The Michronicle

2016-2017

"Scanning the field"

Department of Microbiology

St. Xavier's College,
Mumbai

About Coverpage and the Theme:

The first thing that comes to our minds on hearing the word "Microbiology", is the amazing instrument, the **Microscope**. A Microscope is used to view the small, living (and acellular) entities which otherwise are invisible to the naked eye. The phrase used for viewing objects in a particular area of a slide under the microscope is **"Scanning the Field."** Here we present to you, this cover page, which clearly explains that Microbiology is a lot more than just microorganisms like cocci and bacilli, with flagella and in colonies. Hence, the Microscope depicted on the cover page includes the various instruments used in the Microbiology lab, visible microbes such as mushroom (a fungus), viruses, the DNA molecule etc. This exhibits the perfect amalgam of varied fields such as genetics, cell biology, cloud microbiology and even scientific communication, which perfectly explains our theme, that **there is more than one field to scan in this field of Microbiology.**

Cheers!

Coverpage idea inspired from:
Nature Microbiology
http://www.nature.com/catalog/product/nature-microbiology-2/
https://themes.zapnito.com/tenants/nature-microbiology/eb91a3e69eae354b1f64324e5b25cae9/assets/hero-cover.jpg

Editorial

Neha Banwani
SYBSc 2016–17

The evolution of humans and the growth of science are events as closely intertwined as the fingers of one's hands, complementing each other's gaps and filling them graciously. With development arise even more questions, further leading to the need for many more problem solvers and solution providers.

In today's world, where many mysteries await to be solved, it's not an easy path towards achieving success. And because the field of science is a vastly glorious mess in itself, where every other option looks enticing, it is even more difficult to take a decision that satisfies both, the calm of the heart and the doubts of the mind.

"Your work is going to fill a large part of your life, and the only way to be truly satisfied is to do what you believe is great work. And the only way to do great work is to love what you do. If you haven't found it yet, keep looking. Don't settle. As with all matters of the heart, you'll know when you find it." – Steve Jobs

Many of us may have read this quotation before and have believed in the unquestionable innate truth it beholds. But now, when we stand at this juncture of life where a decision needs to be made, it seems too soon to be late, but time flies.

Therefore, to guide you through, we've tried to bring to the platter all the possible career options that you can look at, because an axenic culture is not what we're aiming for; it's our diversity that makes us unique and worthwhile.

It may seem like a far-fetched idea to some to enter the field of management or become the CEO of a company after graduating in science, but it is from here that we take inspiration – from the legends themselves and from those closer home. We cannot be more thankful to our alumni for sharing their experiences with us. Our teachers, also, have been a constant support throughout and we are grateful to them for everything.

Our writers are our real heroes, the ones who've made this magazine an eventful mix of articles, ranging from topics as varied as tuberculosis, CRISPR, and plastic degrading microbes to interdisciplinary sciences, scientific writing, and many others.

The unsung heroes of this endeavor are the members of my team, without whom this magazine would have remained an unfulfilled dream. Their incessant efforts have made it possible to bring to you this year's edition, where every full stop is symbolic of the dewdrops of their hard work, glistening in their own joy.

From growing from within a box to growing up beyond the box, it is a journey we all wish to cherish. I hope that our imagination, put into words and penned down here on paper, proves instrumental in scanning this humungous field of science, which we have left to unfurl in front of your eyes through this magazine. I hope our efforts contribute in your quest for a career and help you take a step towards the discovery of your liking and the uncovering of your calling.

We welcome you onboard this roller coaster ride called **"Scanning the Field"** and present to you **THE MICHRONICLE 2016-17**, a dauntless journey that we hope will leave you ecstatic and refreshed by the end.

From The Teachers' Desks

"Creativity is contagious. Pass it on." - Albert Einstein.

A real-world and holistic approach to education has become indispensable. Our endeavour at the Department of Microbiology is to go beyond the syllabus and educate students in ways that prepare them to be thinkers and socially responsible citizens. The focus is also to make teaching and learning a joyful process.

Knowledge, imagination, and innovation are encouraged to provide every possible opportunity to prepare our students for success. "The Michronicle" is one such opportunity that unleashes a wide range of creative skills such as writing, editing and designing. We congratulate the entire editorial team for their hard work and dedication.
May God bless us all.

Miriam Stewart
Sangeetha Chavan
Karuna Gokarn
Aparna Talekar
Pampi Chakraborty
Pradnya Gogte
Shilpa Verekar
Asma Chikte

Obituary

A Tribute to Mr Yeshwant Gawde - a former Laboratory Assistant of the Microbiology Department

Shri Yeshwant Gawde joined the Department of Microbiology of St. Xavier's College, Mumbai as a laboratory attendant in 1963. He retired in 1998 after many years of dedicated service to the department. All through these years, Yeshwant worked most sincerely and with a fierce loyalty towards the department. The welfare and training of students was his greatest concern and the faculty depended heavily on him for the optimum working of the department laboratories. He willingly trained laboratory assistants of other Biology departments of the college in microbiological practices. Yeshwant's dependable and cooperative spirit was encapsulated in the title of Shahrukh Khan's movie 'Main Hoon Na.' The Department was very fortunate to have enjoyed his services.

May his soul rest in peace.

Professor Vivien Amonkar
Former HOD
Microbiology and PG Biotechnology Departments

What's Inside

A Peak into Schrödinger's Box

(SCIENTIFIC ARTICLES)

Microbiologists: The real fun-guys

Stacy Louise Pereira
FYBSc 2016-17

Famous scientists and inventors are the rock stars of the scientific community; mysterious figures talked about with envy by their peers and awe by their followers. They impact our lives in many ways, but they are so much more than just their scientific contributions. For example, did you know that...

Louis Pasteur was very artistic:

The name Louis Pasteur brings to mind several terms - pasteurization, vaccination, germ theory, etc. Hailed by some as the 'Father of Microbiology', Pasteur certainly revolutionized the way we understand microbes. However, throughout his life Pasteur exhibited a deep passion for the fine arts. At the age of thirteen, he took up drawing and was formally tutored as well. He was very talented and used pastels (a new medium in those days made of powdered pigment and a binder) exceptionally well in his art. In fact, many believe that Pasteur's eye for art is what helped him make one of the most important discoveries late in his life: The Concept of Chirality.

Edward Jenner acquitted the adult cuckoo:

Cuckoos lead Bohemian lives,
They fail as husbands and as wives,
Therefore, they cynically disparage
Everybody else's marriage.

This short poem by Ogden Nash certainly does not paint cuckoos in a flattering light. For a long time, it was believed that the adult cuckoo pushed the hosts' eggs out of their nest after laying its own. In his paper in the scientific journal of the Royal Society in 1788, Edward Jenner, the inventor of the smallpox vaccine, proved that the fledgling was the real culprit. He also further studied the fledglings through dissection and discovered that they have a small depression on their backs which enables them to cup and throw eggs or other young birds from a nest. The depression disappears after approximately 12 days of the bird's life.

Robert Koch started using agar-agar instead of gelatin at the suggestion of a lab technician:

Laboratory assistants and technicians are among the many unsung heroes of the scientific community and this incident proves this fact. Back in the late 19th century, Robert Koch was on a quest to discover a solid nutrient medium as the liquid media (broth) he had used in most of his studies could not be used for isolating organisms. For his studies on Anthrax, Koch used potato slices as his medium but it did not support the growth of all types of bacteria. Similarly, he used gelatin as a solidifying agent but owing to its low melting point and easy digestion by several bacterial enzymes, it was not a feasible option either.

Luckily for Koch, in 1881 lab technician Walther Hesse's wife Fanny suggested using agar-agar as a solidifying agent instead of gelatin.

She had heard of it being used in Indonesia which was then a Dutch colony from her Dutch neighbour who had immigrated to New York. The agar medium was an immediate success but unfortunately there was no credit given to the Hesses in Koch's scientific paper and neither did they receive any monetary gains. Nonetheless, Fanny Hesse's humble contribution changed the face of cultural microbiology and agar is used in solid media even today.

Sergei Winogradsky changed his degree thrice:

Russian microbiologist Sergei Winogradsky is an icon in microbiology - he discovered chemosynthesis and came up with the concept of Winogradsky's column. However, in his youth he seemed to have had some trouble settling on his degree. At 17, Winogradsky joined the University of Kiev to study law. Finding law tedious, he switched to the field of science a couple of years later. But Winogradsky found the lectures in Kiev to be boring as well as disorganized and he quit yet again, this time choosing to pursue music. Eventually after a little more than a year of music study, he quit that too. At the age of 21 he took up science once again, this time at the University of St. Petersburg. Here he had a better luck as St. Petersburg had better lecturers. He took up chemistry and botany in earnest.

Winogradsky also held academics and the education system in contempt. When he was young, he described his Greek and Latin classes as being "…not only uninteresting and unpleasant but depressing, both physically and morally." Despite winning a prestigious gold medal for his academic performance, he sold it soon after - not due to any financial difficulties but simply because he held it in great disdain.

Why couldn't the rest of the fungi grow on the mold filled plate?
Because there was not mush room!

Alexander Fleming made petri dish art in his free time:

When science and art meet, it leads to remarkable things - just ask any sci-fi novelist! Or for that matter ask Alexander Fleming, the creator of Penicillin. Fleming came up with a technique to make 'germ paintings' using blotting paper. He would lay a disc of paper on solid nutrient media, allowing the nutrients to diffuse into the paper. After this, he would implant pigment producing microbes on the paper and arrested the growth at an appropriate stage using formalin. Once he was satisfied with it, he would leave the disc to dry and mount it. When Queen Mary was to visit the St. Mary's Hospital which was Fleming's place of work, he prepared a small exhibit of bacterial art including a rendition of the Union Jack. Alas for him, the Queen was not particularly impressed and hurried past it.

Scientists overall are quite the quirky bunch and learning about their behavior as well as hobbies is fascinating. Overly competitive, secretive but brilliant, it is sad to know that most of their humanizing habits are forgotten even though these habits are often what lead to their greatest breakthroughs. After all, Alexander Fleming discovered penicillin because he had a messy lab, Sergei Winogradsky took years to finally make a career choice and Antonie van Leeuwenhoek, the inventor of the first microscope started out as a humble cloth draper. So, embrace your oddities and foibles - they just might be the reason you make a ground-breaking discovery one day!

Against all odds
Deinococcus radiodurans

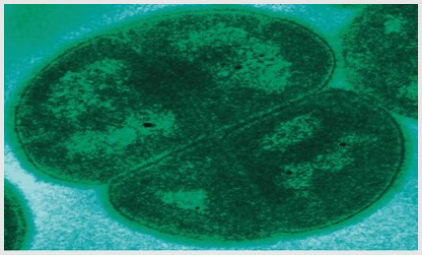
Larissa L. Gomes
FYBSc 2016-17

The existence of an immortal organism has been just another story in books or a theory in ancient texts for many years. Many alchemists have spent their entire lives trying to decode the secret to eternal life or to find the fountain of youth. All these practices were based on the beliefs which humans held to help themselves cope with the limited knowledge in their understanding of life. What if all the answers to these questions were lying right beneath our noses? Or more importantly, just within these tiny cells that make up our body? That is right. It is our DNA which holds all our answers! Not just specifically our DNA, but the DNA of every organism holds answers to the many questions one might ask, regarding what life is and who dictates this ironic essence of life - its complex spontaneity.

One such organism is *Deinococcus radiodurans (D. radiodurans)* which endures all life's hardships and manages to come out strong in the end. *Deinococcus radiodurans* is a **polyextremophile** as it can survive in harsh environmental conditions such as radiations, cold, dehydration, vacuum and acid. It holds a position in the Guinness Book of World Records as the world's toughest bacterium, hence it is nicknamed as "**Conan the Bacterium**." The innate property of *D. radiodurans* to resist high radiations is what makes it so important to us.

D. radiodurans was first found and isolated from irradiated canned food in 1956. This organism is found to exhibit tetrad form of arrangement i.e. four cells clumped together. It stains purple with crystal violet, making it appear Gram positive, although the composition of its cell wall is similar to Gram negative bacteria. In the phylogenetic tree, *Deinococcus* is closely related to bacteria from genus *Thermus*. Earlier, *Deinococcus* was placed under genus *Micrococcus* because of its morphological resemblance with its members, but owing to 16s rRNA variances, it was placed into a distinct phylum with genus named *Deinococcus*.

There are many strains of *Deinococcus* bacteria, out of which *Deinococcus radiodurans* R1 strain is the most widely studied. As the name suggests, *D. radiodurans* is **highly resistant to ionizing radiation**. The amount of ionizing radiation that can kill an average human being is 5 Gy, while for bacteria like *Escherichia coli,* it is 200Gy-800Gy. The infamous *D. radiodurans* can tolerate acute doses of 5,000Gy-15,000Gy of ionizing radiation! The thought of existence of such a radiation resistant organism still on earth is beyond imagination. Some theories suggest that this bacterium originated from space and was brought to our planet by hitchhiking on a meteorite! Some other theories suggest that the bacterium appeared on Earth billions of years ago, and as a result of evolution through horizontal gene transfer (HGT), it has adapted to the current toxic environment which is majorly contributed by man.



One of these well studied proteins responsible in the repair of damaged DNA is the **RecA** Many bacteria synthesize this protein, but sometimes its **protein**. Many bacteria synthesize this protein, but sometimes its repair ability is overcome by oxidative stress that leads to the death of the bacteria. In extreme and harsh environments where the supply of nutrients is low, bacteria employ various survival strategies such as formation of an endospore, but *D. radiodurans* does not form endospores like other bacteria. So how does it manage to survive these harsh conditions?

D. radiodurans, unlike any other bacteria, possesses the ability to resist high levels of ionizing radiation and overcome oxidative stress. When subjected to acute levels of radiation, there is formation of multiple double stranded breaks (DSB) in the DNA of this bacterium. When such breaks occur in DNA, bacteria use the RecA protein to enable fixing of damaged DNA. Sometimes, the DSBs are too many to be fixed which results in the death of the bacteria, but *D. radiodurans* **can fix>100 DSBs per chromosome** without lethality or mutagenesis.

