka Scholarship for a meritorious postgraduate student of Life Science.

International Exchange Programme / Training

- Ms. Jinali Modi (TYBSc 3U) - 5-day Leadership Development Programme for Young Women at King's College and Oxford University, organised by Transcontinental School Innovation Alliance (TSIA)
- Ms. Ananya Agnihotri – St. Louis University, USA
- Ms. Mallica Pandya – Deagu Haany University, South Korea.
- Ms. Neha Jain – IESEG University, France
- Ms. Hamsa Narsimhan – St. Louis University, USA.
- Ms. Pragya Mishra – St. Louis University, USA.

The Depatment of Life Science and Biochemistry

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AKSHI BABEL
REVATHY SURESH
NEHALEE SURVE
TARA ELSA
POOJA RAO
ABIGAIL DSILVA
NIMISHA RAPHAEL
DHRUV CHAUHAN
CHRISTABELLE RAJESH

TOP ROW [L TO R]
MISBAH SHAIKH
JOSHUA FIALHO
DANIEL RAJ
DHRYATA KAMDAR
PRIANKA DHAL
TARUN IYPE
WINNIE PAULSON
KARL PONCHA
IRA GODBOLE
OBED GANGTE
RAMVEER SHIV
MANJUSHA THEKKEMEPPULLY
LAUREN DSOUZA
STEPHANIE MIRANDA
AISHWARYA PAGARE
ANANYA AGNIHOTRI
MALLIKA PANDYA
SHARMISTHA MURALIDHARAN

MSc Part 2

FRONT ROW [L TO R]
MAITHILI JOSHI
DEAN D'SOUZA
NAYTHAN D'CUNHA
SYLVESTER PARKHEY
BACK ROW [L TO R]
SAKINA GAROTHWALA

MERLYN ANTHONY
PRIYANKA KISLAI
DOROTHY BODHAK
FARHA ANSARI
PRIYANKA GOMES
DEVASHRI KADAM
SWETA CHALWADI

ANNACHRIS THANKACHEN
URVI BRAHMBHATT
SABANAZ SAYID
PRACHI CHAVAN
PRATIK ACHAREKAR
AYSIS KOSHY

NON TEACHING STAFF

[L TO R]
PRAKASH DANDGE
AVINASH AGRE
SUDHAKAR KOLGE
MACFEDYAN NORONHA

JAGDISH GULDEKAR
MANOHAR VELAYE
KISHORE SONAWANE
SANDEEP PAWAR

TEAM LIGNUM

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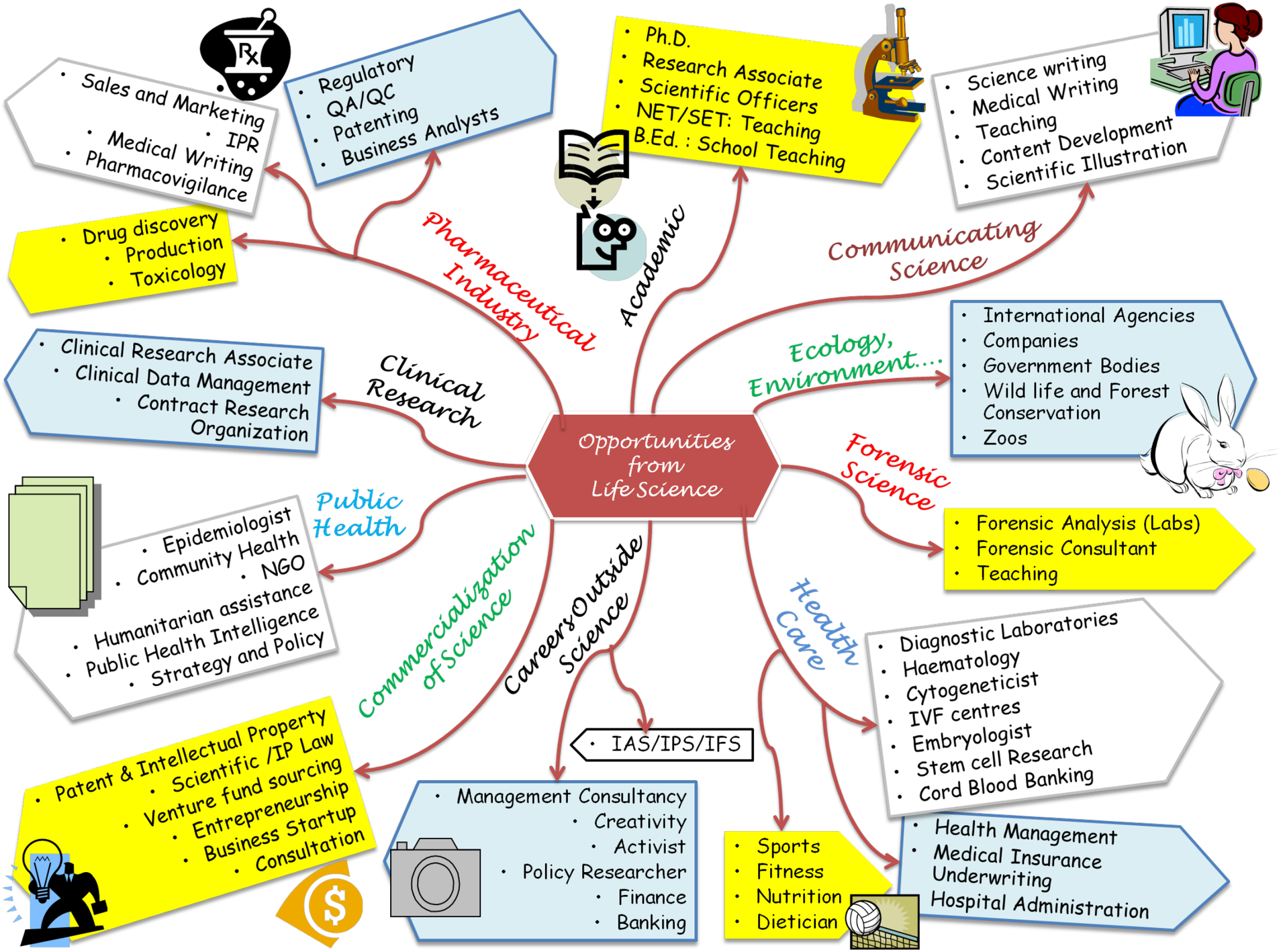
BACK ROW [LTO R]

ISHAAN PATIL
SHANIA MENDONCA
JUDITH FERNANDO
SALAMA YUSUF
SURPREET BHASIN
SHIVANI SURESH
JANVI GANDHI
KRITI RAJDA

FRONT ROW [L TO R]

KENNITH CASTELINO
IRA TRIVEDI
JEMIMA HELEN
MUSKAN MISRA
RIYANSHA ARORA
UPASANA SHAH
JEREMY JOHN



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In case you want to know what "minimalist music" is:
https://www.youtube.com/watch?v=6Stu7h7QupB

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