These DSBs can be fixed by two processes; RecA dependent homologous recombination and RecA independent non-homologous end joining. Homologous recombination is more frequently employed over non-homologous end joining. Some studies suggest two mechanisms of DNA repair: firstly, high levels of intracellular Mn/Fe ratio prevents oxidation of essential proteins, and secondly, the cells possess a highly condensed nucleoid which restricts the diffusion of DNA fragments generated by irradiation. These mechanisms are suggested even in the presence of RecA. Even though the processes of DNA repair is studied in great detail, scientists are still not sure about the actual repair mechanism employed by *Deinococcus*.

The applications of *D. radiodurans* are limitless. It is being currently used in the field of biotechnology and bioinformatics to obtain antibiotic resistant strains and in recombinant DNA technology. *D. radiodurans* is widely used in bioremediation to help clean up sites polluted with organic chemicals and harmful radiation, transforming these chemicals into less hazardous mixtures. Attempts are being made to use *D. radiodurans* (transformed using $CaCl_2$ dependent technique) for the incorporation of plasmid pMD66 in bioremediation of high temperature radioactive waste management. Engineered *D. radiodurans* can be used for bioremediation of mixed wastes containing both radionuclides and organic solvents.

But why stop here? Scientists have even found a way to store data in the form of DNA. With the world always facing the threat of a nuclear war, what will ensure that the information acquired throughout generations will remain safe or even in a reproducible format? An experiment was conducted wherein synthetic DNA was created in such a way that it spelled out the lyrics of a children's song "IT'S A SMALL WORLD." This DNA was incorporated into *D. radiodurans* and generations of this bacterium were grown in the lab. The results of this experiment were substantial and 100 generations of the bacterium were successfully reproduced without loss of data! The few complications that could arise would be on the account of dissimilarity between the natural and laboratory conditions. Regular mutations too can lead to deletion and misinterpretation of data. With advancement in research and with development of various techniques in biology, we can hope for a better future, where we can use bacteria efficiently to help reduce environmental problems and also acquire answers to the innumerable questions we have. Bacteria have always boggled the minds of scientists and they still manage to amaze us, just when we thought we had them all figured out.

Spinach Heart

Lenisa Fereira & Moneza Jafri
SYBSc 2016-17

Spinach, Popeye's favourite super-powering snack, isn't just good for you because it provides your daily dose of vitamins and minerals, but it can also be transformed into heart tissue and aid in the treatment of cardiac diseases. No, this isn't going to turn you into Swamp Thing.

Spinach (*Spinacea oleracea*) leaves are known to grow a network of veins which mimics the anatomy of blood vessels through the human heart. Although it is known that plants and animals have a different approach for transporting fluids, nutrients and essential molecules, it has been found by scientists that they have similarities in their vascular network structures. This was a breakthrough discovery in the field of organ transplantation. Thus tissue engineering holds a promising and a viable solution for this problem.

So, what and how exactly is spinach used in tissue engineering?

Two biological engineers were having lunch with spinach and discussing about the shortage of organs for transplantation even with the advancement in stem cell technology. Scientists Joshua Gershlak and Glenn Gaudette working on this research project at Worcestor Polytechnic Institute (WPI), University of Wisconsin-Madison and Arkansas State University- Jonesboro published a paper online in the May 2017 issue of the journal 'Biomaterial.'

The team obtained spinach leaves from their local farms followed by cannulation of the spinach leaf petioles (a tube/cannula was introduced) and finally decellularization with a decellularizing solution for a few days, which is a series of processes used to remove cells. **What remained was cellulose after the leaf was completely decellularized [DP1].** As explained by authors, **"Cellulose is biocompatible and is used in various medical applications like bone tissue engineering and wound healing."** Further, these decellularized leaves were checked for their DNA and protein content which was found to be significantly less. Next step was to find the exact diameter of veins in the leaf. This was done using fluorescent microspheres of various sized diameters. The result showed that the leaf vasculature supports the flow of particles within the range of red blood cells.

The next important step for the research team was to recellularize this leaf with human cells. The principle here is the ability of human cells to adhere to plant produced extracellular matrix (ECM). Different human cell types were seeded on top of the decellularized leaf and also into the plant vascular network. The human pluripotent stem cell derived cardiomyocytes (hPS-CM) when seeded on these leaves showed cell clusters and adherence. The research team also noticed contraction which was further confirmed by the contractile analysis based on sub-pixel level change in random light intensity of the hPS-CM cluster.

to confirm whether there would be any immune response if this leaf grown heart muscles are integrated into native human vasculature. This experiment holds great light on interdisciplinary research as human stem cell researchers and plant biology researchers have effectively worked together and are continuing to work at Wisconsin and Arkansas. This research has connected two kingdoms (plant and animal) such that various biological features of each kingdom can be exploited to effectively bring out new solutions for the once called unsolved medical problems.

- *Conan the Bacterium: Can nothing defeat this muscle bound Bacterium ?*
- *That 1 % FOREVER ALONE bacteria that never gets killed coz all cidal agents have 99% efficiency!*
- *Why did bacteria fail the math test ? Because it thought multiplication was same as division.*
- *Did you just mutate for a stop codon, because you are talking nonsense.*

Background picture source: https://www.highmowingseeds.com/organic-non-gmo-renegade-f1-spinach-a.html

nuoG and LucA genes contribute to *Mycobacterium tuberculosis* virulence in humans

Danisha L. Pereira
SYBSc 2016-17

Mycobacterium tuberculosis has been in existence for more than 15,000 years. It is responsible for infecting approximately 1.5 billion people and causing about 1 million deaths. Most individuals infected with *M. tuberculosis* (MTB) rarely develop active tuberculosis and most remain asymptomatic, making it difficult to control and cure the disease. Research has revealed that MTB has undergone major evolution over the past several years. It presently contains a variety of genes that aid in its successful evasion from the host's immune responses, ensuring its survival for long periods of time inside host cells. In this article, out of the many genes, two of them namely nuoG and LucA have been highlighted.

Most intracellular pathogens are killed by programmed cell death regulated by the immune system of the host it infects. Intracellular pathogens must therefore have strong anti - apoptotic mechanisms. The MTB genome consists of a nuoG gene that has been found to inhibit macrophage mediated host cell apoptosis. nuoG targets the intrinsic pathway (mitochondria mediated) and the extrinsic pathway (death receptor mediated), thus drastically reducing the number of apoptotic cells produced by the host. Experiments involving SCID mice (immunodeficient mice characterized by an absence of T and B cells, lymphopenia etc) were carried out wherein three sets were infected with M. kansasii cosmid transformants (Mkan- CO), M. smegmatis clones J21 and M24 and Mtb H37Rv strain respectively to test the relation between virulence and apoptosis. After five weeks of incubation, the tissue bacterial burdens were stained and observed to find that Mtb H37Rv strain was the most virulent and mice were killed after 15 days whereas those infected with the Mkan- CO died after more than 200 days. The graph of percentage apoptosis induced and that of survival were compared to conclude that highly virulent Mtb H37Rv induced very little apoptosis by the host whereas in Mkan- CO infected mice, high amount apoptotic cells were found. In other words the Mtb H37Rv strain inhibited macrophage mediated apoptosis in the host. Cosmid J21 showed higher virulence than M24 and was selected for sequencing. It contained open reading frames of 31 annotated genes, one of which encoded 14 subunits of the Mtb type I NADH dehydrogenase (NDH) complex. A deletion mutation in the nuoG region coding for a subunit of NDH- I complex revealed that the nuoG gene was needed to promote inhibition of apoptosis of primary murine macrophages. Further experiments showed that nuoG alone could also inhibit apoptosis even though it was

proposed that nuoG exerts its anti- apoptotic effects not directly but via enzymatic activity of NDH- 1 complex in a specific way. It is hypothesized that NDH- 1 and nuoG serve to pump protons across the bacterial membrane which together with superoxide dismutases neutralize it to generate hydrogen peroxide, which in turn is neutralized by bacterial catalases thus protecting the bacillus.

Bloch and Segal (1956) determined that MTB preferentially metabolized fatty acids in mammalian tissues. Vander Val in 2015 discovered another mechanism that helps MTB persist in the host i.e. its ability to metabolize host derived fatty acids and cholesterol which is a peculiar characteristic of *Mycobacterium tuberculosis*. However MTB does not contain any gene in its genome that encodes for fatty acid transporters possibly as its own cell wall is made of mycolic acid. Initially, Mce proteins (mammalian cell entry) were thought to be involved in transport into the cell and later they were proved to mediate transport of hydrophobic molecules across the cell wall. Forward genetic screening was used to identify the gene encoding the protein Rv3723 (later renamed as LucA for lipid uptake coordinator A) required for cholesterol uptake. Fluorescent tagging and microscopy were used to identify the position of LucA in the cell wall as an integral protein. The cholesterol uptake by a wild type MTB was found and set as 100%. A mutant Mtb ΔlucA::hyg (without LucA) was found to take up 70% less cholesterol than the wild type. MTB normally assimilates cholesterol derived propionyl CoA via the methylmalonyl pathway and methyl citrate cycle. The genes encoding proteins essential for the above pathways were also found to be down regulated in the Mtb ΔlucA::hyg mutant. Further experiments showed that LucA physically interacts with subunits of Mce1 and Mce4 transporters suggesting that LucA is necessary for the functioning of these proteins. In the absence of LucA, the Mce1 proteins were degraded possibly by proteases. Absence of the gene also proved lethal for the mutants when grown in cholesterol rich medium, thus confirming its importance in MTB. The LucA, Mce1 and Mce4 interaction can confer resistance to MTB against some antibiotics.

Thus inhibiting the LucA gene could possibly block the two essential pathways and inhibition of the nuoG gene may help in destruction of *Mycobacterium tuberculosis* via macrophage mediated apoptosis of host cell. Antibiotics inhibiting the LucA protein are currently being researched upon. All the above results emphasize the humongous importance of the LucA and nuoG genes. Many others genes are also involved in MTB virulence and it has proved difficult to target many together to completely kill the MTB bacillus. This along with mutation, difficulty in culturing, slow generation time and resistance to antibiotics makes research of possible cures a difficult task. It is however a steadily progressing field with immense potential.

A Micro Story

Alex Berrhto
FYBSc 2017-18

This is the true story of Microbiology,
Of its students and its modesty.
He was all geared up to prove that he could focus
And make the vague images an unobstructed paradigm.
Inspired with his own cocksure locus,
He devised himself to get the photogenic screen.
He took the slide and washed it off,
Made it crystal clear.
Using his ignited nichrome wire,
On his slide he applied the smear.
He took the stain and flooded the slide,
He followed every single instructing line,
He stared at the watch to walk with time.
He took the slide and washed the stain,
Kept the slide aside to let the water drain.
Then he took out the obstacle to his hope
That old yet magnificent microscope!
Then he switched the illuminating light on,
He changed the angle of the mirror to get a perfect cone.
Took his slide and put a drop of oil on it,
He was so careful that he did not even breath out for it.
Carefully, he placed the slide below the oil immersion lens.
Then he rolled down the tube,
And let the lens give oil a friendly peck.
Then he slowly took his eyes close to the ocular lens,
It was just focusing but yet, he was so tensed.
Then he pulled up the tube using the roller,
He made sure that the lens and oil were still embracing each other.
He wiped the lens, he wiped his sweat,
He made the tube go back and forth again;
But all he could see was just the irritating light,
And sometimes some random particles floating in front of his sight.
Then calling his teacher he screamed aloud,
"This microscope is not working, I doubt!"
The teacher came to him and keenly observed his slide,
Then looked at him and smiled and said,
"Child, you were observing the wrong side!"

Zombies in Nature

Kartikeyan Premrajka
FYBSc 2016-17

The microbial world is believed to outweigh entire plant and animal kingdoms in terms of their sheer effect on the environment and importance in the living world. There are billions of microbes, each with a distinct role to play. From *Lactobacillus* being involved in the formation of curd to *Plasmodium* being fatal for humans, microbes hold a privileged place on Earth and in our lives. These pathogens have evolved in a manner where they have managed to gain specialization in accommodating themselves into their hosts. The course of evolution took a strange turn, enabling them to use other animals as vectors. The interaction of these two huge groups of organisms with other species is more like an excerpt from a science fiction. Nature is an amazing artist, author or a director, for it surely manages to surprise us with its unique events, day in and day out. Here is one such example that looks like it has been taken straight out of a horror film:

'The microbes turn the vectors into zombies and control their behavior and movement to suit their needs!'

That's not all. Not only microbes, but also the larvae of insects and flatworms are parasitic in nature and are known to have specific hosts and vectors whom they enjoy controlling at their own will. Toxins also play a major role in the zombie producing factory of the miniature world. Here are a few examples in nature that might just make you believe in the existence of fantastic beasts.

The 'Kill'-ifish

The Killifish is a type of fish which serves as food for some birds and as a vector for ***Euhaplorchis californiensis*** (a fluke). The snail is the first host of this fluke, which is then eaten up by killifish. This engulfed parasite attaches to the gills of the killifish and migrates to its brain.

In the brain, the fluke larva releases certain chemicals like **dopamine** which interferes with the neuro-muscular coordination of the fish, making its movements very vigorous and aggressive. This makes the fish easily noticeable by predatory birds. The fluke finally reaches its intended haven and sexually reproduces in the bird to produce its off springs. This cycle starts all over again when the snail consumes the bird's droppings. Thus the fluke's effect on the killifish is in essence, like that of a mind controlled zombie.

Dead ant walking

According to experts, ants are one of the most socially organized insects. However, they exhibit an unusual phenomenon which is a result of an infection by fungi. This can be clearly identified by a spore-bearing body projectingout of their skulls.

Ophiocordyceps is a genus of fungi whose spores germinate on the ant's body. The inter-

esting thing about this interaction is that scientists have still not discovered the mechanism which the fungus uses to control the ant's movements. The best estimates include dopamine regulation, interfering with the nerve-muscle interaction in the ant.

Several species of this fungi genus leads to the death of ants in the most unnatural places. Dead ants have been found perched to the underside of leaves, the tips of grass stalks etc. This helps the fungus obtain a wider area for spore distribution, thus increasing the number of their ant carriers. This is a classic example of the horrendous mind manipulation of innocent laborious insects.

Roaches from hell

Nature decided to troll us and create **Zombie roaches**, a scarier version of the pre-existing scary roaches. Some species of wasps require certain hosts to complete their larval stage. One such species of wasps is the **Jewel Wasp**.

The wasp first finds a suitable host, preferably a male cockroach which is close to metamorphosing into an adult. It then stings the cockroach, injecting a toxin which interferes with the movement controlling system present in the cockroach's ganglion.

This renders the roach incapable of free movement. Hence it is guided easily by the wasp, which grabs its antennae and leads it everywhere. After the cockroach is safely left paralyzed in a burrow, the wasp lays her eggs in the abdomen of the cockroach which hatch into larvae. These larvae eat the roach alive from the inside. Here, the toxin acts as the medium to turn the roach into a living zombie, destined to be eaten by the larvae of the Jewel Wasp. There are several other examples, for instance, female *Anopheles* mosquitoes are said to be mind-controlled by the malarial parasite *Plasmodium*.

We have just skirted this vast and weird world and would certainly have to agree that there are still many stones unturned and many realms unexplored. Who would have thought that the apocalypse that people fear (or dream about) is presently unfurling at our feet? Winter sure comes fast for these little wights.

Trippin'over loops

Ritvik Chandavarkar
SYBSc 2016-17

We trail our familiarity with nucleoside base pairing, to the model proposed by Watson and Crick of hydrogen bonding between nucleoside bases, maintaining complementary DNA strands in a right handed DNA double helix. The "B form" of the long double stranded genetic information storing molecule, accepted as the canonical structure of DNA, has accommodated non Watson-Crick base pairing conformations, whilst withholding the structure of DNA and its information storing capability intact. The ability of nucleic acids rich in guanine to self-associate, has been speculated for about half a century, from even before the discovery of the canonical form of DNA. The structures formed, as a result of these associations were of negligible scientific attraction, until their molecular characteristics were established by X-ray fibre diffraction and biophysical studies.

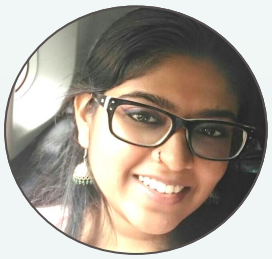
The tracts of guanine, separated by other bases, form G-tetrads (G-quartets) using Hoogstein base pairing. These planar G quartets stack to form **G-Quadruplexes** (G4's). They are formed spontaneously when G4 formation is thermodynamically stable against a weakened Watson Crick base pairing. There is a great interest in G4 formation at telomere ends, since telomeric DNA sequences contain non guanine bases in between scattered short runs of guanine. G4's are present in the RNA, in human RNA and DNA viruses also. G4's are conserved in species and potential sequences are conserved greatly in mammalian species, while lesser in non-mammalian forms. G4s may have individual strands parallel or antiparallel to the other. In a double stranded DNA, potential G4 sequences (PG4s) have been identified in non-telomeric regions of the genome, particularly in gene promoters, immunoglobulin switch regions and recombination hotspots. Thus, there was a developing understanding that G-quadruplexes have a noteworthy role in functions similar to that of regulatory elements.

However, association of G-quadruplex motifs with intrinsic cellular function is poorly known to this date and is a subject of extensive research. In the path to satiate this curiosity, research was conducted to understand G4 regulation of transcription. Due to complexity of eukaryotic genome regulation, the study was carried out on comparatively less complex bacteria. It was conducted on the relationship between functional classes and PG4s, both at the level of individual genes and the genome level. It revealed that the PG4s occur in a way such that they probably impart functional features in organisms. An algorithm scripted in Java was designed such that it identified potential G4 forming sequences calculating loop length and count, conducting sequence randomizations to achieve statistical significance of results. The

consensus sequence calculated was (GGG-N_{1-7})4 for Potential G quadruplexes (PG4s), promoters containing a large amount of PG4s can be studied.

The rationale used was that, if G4s do not have a significant role in expression of the gene of a specific function, there would not be segregation in the pattern of function expression. Radiation resistance was selected, as it was extensively studied, with respect to organisms and functional genes, also because the response to radiation resistance is distinct. Genes directly responsible for radiation resistance were determined using KEGG. Ligands which specifically interact with G4s inside a cell will alter radiation sensitivity, and keeping this in mind, NMM (**N-methyl mesoporphyrin**) was selected and MIX (**mesoporphyrin IX dihydrochloride**), an unmethylated analogue of NMM was used as negative control. *D. radiodurans* and *D. geothermalis* were selected as they were most extensively studied from genus *Dienococcus*. The rate of survival of the selected strains decreased in a dose dependent manner in the presence of NMM. Thus proving that the G quadruplexes play a significant role in gene expression. Extensive work is being carried out to understand the effect of G4s in expression and regulation of gene function in various organisms.

The Micro Knowledge behind Mythology



Geervani M
SYBSc 2016-17

Imagine being asked to follow traditions of Hinduism which you possibly do not like because they seem absolutely bizarre and superstitious.

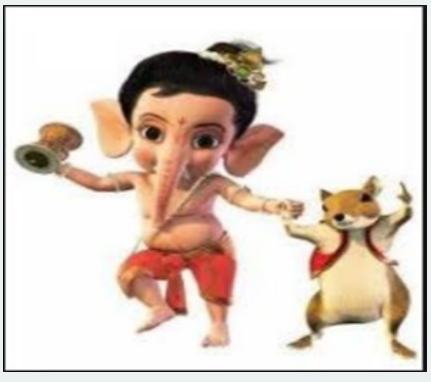
For instance, Lord Ganesha has the head of an elephant and the body of a human, his *vaahan* (vehicle) is a *mushak* (mouse). Why is it specifically a mouse? Why is it believed to be the combination of an elephant and a human?

Camphor is supposed to be burnt in the morning and evening at homes. Why is this so? Well, most of us are taught to believe that by following this ritual, we will burn our ego and remove negativity from our lives.

In other instances, like on visiting a temple, it is quite often observed that the foreheads of deities are made of sandalwood paste, while limes are placed on *trishuls, murtis, yagna kund* and on either side of doors.

Why are these specific elements used in a conventional manner for particular reasons? Does it not seem like these might have a **deeper meaning**? Maybe this logic transcends science of today! Perhaps, our ancestors were smart enough to frame mythological stories to actually help us remember the significance of everything found in nature and also the right technique to obtain benefits from them.

Let us start off with the example of Lord Ganesha. Inspite of having innumerable options to pick from, he still chose the mouse as his vehicle. According to some studies, this choice of his finds its roots in the field of genetics. Mice are used as vectors to identify pathogens, for RNA recombination, to test the efficacy of a drug etc. It has 42 chromosomes while humans have 46 chromosomes, which indicates that they both are genetically similar to some extent. Scientifically it has been observed that many conditions in humans, such as diseases can be replicated in mice. Moreover, they even share significant resemblance in their biological and behavioural characteristics. This implies that **the mouse model is nearly perfect** for research and development in science, specifically in biology. Who knows, further research might even prove that a human body could actually bear an elephant's head. This might just be a fantasy but plastic surgeries, kidney transplants and heart transplants might pave way towards 'head transplants' from a totally different species i.e. elephants.



The Ashoka tree finds significance in Hinduism, Jainism and Buddhism. Why is it called 'Ashoka?' The answer to this you'll find out below:

Its other names also include 'Sita Ashoka' or 'The Sorrow Less Tree.' But it is not just any random name given to the tree. 'Ashoka' is a Sanskrit word which means sorrow less.

✦ Each and every part of the tree such as the bark, leaves, flowers and seeds are used for medicinal purposes, because of which it is called universal plant. The bark is comprised of sodium, magnesium, aluminium, iron, calcium, silica and strontium.

✦ The bark, seeds and flowers of the tree are helpful in preparing capsules and tonics to solve various gynaecological problems in women.

The juice extracted from its flower is used to cure dysentery (caused by notorious microbes such as *Shigella dysenteriae*).

✦ Medicines prepared from the leaves, flowers and bark of this tree are used for purification of blood and for treatment of diarrhoea, piles and kidney stones.

So, now you know why our ancestors named it 'Ashoka.'

Camphor

It has been scientifically proven that camphor has antimicrobial activity. Taking ***aarti*** (swaying your hands across the flame and touching your face) from burning camphor ensures that your facial skin comes in contact with camphor. This helps in relieving skin irritation and itchiness, cures acne (caused by *Streptococcus*), soothes skin rashes, treats dandruff (caused by yeast like fungus: Malassezia or mainly by bacteria like *Propionibacterium* and *Staphylococcus)* and also helps in treating nail fungi.

When camphor is burnt in the house to worship Gods/Goddesses, the vapours of camphor reach various corners of the house killing pathogens, thus making sure that the family is **protected from disease causing microbes**. This is the reason why it is symbolic of burning our ego and negativities.

At times it feels as if these mythological stories are presented in the form of riddles and rhymes, which when accompanied with proper research can take India to a whole new level of scientific brilliance and bring us glory.

Tulsi (*Ocimum sanctum*)

When one visits a temple, the pujari gives Teertham from a silver container using a silver spatula. The holy water that is given, comprises of Tulsi leaves, cardamom (*elaichi*), benzoin (*karpura*) etc. Let us focus on Tulsi for now.

Research conducted on 'Biosynthesis of silver nanoparticles using *Ocimum sanctum* (tulsi) leaf extract and screening its antimicrobial activity' by Garima Singhal *et al.* (2010) showed that its leaf extract could **reduce silver ions into silver nanoparticles** within 8 minutes of reaction time.

Thus, tulsi is found to be beneficial in generating an eco-friendly method of biosynthesis of stable silver nanoparticles, with a size ranging from 4nm to 40nm and possessing antimicrobial activity. Tulsi leaves also help protect one from cough and common cold (caused by *Rhinovirus*).
The Tulsi plant **releases oxygen during the day as well as night,** while other trees and plants carry out respiration during the day and release carbon dioxide only during night.

Cinnamon (*Cinnamomum zeylanicum*)
Indians use cinnamon in almost everything they eat. It is used to prepare chicken biryani, methi pulao and various other delicacies. Cinnamon is used as dust on doughnuts and cinnamon tea also forms a major part of the recent health conscious fad.
Cinnamon, in the olden days had its value ranked with gold, ivory and frankincense and was one of the costliest offerings in the temple of Apollo in Miletus in 243 BC.
Cinnamon has shown to possess powerful antimicrobial effects. When mice were injected with *Salmonella typhi*, the fever caused in them due to this infection was seen to reduce when they were treated with cinnamaldehyde.
Research has shown that **cinnamaldehyde** present in cinnamon powder, more strongly in cinnamon oil, can tranquilize both animals and human beings.
Cinnamon oil **exhibits antifungal, antiviral, bactericidal and larvicidal** activities. The ingredients in cinnamon have shown to possess specific cidal activity against Escherichia *coli*, *Staphylococcus aureus*, *Salmonella*, the Asian flu virus A and Echovirus. These microorganisms are known to cause a menace in our everyday lives. So, now you know the secret of beating them before they beat you!

Salmonella causes food poisoning, *Escherichia coli* causes Montezuma's revenge and *Staphylococcus aureus* causes lesions, pustules and boils which can be terminal if they spread to organs within the body. The folk belief that cinnamon can prevent bacteria, fungi and viruses from attacking food or people is scientifically proven and absolutely true.
If you've got intense menstrual cramps, then cinnamon can aid in relieving this pain and also help in maintaining a regular menstrual cycle.

Research carried out at St. Xavier's College, Mumbai (Autonomous) in 2016 on 10-year old cinnamon powder showed brilliant antimicrobial properties and proved to act as a **broad-spectrum antibiotic**.
So if you believe in this famous ideology of **health is wealth**, munch on some cinnamon or sip some hot, refreshing cinnamon tea to get healthier and happier!

What is another word for Cinnamon? Synonym.

The Three Magical Gifts

Sharmistha Panda
SYBSc 2016-17

The scorching summer receded. And so did the angular velocity of my ceiling fan. The balcony was flooded with coccoid drops when my father suddenly hugged me with joy and said,"Pack up your stuff dear! Time for Xavier's!" Through eyes filled with fresh enthusiasm, I could see my parents' smile exceed the length of my 26 hour excruciating train journey from Odisha to Mumbai.

The admission process seemed very simple. A bright yellow papered clone of *Xanthomonas* was handed over to me and they said,"Use this fee receipt at the gate till you get your identity card. Get it photocopied as you might lose it."

This landed me onto the most motivating place of the college - The Xerox Centre. It looked exactly like an isolation performed for the first time - variety of selfless beings cluttered together without any remorse. After about forty minutes, I managed to be that lucky contaminant who passes all sterility and disinfection examinations and nails it there.

I got my *first magical gift*.

"Oh, we don't have theory lectures today? But I have brought all my notebooks along. So do we have practicals?" A past version of me who was very sincere, asked this to a much ignorant yet, a bit helpful senior.

His ignorance was gracefully administered in his reply," Nope dude! It's just the first day bro, chill out a bit, they start *pracs* much later." Maybe, he decluttered the word purposely rather than ignoring. Those five letters that he omitted, actually represented his possible number of attempts to bunk college in three years. The omission was basically his way of getting over the 'glory' of being a regular student.

A month passed by. It was time for me to get over the scintillating crispy aroma of my newly photocopied study packs. It was painful but till I appeared for the last CIA, I was pretty okay with it. I was immune enough to see those brilliantly highlighted sentences, every topic dancing with a tiara of triple asterisks on their heads and completely starving poor little exercise questions that were waiting for an infinite length of time to get themselves fed with cute little tick marks and symbols of doubtful queries.

Everything was just changing. Be it the transformation from *canteen* to *foyer* or *What's been up?* to *Sup?* I was slowly mutating my way of interaction to a more sterile, cultured and incubated one. Now,every word that I uttered, was opsonized with the antibody that could easily attract and agglutinate the temperament of the person in front.

This was the *Second Magical Gift*.

You must be wondering, "When is she going to talk about the third magical gift?"

Well, I haven't received any third gift yet. I'm just being a true Xavierite- We make **bold** statements first**,** *realize it second.*

(Courtesy: My favourite biochem professor!)

Telomerase in Cancer Biology and Contact Inhibition of Cells

Marwan Malik Sher Mohd
FYBSc 2017-18

Cancer, a disease almost all of us have heard of, is a condition in which abnormal cells divide and invade other body tissues. In this article, we shall see how cancer survives in our bodies and how it can be treated.
Cancer is an age dependent disease. Cancer cells have abnormal genetic constitution which makes them divide rapidly and continuously, avoiding death per se. Before we understand how cancer cells can divide continuously, unlike other somatic cells, let us get acquainted with a few related terms.

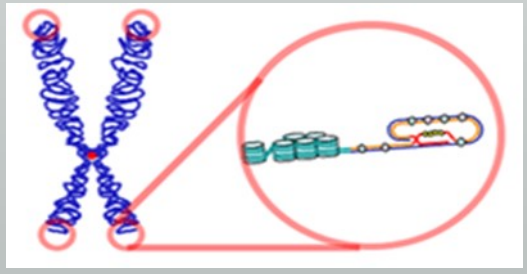
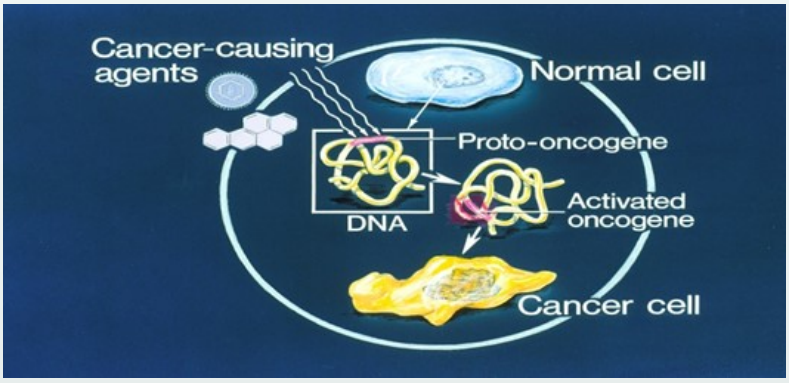


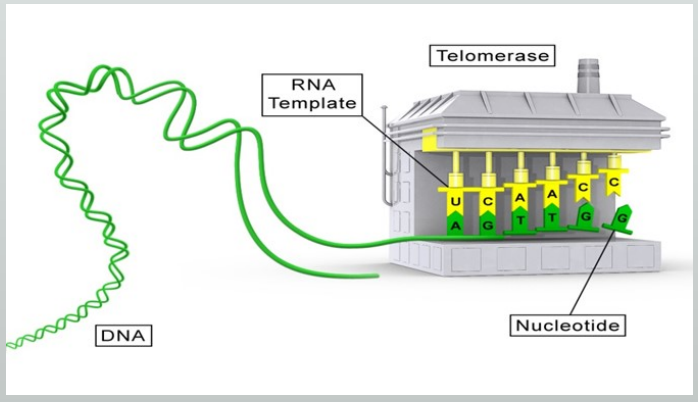
Fig.1. A TELOMERE WITH THE OVER HANG CIRCLED

Telomere is the end part of a DNA strand. It is made up of **TTAGGG** repetitive units and acts like a cap of the DNA molecule. It protects the end part of chromosomes from fusing with each other. Telomere has single stranded TTAGGG overhangs present at the ends. The overhang folds back to the double stranded sequence and forms a **Telomeric loop (T-loop)**. Because of this property, the DNA damage machinery cannot recognize telomeres. The proteins associated with telomeres are collectively called Shelterin complex and consist of three subunits: TRF1, TRF2 and POT1. These proteins provide structural support to the telomere.
Now, we shall take a look at how telomeres function.
A normal new born child has very long telomeres. As the child grows, that is the somatic cells divide more and more, the telomere length shortens by 20 bp -150 bp in every cell division. This also helps in determining the approximate age of the individual. **Telomeric shortening can cause genomic instability.** When the telomere length shortens to a certain critical extend, cells stop dividing further. This is called cellular senescence. The mutational events occurring at this time are very less and therefore not enough to cause cancer, so this process is in a way an anti-cancer process. During this phase, the DNA damage mechanism starts working on the chromosome and the cell finally dies. This is termed as mortality.



If that is the case, then should not all telomeres and their DNA just exhaust in a few generations? Well, the answer to this question is the enzyme telomerase. **Telomerase** is a ribonucleoprotein RNP that maintains the telomere length by **adding TTAGGG sequences** at the ends.

It is produced by the *TERT* gene and essentially functions as a reverse transcriptase. Telomerase consists of a number of subunits: A protein called telomerase reverse transcriptase TERT or hTERT protein (not to be confused with *TERT* or *hTERT* gene) which catalyzes the addition of nucleotides to the telomere. Next is a RNA component called telomerase RNA (TR) which acts as a template. Fig 3. shows how telomerase adds new nucleotides to the shortened telomere to maintain its length. **This is the reason why the telomere is never shortened in germ line and stem cells.** Experiments prove that the somatic cells treated with telomerase in a culture had longer telomeres as compared to the cells that were not treated with telomerase.



Let's take an example of the proto-oncogene which promotes normal cell growth and proliferation. Once the cell is destined for apoptosis (programmed cell death), this gene stops working (switches off). In case this gene undergoes mutation, it will become a 'bad gene' called **oncogene** which is always functioning (switched on). The cell which was meant to die, now grows and proliferates further. This type of cell is called an oncogenic cell. Oncogenic cells can bypass the phenomenon of cellular senescence.

Be proactive! Said no one ever to an oncogene.

What did the protooncogene say to the oncogene?
Who turned you on?

This mechanism can also occur due to tumor suppressor genes. The tumor suppressor gene slows down cell division, repairs faulty DNA molecules and sends death signals to cells. In case this gene shuts down, these tasks are not completed and cells become immortal, divide rapidly and the errors in DNA are not repaired adequately.
The difference between the two is this; oncogenes are always active (on), "bad guys that dirty a place", while tumor suppressor genes are not active (in case of cancer), "good guys that can clean a place but are not able to." This results in rapid division of cells, which leads to exhaustion of the telomere and causes the chromosomes to stick together. This is called **Crisis**. Most cells die at this stage but some cells bypass crisis and become immortal. These are called cancer cells which have abnormal DNA.
Cancer cells have very short telomeres but they survive as well as divide because of the enzyme telomerase. Due to telomerase, the length of their telomere is maintained and they can divide successfully almost every time. The reason behind the presence of telomerase in these somatic cells (telomerase is not usually found in somatic cells) is still unclear. But it is known that the telomerase producing gene (*hTERT* gene) is found to be active in cancer cells. This is the current question in research with the aim of finding out the potential promoters of the *hTERT* gene. Many hypotheses have been proposed, but so far but none have led to the formation of a theory or a law. Telomerase is found in large amounts in cancer cells. This is one of the methods used to detect cancer. Also, the TERT proteins are found in large excess in these cells.

Treatment methods with respect to telomerase:

Anti-telomerase drugs are used in the treatment of mild cancers, but not severe cases. The drug stops the action of telomerase by destroying it. Due to this, the cancer cells do not receive telomerase signals while dividing and thus their already critically shortened telomere gets exhausted. Thus, no telomeres are remaining, which leads to extensive DNA damage and the cancer cells finally die. This way the cancer tumor cells can be killed. This method can be used with other methods such as chemotherapy, radiation therapy, hormonal therapy etc. For now, this method has been successfully tested in mice.

If anti-telomerase drugs are used, would they not affect other telomerase containing cells such as the stem cells and germ line cells also?

Well the answer is **NO**. As we know, telomerase is only required by dividing cells and the above cells do not divide as frequently as cancer cells do, especially the stem cells which rarely divide. Once the disease is successfully treated, the intake of drugs can be stopped and telomerase can then function normally.
Another new way to treat cancer is by externally adding nucleosides. In this way, the telomerase is not targeted but while building the telomere, the telomerase incorporates these faulty nucleosides in it. Due to this, the structure changes and the shelterin proteins are unable to bind to the 'changed' telomere efficiently, which leaves the telomere

dysfunctional and causes cell death. This experiment was performed successfully in a laboratory using mice as model organisms.

Another anti-cancer mechanism shown by our body:

During the normal cell cycle, the cells stop dividing at a time when they are all in contact with each other and there is no possible space to grow any further. This is called **contact inhibition of cells**. The cancer cells do not stop dividing at this phase and continue growing, leading to the formation of tumors. Few of the reasons for this are oncogenes and tumor suppressor genes as discussed above.

This can be experimentally shown on a Petri dish. As soon as the normal cells form a monolayer on the surface, their division is halted. This is brought by certain proteins which signal cells to stop dividing. In case of cancer cells, they keep on forming layers of cells on top of each other which eventually forms a tumor. Contact inhibition is an anti-cancer mechanism shown by the cells.

Future research in cancer:

Researchers are now trying to genetically modify the immune system to help it fight cancer. For instance, Chimeric antigen receptors (CAR) therapy is employed nowadays, where the T cells are genetically modified to carry a specific protein on their surface which can recognize cancer cells and destroy them. This protein is called CAR and is a receptor. This method is now used to treat acute leukemia. The T cells of the patients are modified *in vitro* with the help of a retro virus and then injected into the body. The retro virus integrates the gene for CAR into the T cells genome which helps the T cell to express the receptor on its surface. The problem with using retro viruses is that they can be non-specific while adding the gene, i.e. it might add the gene at a wrong locus.

CRISPR (clustered regularly interspaced short palindrome repeat): This region is seen in the bacterial genome and is used as a defense against invading viruses. When a virus injects its genetic material called 'spaces' into the bacterial cell, the DNA gets incorporated and transcribed into an RNA molecule and becomes a CRISPR RNA. This RNA binds to the cellular machinery and guides it to destroy the viral genetic material. These spaces are retained to be incorporated into the cell memory to enhance the immune response in case of a future encounter with the same virus. When a new type of virus tries to infect the bacteria, a new space is added. This phenomenon was first noticed in *Streptococcus thermophilus* in a food industry, where it was observed that certain viruses can infect bacteria causing damage to the quality of food. Although *S. thermophilus* was showed to possess immunity against viral infections.

CRISPR can now be used widely in research. Scientists can synthesize CRISPR RNA in the laboratory and use it for several purposes. The advantage is that the RNA is a transcript of the same DNA sequence, hence they can act as accurate guides to the specific DNA locus. This RNA can be used to silence many genes and also alter the genetic constitution of many genes. Hence, CRISPR can be used effectively to induce CAR gene in the T cells genome. Dr. Sadelain and his colleagues at the National Cancer Institute were successful in

performing this experiment in mice. According to Dr. Sadelain *et al.,* the advantages of using CRISPR over traditional methods such as the retro virus method are far greater. The specificity is higher in the case of CRISPR. They were successful in inducing the CAR gene in the TRAC region (includes gene for T cell receptors) of the genome. These cells also showed less than 2% 'Exhaustion,' which is a condition when modified T cells stop recognizing and attacking cancer cells after a certain time, this is , exhaustion is more than 50% when traditional methods are used.

Cancer remains one of the deadliest diseases in the world and is a matter involving continuous research. Novel ways to treat cancer are tested every day. We hope someday cancer will become easily curable.

One telomere asked the other telomere," where do you party?"
The telomere said 'The Shelter Inn.'

A food for thought:
What the rings on a stump are to a tree, the length of telomeres is to a human.
Fascinating, right?

What is common between the Cancer star sign and the disease cancer?
They both are clingy.

The amazing story of CRISPR

Nancy Eunice
FYBSc 2016-17

Did you ever think there can be a raging war in the tiniest of the tiny organisms?
Yes, there is an ongoing battalion within these tiny organisms too. This provides an evidence that bacteria also have an immune system.
So let me introduce you to the Prokaryotic immune system.
This definitely is a major breakthrough in scientific research and has been creating a buzz all over.
In the microbiological community, this immune system is termed as CRISPR Cas-9.
CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats, which is a series of short repetitive sequences in the bacterial genome which helps bacteria fight foreign elements of intruding viruses.

So how does it work?
This system is very similar to the adaptive immune system of humans. Bacteria store remains of a virus, which previously infected them as an antidote. These antidotes are nothing else but CRISPR sequences in the form of CRISPR RNA, representing the enemies the microbe encountered throughout its life span. So the next time when a virus attacks the bacterium, the CRISPR Cas9 will elicit an appropriate response. The small RNA molecule directs the Cas9 enzyme to the specific DNA sequence, where it chops the viral DNA preventing its replication.

How is this system integrated?
This system has paved way to the technique of gene editing. Scientists have recently discovered that Cas9 enzyme "guides" the RNA molecules into the cells, where these molecules cut the cell's genome at desired locations. In this way, they can remove or add new segments of DNA, anything without limits, although ethical issues are a major concern as well.

Latest applications of CRISPR -
CRISPR has allowed scientists to eliminate HIV in mice, activate genes from promoters and enhance the editing of human primary cells etc.
So, if you start brain storming, you can probably discover another application of CRISPR and contribute further in this breakthrough scientific discovery.

- ***Crisper fries will not help your defenses! (even though you are not a prokaryote)***
- ***Flashback of enemies helps in defending the hero.***
- **Who else loves their immune system? Antibody? Antibody?**

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Quasispecies

Esha Bansal **Snigdha Bhattacharyya** **Moumita Sengupta**

FYBSc 2017-18

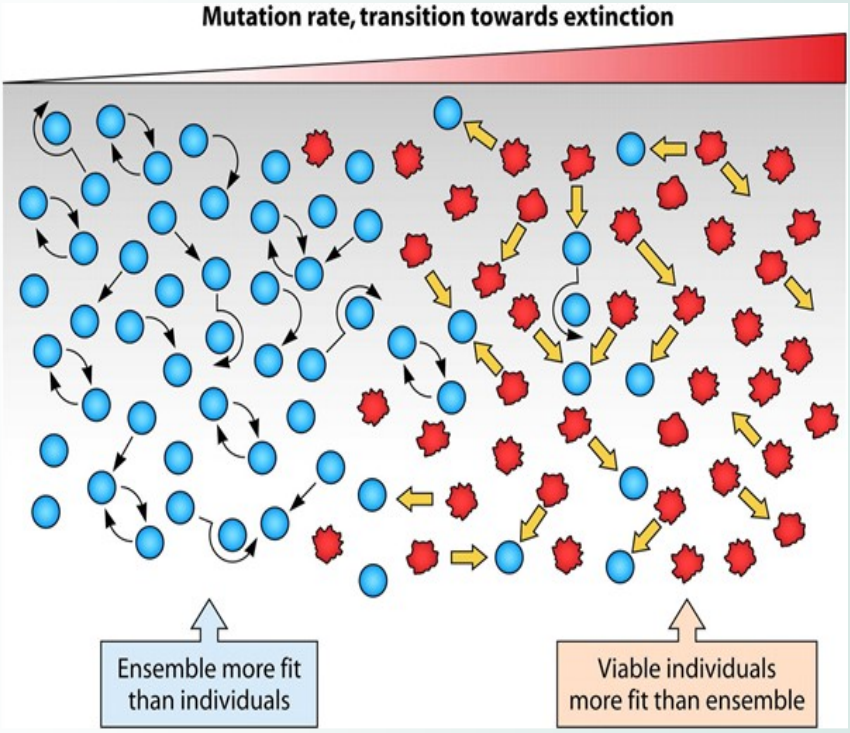
Hepatitis, HIV, H1N1…these words do ring a bell, don't they? And what exactly are these? They are names of a few viruses, and being microbiology students, we are quite familiar with the term 'Virus' and other related terminologies. But are we not missing out on the recent diversification of virology?

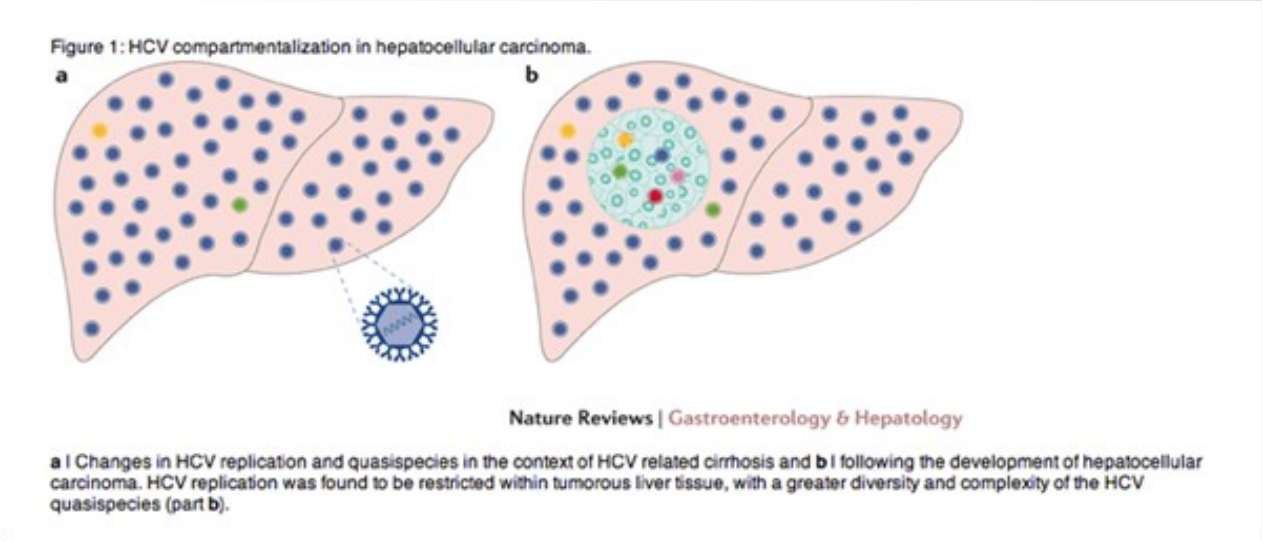
Until the late 1970s, the diversity of viral populations was not widely appreciated. The first study to quantitively describe viral diversity employed **RNA bacteriophage Q-beta**. The authors of this study have made a striking conclusion, based on their analysis of variation within populations of viruses. It was seen that the **Q-beta phage population showed a high rate of mutation as well as a strong selection during the process.** The mutation rate was more of a weighted average than that of each individual phage.

Virologists now understand that viral populations are not made of a single member with a defined nucleic acid sequence, rather they are dynamic distributions of nonidentical but related members called **'quasispecies'**. So, how do we describe quasispecies (or rather, how do researchers describe quasispecies)?

Martin A. Nowak described quasispecies as a **well-defined distribution of mutants which is generated by a mutation-selection process.** Selection does not act on a single mutant but on the quasispecies as a whole. More recently, viral populations have been called quasispecies to indicate their **extensive genetic heterogeneity**. The significance of the quasispecies model for virology is that if the mutation rate is sufficiently high, selection acts on clouds of mutants rather than individual sequences.

An RNA virus population does not consist of a single genotype, rather it is an assemblage of related sequences named quasispecies. **Quasispecies arise from rapid genomic evolution, powered by the high mutation rate of RNA viral replication**. While the high mutation rate is dangerous for a virus because it results in nonviable individuals, it has also been hypothesized that high mutation rates create a "cloud" of potentially beneficial mutations at the population level, which provide the viral quasispecies with a greater probability to evolve and adapt to new environments, as well as with the ability to face challenges during infection. More importantly, mathematical models predict that the viral quasispecies is not simply a collection of diverse mutants, but a group of interactive variants, which together contribute to the characteristics of the population.





What did the chronic HCV tell the young HCV?
You are acute infection.

Why did the virus fail the Pathogenic Advantage Test [PAT] by Professor X?
Quasi he was not a mutant!

What is HIV's anthem?
I am all about that CD4, CD4, CD4 cell! All trouble!

From this perspective, viral populations, rather than individuals, are the target of evolutionary selection.

Recent Research Work Related to Quasispecies:-
In science, what is the value of facts without proofs and experiments? As intriguing as it sounds, quasispecies has been a hot topic of discussion in the research field for some years and its vast scope promises to trigger the grey cells of many more scientists in the future. Quasispecies has been studied more extensively with regards to HIV and HCV.

Research With Respect To HIV:-
Genetic study of the Human Immunodeficiency Virus (HIV) tat gene has been performed using sequential HIV-1 isolates and the corresponding infected peripheral blood mononuclear cells. DNA was amplified by polymerase chain reaction (PCR) and cloned into a eukaryotic expression vector. Comparison of the sequences of the various HIV isolates, showed abrupt differences which were not even reflected in the in vitro samples. These differences were therefore, termed to have arrived due to quasispecies mutation, which is a potential mutation of the 'cloud'. These complexities make the task of defining HIV infection, in molecular terms, even more difficult.

Recent Research on HCV:-
Viral mutations occur over time in Hepatitis C virus (HCV) populations *in vivo*. Sequencing of multiple recombinant clones generated from PCR-amplified products demonstrated that the degree of heterogeneity, of two regions of the HCV genome within individual plasma samples from a single patient, was consistent with a quasispecies structure of HCV genomic RNA.
An example of the significance of quasispecies is seen in acute HCV infection. Herein, the isolates develop little genetic diversity in a region where they produce self-limited hepatitis, whereas they develop greater genetic diversity in the onset of persistent infection. Thus, the dynamics of quasispecies evolution during acute infection may reflect the future course of infection. HCV variants also can be used to prove linkage of infections that are associated epidemiologically.

Conclusion:-
As seen from the above discussion, quasispecies have made a distinct mark in the microbial world. It has not only given a new meaning to mutants but has also provided us with the potential knowledge needed to invent more effective synthetic drugs against HIV, only once the codons involved are well understood. And who knows, maybe one day, one amongst us might hold a patent for this life changing drug.

If Darwin's theory was Survival of the Fittest... then William carpenter's theory should be Survival of the Flattest (earth).

What did one amino nucleotide say to the other imino nucleotide? Why do you want to change meee!

Mesmerizing Microbiology!

Swanandee Nulkar
FYBSc 2016-17

An under-cooked cake, will certainly make you ill..
Then a crude syrup you take, or just gobble down a pill ?

By far in a day or two, you should be fine,
Or rushed to the hospital, if your fever runs a hundred over nine!

Once back on your heels, if it doesn't cross your mind,
To look into your cells, for the trouble makers you outta find..
Then my friend your curiosity, has been flushed down the drain,
If you no naught, how to work up your brain..

For if Fleming hadn't thought, what made one ill?
You probably would've ransacked a house to pay your doctor's bill.

But now you surely know, what exactly is the mystery,
Guided by the great minds, looking through history.

Microbiology - Louis Pasteur's the Father,
And if you don't agree well think; would you just rather..
Go without anti-rabies immunisation?
Perhaps suffer bad wine or lack Pasteurisation?

So put on your lab coats, wash the slides dry,
Microscope atop the table, peering through to further pry.

Funny little things you'd see, in all shapes and sizes,
Astonished you would be to know , they indeed are your vices!

There on, every smear, every loop, and every rack full of suspensions,
Should pose your thoughts into an inexhaustible list of questions.

Are viruses ever really dead?
How are Staphylococci fed?
Will there ever be a single best antimicrobial?
Could the bacterial count proceed over 12 factorial?

And you might, as you probe deep, come across things, that give you a creep!
Like a fine specimen of repulsive green fungus on crates..
Or perhaps maggots infected petri plates!

Every now and then in the lab you'll find, someone of a weird kind,
That'll obsessively arranges pipette tips, or hastily puts on stage clips.

From disinfected table tops, to phenyl treated sweeping mops,
Here, asepticity is the rule, follow that.. don't be a fool!

And the next time someone says, microbiology is too much pain..
Shove them in an autoclave,
Trust me the attempt won't go in vain.

I can EAT anything - Microbe!

Savannah Baptist
FYBSc 2016-17

Plastic! Plastic everywhere! Wherever you go, you see materials made of plastic, right from storage containers to toys to vehicles. It is used in many products due to its structural versatility. But what happens when the need to dispose off this material arises? Owing to its slow degradation, plastic waste builds up and begins to accumulate over years.

On an average, it can take a plastic bottle about 1000 years to degrade because of its structural complexity. Since plastic degradation is not a fast process, plastic starts accumulating and consuming space. It is a known fact that when plastic is heated, it release toxins. According to the New York Times, the production of plastic is about 300 million tons globally. **In India, 15,342 tons of plastic is produced daily.** Hence, a solution is needed to help degrade plastic faster!

There are chemical and physical processes involved in the degradation of plastic such as Thermo-Oxidative Processes, Mechanical Processes, Ultrasonic Methods, Hydrolytic Environments, Photo-oxidative Methods and other chemical methods but these methods may have undesirable effects on the environment and are quite expensive. With the help of advanced scientific research leading to the discovery and identification of new microorganisms, it has been found that plastic can be degraded by microorganisms too!

Microorganisms are diverse in nature and they encompass several different fungi, bacteria etc. More fungi have been found to degrade plastic in comparison to bacteria. In a study, a polyester PU foam was buried for 28 days, which served as the only available carbon source. The organisms involved in this degradation were isolated and identified and were found to be from the genera *Emericella, Trichoderma, Aspergillus, Fusarium, Gliocladiumc* and *Penicillium. Geomyces pannorum* was found to be the predominant fungus involved in degradation of the polyester PUR (polyurethane). The other genera of fungi, including majority of the organisms found in soil for the degradation of polyurethane were *Plectosphaerella, Nectria, Neonectria, Phoma* and *Alternaria*. Some bacteria that can degrade polyester in vitro, utilize PUR as their carbon source. These bacteria have been identified and belong to the genera *Pseudomonas, Comamonas, and Bacillus. Brevibacillus* (thermophile) strain isolated from soil was recovered and was found responsible for the degradation of branched low-density polyethylene. In another study, a culture of *Brevibacillus borstelensis* was incubated along with a polyethylene film.

Results showed a massive 30% reduction in molecular weight of the polyethylene film. It is easier to use micro-organisms for degradation, as cultures can be grown within 24 hours

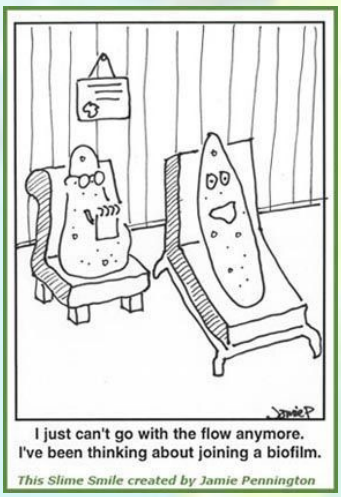
Background picture source: http://www.theinertia.com/environment/ocean-microbes-might-be-evolving-to-break-down-plastic/

of incubation and then inoculated in the waste pile.

Microorganisms degrade plastic using a mechanism called **enzyme degradation** which is a component of the plastic waste treatment process. The enzymes secreted by these plastic degraders are high molecular weight complex proteins with hydrophilic groups such as -COOH, -OH, and $-NH_2$. The process of enzymatic degradation of polyethylene involves two steps: primarily, there is an interaction of the enzyme and its substrate, that is, the enzyme binds to the polythene. After binding, the enzyme proceeds to catalyze a hydrolytic cleavage. The depolymerases, both intracellular and extracellular that are present in bacteria and fungi assist in degrading polythene. The short chain oligomers, dimers and monomers formed by the disintegration of the complex polymers, pass through the bacterial membrane and act as sources of carbon and energy for the cell. This process of disintegration of the polymers is referred to as **depolymerization.** Mineralization is the process in which the end products formed are carbon dioxide (CO_2), water (H_2O) or methane (CH_4).
Several factors such as temperature, pressure and moisture assist these enzymes and other metabolites produced by the microorganisms to induce the digestion process by mechanically damaging the polymers. Enzymes are present in all the organisms and are produced in varying quantities. They are also very specific in nature. *R. ruber* is involved in biodegradation of polyethylene, whereas **papain and urease** which are proteolytic enzymes, were found to **degrade medical polyester polyurethane**.

Biofilms are another microbiological component which help in plastic degradation. The basic deterioration of polymeric materials is caused by the adherence of microorganisms that colonize the surface of a material forming a *biofilm*. The formation of a biofilm is a prerequisite for substantial corrosion and deterioration of materials to take place. A biofilm is a slimy layer, primarily composed of water and extracellular polymeric substances, where bacterial cells are found encased in a hydrated matrix of polysaccharides and proteins. Biofilms break down the structures of synthetic polymeric materials using several mechanisms, like by coating the surface, masking the surface properties, contaminating adjacent media such as water, leaching additives and monomers out of the polymer matrix, the attack of enzymes or radicals of biological origin on the polymers and additives, all of which lead to both embrittlement and loss of mechanical stability.

- Getting out of a Pla-STICKY situation!
- Did you hear about the recycling triplets? Their names are Polly, Ethel and Ian.



Can an antiviral state be created in a cell infected with smarter viruses? Yes!!!

Tracy D'Silva
SYBSc 2016-17

In this ruthless race between survival of infectious organisms and their destruction by drugs, it is surprising to know that bacteria and viruses have become the torchbearers of this contest. They are leading this race by being the most difficult ones to be killed by gaining resistance towards drugs.

One such recent example is the ***Herpes simplex viruses* (HSV)**, which has gained resistance towards antivirals that were targeted towards the virus's DNA polymerase. To prevent pathogens from gaining further resistance and becoming even more dangerous, many methods are being designed. Recently, a cure for this has been formulated, which works on the fact that some DNA viruses like HSV, Human cytomegalovirus [hCMV], adenovirus 5 [Ad5], as well as other unrelated RNA viruses, like Zika virus [ZIKV] etc follow **epigenetic regulation**.

This epigenetic regulation (i.e. productive infection, persistence and latency of the viruses) is determined by observing the modulation of chromatin associated with viral genomics.

A virus which was responsible for creating a havoc by causing an infection was the *Herpes simplex viruses* (HSV). It was the cause for a wide range of problems, like mild lesions and severe ocular and neurological damage. HSV, as mentioned above, can undergo epigenetic regulation wherein the virus hides within the neuronal endings and undergoes latency. According to published literature, LSD1 and JMJD2 families of histone H3K9 demethylases were the chromatin tools required for epigenetic regulation, for which inhibitors were created. This lead to suppression of the spread of HSV infection and reactivation of those latent viruses which had a higher chance of coming in contact with the individual's innate immune system.

In the quest of similar chromatin tool targets, researchers came across cancer biology studies, where histone H3K27 methyl transferases EZH2 and EZH1 (also known as EZH2/1) confirmed the presence of a component known as **Polycomb Repressive Complex 2 (PRC2)** within them. This complex is responsible for modulating histone marker genes (H3K9me3 and H3K27me3). These genes enable the transition to either an active state or a repressed state, which depends on various other environmental signals. Inhibitors for EZH2/1 act as potential therapeutics for the treatment of cancers which were caused due to mutations of E2H2.

Hence, this theory gave us a push towards the study which lead to the realization, that

EZH2/1 PRC2 complexes are involved in the regulation of the lytic-latency cycles of the herpesvirus family, including HSV. When a cell is infected with HSV, its genome is assembled into chromatin structures that initially exhibit both the histone markers H3K9me3 and H3K27me3, which are known to establish and maintain latency of HSV sensory neurons. Inhibition of either of these components involved in these cycles (such as HCF-1-associated H3K9 demethylases or the UTX/JMJD3 H3K27 demethylases) prevents productive viral reactivation. This indicates that EZH2/1 is a suppressor agent, hence it does not allow reactivation.

But if the inhibitor is developed against the suppressor agent EZH2/1, it will result in no inhibition. This will lead to reactivation of the latent virus which will be killed by the soldiers of our body (the immune system), leading to reduced HSV gene expression and lytic infection. According to studies carried out on the component inhibitor, it was deduced that it did not induce reactivation, rather it suppressed the spread of viral reactivation in a ganglion explant model; investigation regarding the mechanisms is still into play.

Hence to sum up, I would like to state that antiviral activities of these inhibitors have shown that treatment with these antiviral constituents facilitates multiple components of antipathogen pathways, which result in an enhanced cellular antiviral state. More importantly, the antiviral effects are not limited to only HSV, but also extend to other representative nuclear DNA viruses (human cytomegalovirus [hCMV], adenovirus 5 [Ad5]), as well as unrelated RNA viruses like Zika virus [ZIKV]). Nowadays, many studies are mostly focused on breaking the latency period of the viruses and bacteria like that of HIV viruses etc. Hence, a lot of focus is on remodeling of the available information to obtain a new weapon to defeat our infectious enemies.

Do panic, Its synthetic!

Anasruta Das
FYBSc 2017-18

A breakthrough discovery in the scientific community occurred earlier this year, it was based on the research conducted on DNA base pairs and sequences. Scientists at **The Scripps Research Institute (TSRI), USA,** managed to create a new bacterium which harbours not only the four universal nitrogenous bases of DNA (namely A, T, C, and G), but also two fully functional and chemically synthesized base pairs—X and Y.

This new organism is stable enough to hold on to the base pairs as it divides. The significance of such a discovery is huge, the horizons of which we still have to fathom. The genetic alphabet that codes for all our biological functions was limited to only four bases which formed two base pairs. With development of the new nucleotides (from here on, referred to as **'alien base pairs', Unnatural Base Pairs or UBP**), the amount of genetic information stored in the DNA increased manifold. Drs Zhang, Lamb and Rosemberg, chief authors of the paper about the above mentioned research, had conducted studies previously on the alien base pair.

The expansion of the genetic alphabet with two synthetic alien nucleotides that selectively pair to form a UBP would increase the information storage potential of DNA, an immense leap in scientific discovery. In their abstract, the researchers state that *Escherichia coli*, a prokaryote, was previously made to grow in an environment of unnatural nucleoside triphosphates dNaMTP and d5SICSTP (as nucleosides or purines and pyrimidines act as growth factors for several micro-organisms) as well as were provided with the means to import them via expression of a plasmid-borne nucleoside triphosphate transporter.

In the beginning, records show that the nascent semisynthetic organisms (here on referred to as SSOs) died quickly and could not hold on to the UBPs as they multiplied. Fortification of such a mechanism was done by bioengineering the transporter involved and using a more chemically optimised UBP to harness the power of bacterial immune response using a gene editing tool named CRISPR-Cas9. Being extremely popular for its use in human genome experiments—the researchers took advantage of the original role of CRISPR in bacterial systems and designed the microorganism to recognize a genetic sequence without X and Y as "foreign". A cell which did not contain X and Y after cell division would thus be marked and get destroyed by immune responses, leaving the researchers only with organisms that could hold on to the new bases. Their SSOs were able to keep X and Y in their genome after dividing 60 times, thereby leading to the belief that the SSOs can hold on to the base pairs indefinitely.

In the first few experiments, the synthesis of the SSO was grounded in solid theory and the development of one would imply proof of such a theory. The generality of the expanded genetic code (i.e. more than the four genetic bases known initially) remained unclear as the research of UBPs took place at a single locus in a single DNA sequence. Although the expression of such nucleosides was made possible via the nucleoside triphosphate transporter mentioned earlier, the expression of such UBPs resulted in suboptimal performance of the bacterium and showed lower work efficiency when compared to the parent strains.

Another reason for lack of viability of the first few experiments was that the retention of UBPs was not possible in high-density growths or growth on solid media, seemingly due to release of phosphatases which degraded the chemically synthesised UBPs.

The transporter in the first SSO was expressed from a T7 promoter on a multi-copy plasmid in *E.coli* C41(DE3) and its toxicity was carefully supervised in controlled induction. In its native algal cell *Phaeodactylum tricornutum*, PtNTT2's N-terminal signal sequences direct its subcellular localization and are ultimately removed by proteolysis. PtNTT2 derives its name from plasmid-encoded nucleoside triphosphate transporter (NTT2) and Pt from its location of origin. In *E coli*, due to PtNTT2 primarily, the retention of the UBPs, the successful import of the unnatural triphosphates and replication of a single dNaM-d5SICS UBP on a second plasmid were seen.

From the next set of observed organisms, strain YZ3, which expresses the codon-optimized chromosomally integrated PtNTT2(66-575) which is the engineered transporter, exhibited an optimal compromise of robust growth and was selected for further study. To check for retention of UBP in YZ3, reconstruction of 3 plasmids was carried out. When compared with the original organism from the first few experiments (which did show variable levels of retention and reduced growth, especially with the high-copy plasmids), strain YZ3 showed uniformly high levels of UBP retention and robust growth with all three UBP-containing plasmids.

To further study the efficiency of the SSO, development of strain YZ4 was carried out by integration of IPTG-inducible Cas9 gene at the *arsB* (arsenical pump membrane of *E coli*) locus of the YZ3 chromosome, which allows the use of a single plasmid that carries both: a UBP and expresses the sgRNAs (single-guide RNA, useful in the process of Cas9's gene editing) which enforce its retention. Despite variable levels of retention in the absence of Cas9 (YZ3) and with induction of Cas9 expression in YZ4, loss was minimal to undetectable in 13 of the 16 sequences under consideration.

In the last set of experiments conducted, induced immunity within the strain YZ4 (in which YZ3 was held as control, Cas9 was absent and UBP retention decreased steadily as predicted), the increased immunity (20 or 40 μM IPTG) showed 100% retention of the UBPs.

Ever since the beginning of life itself, all the coded genetic information has been stored under the lock and key of the four ubiquitous alphabets denoting the bases. By the combination of chemosynthetic technologies, immunological engineering and autonomous SSO, the capacity to store information within a man-made three base pair DNA was made possible. With a now virtually unrestricted ability to maintain this increased capacity to hold information, the optimized SSO provides a suitable platform for efforts to retrieve the increased information as well as create organisms with wholly synthetic attributes and traits not found elsewhere in nature.

Ice Forming Bacteria

Mubasshira
SYBSc 2016-17

Bacteria are found everywhere; from deep inside the ground in soil, to high up in the sky in clouds. They play a very important role in our lives. Interestingly, they also contribute majorly in the formation of ice. **They induce the formation of ice by changing the order and dynamics of surface water molecules.** We all are well aware of the fact that the freezing point of water is 0°C. However, small droplets of the purest form of water freeze at an extremely low temperature of -37°C. Crystallization of ice by bacteria requires the synthesis of ice forming proteins on their surfaces at just under 0°C.

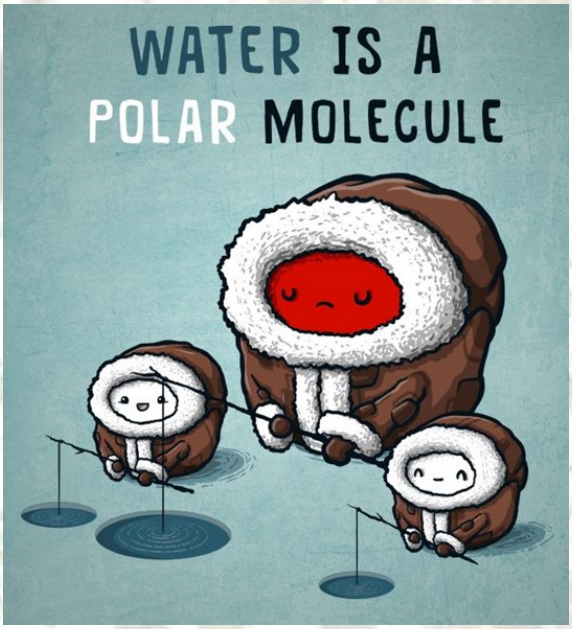
In one of the researches at Max Plank Institute for Chemistry and Polymer, the molecular mechanism of how proteins congeal with water molecules has been explained. Proteins create orderly structures and remove heat from water. Bacteria also play a key role in the formation of clouds and precipitation: this causes uncertainty in weather forecasting because bacteria being airborne, promote formation of ice crystals in the atmosphere.

Max Plank researchers have now unravelled the interactions between water and protein sequences on bacterial surfaces. Ice-active bacteria influence the order and dynamics of water molecules along with causing frost damage on the surface of plants. Crystallisation and condensation nuclei are formed when they are carried by wind; this in turn influences the hydrological cycle due to formation of rain and snow. However, the spread of bioactive aerosols in the atmosphere and their impact on the formation of clouds is an intensely discussed topic in the current climate and Earth system research. An example of ice-active bacterium is *Pseudomonas syringae.* It is one of the most widely dispersed species on the planet found in the atmosphere; mainly in the troposphere. Amazon rainforest houses these species in abundance. It emits large amount of these ice nucleating bacteria which bring about rainfall. Conversely, cutting down Amazon rainforest will reduce the number of these ice nucleating bacteria, which could result in inadequate rainfall and dry weather conditions.

To understand how *P. syringae* accomplishes this, a technique called **Spectroscopy** is used, which analyses the vibrations of both bacterial and water molecules. This technique can reveal which

molecules are present and how they are arranged in a given sample. It was found that the water molecules which were in contact with *P. syringae* arranged themselves in a more orderly fashion as compared to other water molecules which were in contact with some different bacterial species.

Thus, it would be safe to assume that this orderly arrangement contributed to an increase in the bacterium's freezing abilities. This bacterium has the ability to trigger the formation of ice in water droplets, beginning from just -2°C. It is used for the production of artificial snow because of its high ice nucleating ability. Its commercial product is commonly known as **"SNOMAX"**. Thanks to this new finding, it is now possible to imitate the bacterial ice nucleating mechanism and use it in various fields. It has now also become achievable to produce artificial nano-structural surfaces and particles to selectively influence and control the formation of ice.

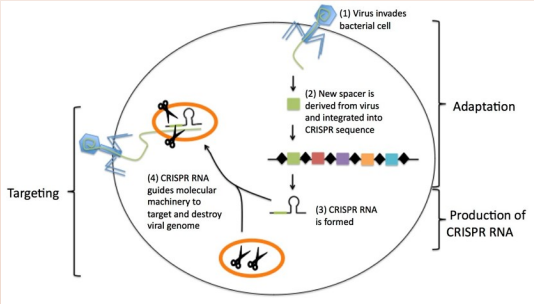


Background picture source:https://www.gardeningknowhow.com/plant-problems/environmental/hard-frost-information.htm

CRISPR-Cas9

Mathew Salazar
FYBSc 2017-18

Genome editing allows insertion, deletion and replacement of DNA in the genome of a living organism, using engineered nucleases or "**molecular scissors.**" These nucleases create double-stranded breaks at specific sites at desired locations within the genome. These induced double-strand breaks

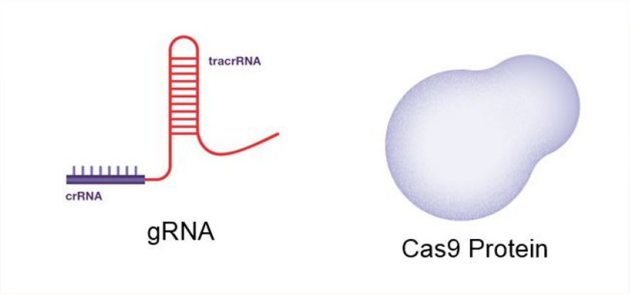


are repaired by the repair machinery of the cell. CRISPR (**Clustered Regularly Interspaced Palindromic Repeats)** technology was discovered during the course of a basic research project, which was aimed at finding out about the various bacterial defence mechanisms against viral infections. Many bacterial cells have an adaptive immune system called CRISPR, which allows them to detect viral DNA and destroy it. When a virus infects a cell, it injects its DNA into the host organism. This system then allows the viral DNA to be inserted into the host cell's chromosome at a site called CRISPR.

In bacteria, CRISPR loci are composed of a series of repeats, separated by segments of viral DNA called **spacers**. A number of genes called **Cas genes** are associated with CRISPR which synthesize Cas proteins. Cas proteins in general, are helicase proteins that unwind the DNA strand and nucleases that cut the DNA. This adaptive immune system allows cells to keep a record of the viruses that have attacked them in the past.

These bits of viral DNA are passed onto the cell's progeny, protecting it from the virus over many generations, thus allowing it to keep a record of earlier infections too. Once these bits of DNA have been inserted into the bacterial chromosome, the RNA, called **crRNA** gets transcribed from the viral DNA. This crRNA associates with a protein called **Cas9,** and forms a complex which searches the entire genome of the cell, to find sites with sequences that are complimentary to that of the RNA. Once the sequence is found, this complex binds to that DNA sequence and the viral DNA is cut by the Cas9 cleaver by making a double stranded break in the DNA helix. It is similar to the way we use a word processing programme's **'Spell Check'** to fix a typo in a document.

CRISPR-Cas9 in Genome editing



Scientists have realized that they can harness this mechanism as a tool in genetic engineering, which allows the deletion and insertion of DNA with great specificity. The CRISPR-Cas9 system consists of a **guide RNA (gRNA)** that has two molecular components: a target-specific CRISPR RNA **(crRNA)** and a **tracrRNA**. The gRNA unit guides the Cas9 protein to a specific sequence in the genome through base pairing between the crRNA sequence and the target sequence. After binding to the target sequence, a specific double-strand break is induced by the Cas9 protein.

This break is then repaired by the cellular repair machinery. Because of its high specificity, the CRISPR-Cas9 system greatly simplifies genome editing. It serves as a remarkably easy system to be used in comparison to the other genome editing technologies. It serves as a more feasible option and has already been used to change DNA in the cells of mice, monkeys etc. It has been used to change genes in some human embryos also. After CRISPR's discovery, newer applications of gene editing in plants and animals have come up. A few such examples are stated below:

1) **Citrus Fruit:** Scientists at South Carolina's Clemson University are utilizing the CRISPR mechanism to create disease resistant citrus trees.

2) **Goats:** Chinese scientists have applied CRISPR to suppress the gene that regulates hair growth in Shanbei goats. These goats have high commercial value due to their high quality wool. The CRISPR system has tripled fur production in these goats as compared to their counterparts.

3) **Monkeys:** Scientists in China are utilizing CRISPR to create monkeys, who can mimic a variety of human diseases like muscular dystrophy, cancer etc., thus paving way for finding cures for many more diseases, without the problem of endangering human lives.

The use of CRISPR-Cas9 offers enormous options for the enhancement of human health and its well-being. This system is being researched for a variety of human diseases, including cancer and HIV infections. The benefits of CRISPR-Cas9 are still being evaluated skeptically, owing to its newness. It does entice us with the option of an affordable platter, which is undoubtedly full of resolved issues and promising solutions for the future but risks of its potential misuse and other unforeseen consequences cannot be neglected completely.

How to write a scientific paper

Abel Mathew Abraham
SYBSc 2016-17

Title: Write a title that is similar to those found in fairy tales. But, do not write a title found in fairy tales because we're scientists (confused?).

Authors: This is where you write your cute nick name that your mother, friends or your significant other gave you, eg. Shona, Sugar, Honey etc. You also mention Google and Wikipedia without whom you couldn't have studied for your research (Professors..?).

Abstract: Over here, you mention your life's work on the topic in brief. It should definitely include the time you've wasted on Facebook, watching TV, sleeping during lectures, worshipping YouTubers, how you've slogged for years to get admitted into Xavier's and also some spoilers on what to expect from your paper.

Keywords: This is where you'd include words like jargon, Jargon, jArGoN, J.A.R.G.O.N. and more jargoN that have been frequently used in your highly non fairy tale-ish research.

Main text: Use the **Indian Method of Rona and Dhona (IMRAD)** format to write the main text because there is no better way to write anything (Yes, I'm referring to the way you write a 2 page answer filled with nonsense when you need those 3 marks badly).

⚜ **Introduction:** This is where you write what motivated you and why you researched on your topic (Hint: Marks, LOL). You should address your initial hypothesis about how Jon Snow is not related to the Starks and how Hermione ended up with Weasley, stating sound scientific facts and citations to fan theories as needed. Your introduction should at least be compelling and easy to read to a 5 year old who has just learnt to read because kids these days know everything.

⚜ **Methods:** Here you describe, in detail, the various methods employed in your research like "that one technique that took so much time to google but you're never going to remember it again" , "that other medium which was probably named after MacDonkey" , "that medium which lies to you by saying that it's made of chocolate" etc, mentioning the composition like pixie dust, Sauron's ring, fake chocolate, the percentage of apathy towards your topic and the number of hours you spent pondering why people would lie about adding chocolate in a medium.

⚜ **Results:** No, you don't have to mention your GPA here. No one cares.
You just have to mention the degree of misery you were in after spectacularly failing in finding anything. It'd help to include pictures of yourself crying on someone else's shoulder, crying in the bathroom, the feel graph, hate memes and a poster that says "Knowledge is Power" (A figure is worth a thousand words).

⚜ **Discussion:** Are you sure you want to discuss your failures? Don't think so.

Conclusion: At this point you might've concluded that if only you hadn't bunked those SCS lectures, had wasted less time playing Pokemon GO, thought twice before taking science or hadn't been born, you would've saved yourself from a lot of misery.

Acknowledgements: Mention the "real heroes" who helped you write this paper and your research. J.K. Rowling, Stan Lee, E.L. James (oops!) are some of the common mentors for sound scientific guidance. Also mention those random YouTube videos which helped you through your depression.

References: Your references should be in the correct format which should look something like, www.google.com; en.wikipedia.org; bulbapedia.bulbagarden.net.

Note:

- If it wasn't evident enough earlier, this piece of literature is built on sarcasm.
- The guidelines mentioned here shouldn't be followed to the point.
- There are some minor (or major, depends on the point of view) spoilers for certain shows and books included.
- To make it clear again, do not follow any of the guidelines listed and try paying attention during your SCS lectures.

Did you know you can store a movie into bacterial DNA!

Tinci Thomas
SYBSc 2016-17

On 13th July 2017, a team of scientists led by Seth Shipman, a post doctoral fellow in genetics at Harvard Medical School, successfully inserted a short film into the DNA of a live bacterial cell.

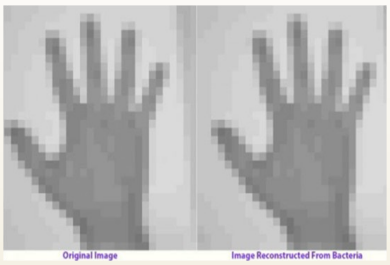
One can call it the smallest movie ever made. The image that was used for this mini movie was a GIF, consisting of a 5 frame animation of a galloping horse named Annie' G. This image was taken by the pioneering photographer 'Edward Muybridge' in late 1800s from his photo series 'Human and Animal locomotion'.

Shipman said, "DNA has a lot of properties that are good for archival storage. It is much more stable than silicon memory if you want to hold something for thousands of years". **He wanted to turn cells into historians.**

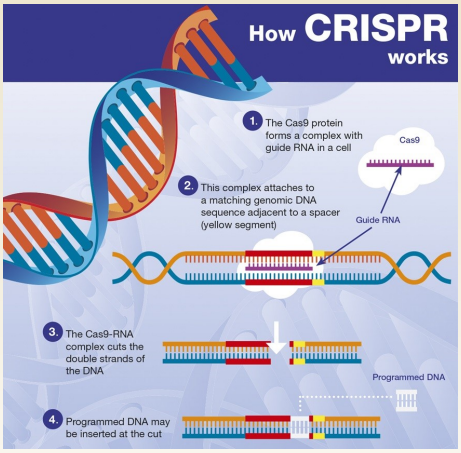
Inorder to insert this information into the bacterial genome, each frame was broken down into36×26 pixels. Each pixel was denoted by nucleotides A, C, T and G, the building blocks of DNA, where each nucleotide was given a different colour code. They also included a code to indicate where each pixel belonged to in the frame.

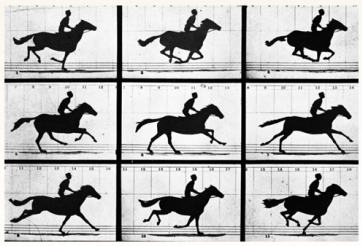
Scientists ventured into this journey by using the static image of a hand first, after which they successfully inserted a movie into the bacterial genome. They encoded one image into the nucleotides of live bacteria (original) and the other image was recovered by sequencing the bacterium's DNA. After succeeding at this, they encoded the horse GIF, which was an even more challenging task.

In the end, each frame had 104 DNA sequences .They followed the procedure of electroporation to embed various bacterial cells. Essentially, they destroyed the cells with application of high voltage, which allowed the opening of membrane pores, facilitating the entry of the synthesized DNA into the cells.



I could write a joke about CRISPR, but it might get edited ;)



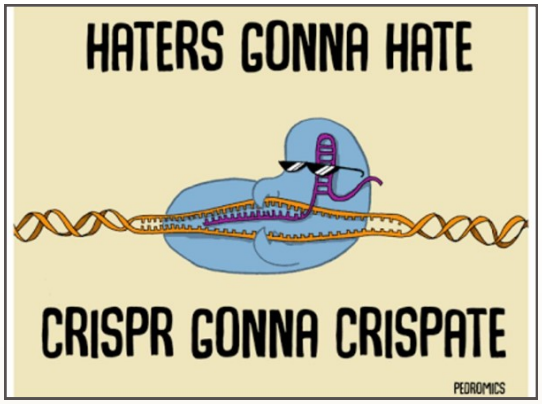


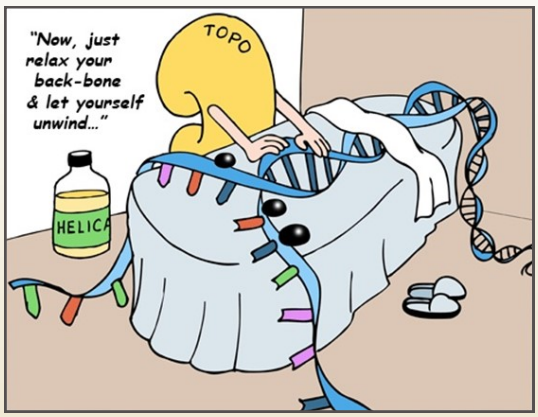
Researchers used CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) which is an emerging gene editing tool, to inserta horse GIF into bacterial cells.**CRISPR is a family of DNA sequences in bacteria that contains bits (small pieces) of DNA, also known as snippets from viruses that have attacked the bacterium**. These bits are in turn used by bacteria to detect and destroy DNA from future attacks by similar viruses. This forms an intrinsic part of the bacterium's defense system and the basis of CRISPR, the novel gene editing technology.

The CRISPR-Cas9 system consists of two key molecules that bring about a change in the DNA. It makes use of an enzyme called Cas9, which acts like a pair of 'molecular scissors'. Cas9 can cut the two strands of DNA at a specific site genome, with the help of which parts of DNA can be added or removed. It has a piece of RNA called guide RNA (gRNA), which is made up of a 20 base long pre-designed RNA sequence. This pre-designed sequence 'guides' Cas9 enzyme, ensuring that it makes cuts at the correct position within the genome.

"One day, we may have the capacity to follow all the decisions that a differentiating neuron makes from an early stem cell to a highly-specialized type of cell in the brain, leading to a better understanding of how basic biological and developmental processes are choreographed." said Shipman.

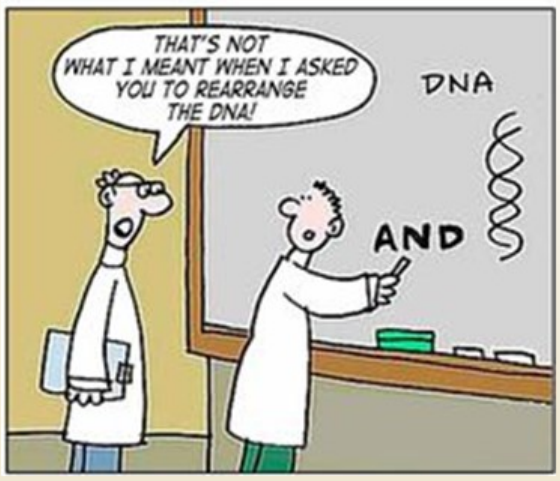
The ultimate goal of our scientists is to test CRISPR's potential to treat diseases in humans. Scientists are optimistic about retrieving significant data from clinical trials, which will further aid in recoding genes. Cells can be genetically modified to fight diseases like cancer with the help of CRISPR.

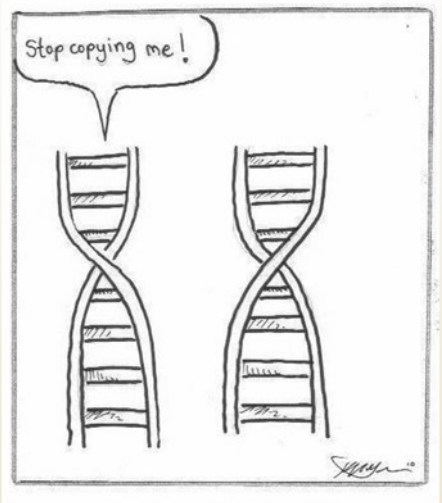




Its potential is not only being studied for cancer, but also for genetic disorders like sickle cell anemia, type2 diabetes and Alzheimer's. Studies like these, in combination with development of tools like CRISPR, serve as a promising step towards a healthier, happier future.

Cell about to undergo mitosis to an interested geneticist: "I hope I have your divided attention"





Relating Pokémon To Microbes

Kartikeyan Premrajka
FYBSc 2016-17

As a microbiology student, I believe I am sufficiently authorized to make a remark that the complexity in characteristics of microbes is difficult to understand and accept. This is mainly because of the huge similarities between species and the stark differences between strains.

Then what should we do to understand these characteristics? The answer sounds too silly but simple. We can relate microbial features and draw parallels with anything that we like or find easy to remember.
Pokémon is one such analogy which is quite interesting. For instance, Rhizobium sp. can be easily classified as a ground/grass type Pokémon, like Torterra, as it is a soil organism which is found to be in a symbiotic relationship with plants. Doesn't it sound quirky yet entertaining? Here are a few more examples for all my geeky friends out there:

The Volcanion:
Quite similar to the Water-Fire dual type Pokémon is our friend, the prokaryote Thermus aquaticus. Found in Yellow-Stone National Park's hot water geysers, this microbe is a thermophile as it can survive in very high temperatures (up to 150 degrees Celsius). Hot water and steam have no effect on it unlike most microbes, making it one of the most robust microbes to be found. It is also used to make Taq Polymerase for PCR as the polymerase does not denature at high temperatures.

Poisonous Guts:
Who lives in the gut of peaceful bovines? Methanogens! They help in the digestion of cellulose symbiotically in the rumen of cattle, resulting in the release of a lot of methane, which when inhaled in high concentrations can be poisonous to humans. Cellulose is converted to easily digestible starch and other simpler carbohydrates along with the release of methane as a by-product, which the cow then burps or farts out. This weird combination of a poison and gas releasing microbe resembles Weezing, the poison type Pokémon.

Doesn't it?

Its similarity with the Ghost type Pokémon is uncanny. Haunter is a ghost Pokémon which is notorious for possessing random objects, to give passers-by the scare of their lives, which it thoroughly enjoys.

Microbial possession:
The bacteriophage is a type of virus whose hosts include a wide array of bacteria. It infects bacteria by inserting its genetic material into the host's protoplasm. The injected viral nucleic acid utilizes the machinery of the host cell to multiply and give rise to viral progeny, which ultimately lyse the bacterium. The interestingly noticeable fact here is that, even though the virus is not alive outside the host cell, it still possesses the ability to take control of the host's functioning. One would certainly not want to be "possessed" by these ghosts.

The DNA technician:
Agrobacterium tumefaciens is the bacterium used as a vector for inserting recombinant DNA into plants. Deoxys is the DNA Pokémon. I do not think I need to elaborate more! This was just a gist of how pop culture can help you study remember concepts vividly. So go ahead geeks, there is more information out there which needs parallels to be drawn, be it through your favorite BBC series (perhaps FRIENDS?) or your favorite manga. Who had ever thought that one could use what one loves as a mechanism to enhance learning?

Dark side of Science

Shiva Joshi
FYBSc 2016-17

Within the burgeoning field of science, teams of biologists and engineers are taking great strides in understanding the cell and it's functioning. What was initially perceived to be science fiction, seems to be turning into reality now, constantly challenging us to accomplish what we once conjectured as "impossible."

However, along with these triumphs and achievements, the other side of science needs to be discussed as well. The endless curiosity of the human brain has helped us reach the pinnacle of evolution, but humans have always had the tendency of getting attracted towards something rather destructive too.

Bioterrorism gives a tiny insight into how humans are capable of applying their knowledge to cause destruction. There are accounts; dating back to 6th century that show that as soon as we learnt how to culture bacteria and fungi, we began using them to destroy crops of enemy states. In a relatively recent instance in 2001, 5 United States Congressmen died when they opened letters which were intentionally laden with prepared anthrax spores. This instance led to widespread outrage and by 2011, 165 countries had officially pledged to actively condemn biological weaponry.

There have also been incidents where scientists and doctors have refused to provide diseased individuals with medicines and proper healthcare; just to study the progression of a disease. **Tuskegee syphilis experiment**, which was sponsored by the government in Alabama, is one of the most deceitful and horrifying of the bunch. In the late 19th century, a group of researchers from **The Public Health Service (PHS) of USA** came together to study the effects of untreated syphilis in the black male population. PHS lured 600 men to be a part of their study, on the pretext of "free health care." Out of those 600 men, 399 were affected with varying stages of the disease. Those who were suffering from syphilis were never informed about any of the diagnosis or treatment processes. The study which was speculated to last for just nine months, continued for over four decades; owing to the various breakthrough discoveries the researchers made with respect to the disease. Despite Penicillin being the accepted treatment for Syphilis by 1945, it was not offered to the subjects, as the researchers wanted to observe the progression of the disease; which eventually resulted in the death of over 125 men during the course of experimentation.

Apart from Tuskegee Syphilis Experiment, one of the other infamous instances of scien-

tists disregarding the humane quotient of scientific endeavors is the **Nazi Human Experimentation**, which was a series of experiments where prisoners were tortured, and thousands died during the process.

The ethical dilemma now faced by scientists is whether to use this information or not. While most of such grotesque experiments have little scientific accuracy, some of them have given us immensely valuable scientific data as well. **But, should the pursuit of knowledge be valued over the lives of our own kind?**

Coming to today's scenario, one of the most controversial topics in the field of genetics is the research and development of **Crispr-Cas9 system**, which provides us with tremendous possibilities of further development. While it is a huge breakthrough in the quick treatment of genetic diseases, it also presents us with the possibility of genetically modified fetuses to suit our needs, and possibly result into a genetically superior generation. This can alter the human genome to a great extent and completely change the course of evolution.

We can no longer naively hope that science and its results will be used majorly for public welfare. Hence, to provide a system of regulation, several government and non-government bodies have been set up. There is a sense of responsibility that comes with the freedom of research, and we as torchbearers of science, should be completely willing to accept it; truthfully and wholeheartedly.

Science Beyond Boundaries

Shreeya Tavkari
SYBSC 2016-17

Science has always been dissected into branches such as chemistry, biology, physics etc. However today when cutting edge technology which is built on the principles of some otherwise neglected fields, brings to light its immense capacity to influence our understanding of some of the well-known phenomena, it is clear that an interdisciplinary approach not only holds the power to improve resolution, but also reshape our perspective towards biology. If one looks back in time, one can always find references to such an interdisciplinary approach that was adopted to explain some of the most fundamental concepts in biology.

To begin with, the father of genetics, Gregor Johann Mendel could explain his idea of genes only with the help of biostatistics, which in turn is a branch of mathematics. Another well-known example could be the mechanism of ATP synthesis by the enzyme ATP synthase. Coupling of proton motive force to generate energy is the basis of this system. But for one to truly understand how the subunits of the enzyme catalyse this reaction, picturing the subunits as intracellular motors is important. Understanding the ability of a charge gradient to act as an energy source to drive a motor could be attributed to physics. These are some of the known events that tend to go unnoticed when it comes to the whole concept of interdisciplinary sciences and what they really tell us is that certain phenomena can be understood wholly only if supplemented with the principles of physics, mathematics and of course chemistry.

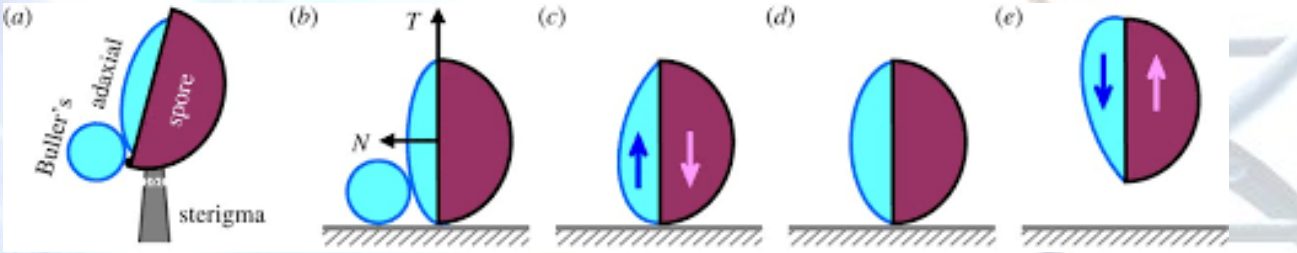
However, what really is different today is that not only are people more aware of the existence of such a field, not only do people realize its importance but they are also interested and enthusiastic about putting a foot forward in this field, which possibly has the potential of changing our idea about science. Today we are aware of the impact that biostatistics has when it comes to the epidemiology of a disease, we are aware of the major role that physics plays in some of our basic analysis systems such as electrophoresis, heavy isotope tagging, mass spectroscopy etc.

And yet most of us seem to harbour the old school of thought that divides science into biology, chemistry, physics etc. Nature sees no boundaries, biology exists only when chemicals work together, and chemicals interact based on some of the most fundamental laws of physics. But to give the readers an insight into the wonders of interdisciplinary sciences I have discussed some of the most interesting findings

Background picture source: https://wallup.net/mathematics-equations-science-3d/

To begin with, a really interesting study that talks about the physics behind spore dispersal in basidiomycetes, has the potential of being applied to bio warfare and contamination studies. However, there is scope for further development in the suggested model for the same. For any spore to be successfully launched, it must undergo two phases; an initial horizontal launch from a vertical gill and then on the bases of the air drag and gravity, it must land on a nearby surface. In order to facilitate this attachment, the exterior of the spore is usually sticky. However for successful dispersal, the spore must achieve this without getting attached to the gill and hence it is launched orthogonally. **The energy required for the process is said to be generated by the surface energy released by the coalescence of what is called as the buller's drop and the adaxial drop.** A small drop that is formed at the tegmental interface (buller's drop) and another drop at the adaxial position of the spore. The adaxial drop slowly grows in size and on merging with the buller's drop, leads to the release of energy and spore dispersal ultimately. In order to explain this adaxial drop formation via condensation, it has been suggested that the spore releases certain hygroscopic substances such as mannitol in the adaxial position of the same. The following diagram might aid one in attaining a better understanding of this phenomenon.

Today, humanity dreams of making bioimplants and biosensors which are possible only with the help of biophysics. This in turn has increased enthusiasm and awareness about the blooming field of interdisciplinary sciences, and to demonstrate progress in this direction, I would like to draw your attention towards the use of melanin in these bioimplants. Melanin is a well-known biopigment which has the ability to bring about semi conductivity and ion transport, making it unique as a semiconductor [The presence of this pigment in the brain therefore makes more sense now as it is believed to help in conduction of electrical impulses in the brain]. Furthermore, it also solves the problem of biocompatibility that any of these silicon implants would otherwise place. If one is able to improve the extraction process of the pigment, it could be made cheaply available, considering that a number of microbes are known to produce melanin. This is yet another uncomplicated application but could play an important role in bioimplants, and infact it is being considered as a viable option in the case of eye implants.



And maybe after all this, there still is some scope for probability and maths when it comes to areas of science such as oncology & immunology. Could one apply the principles of probability to predict the possible outcomes of gene recombination, given the set of alleles that exist on the chromosome (for that individual)? Could this concept give us a better idea about the possible number of oreceptors, i.e TCRs and BCRs that maybe be formed?

To conclude, I would like to say that interdisciplinary sciences not only has led to advanced understanding of biological sciences, but has also played a supporting role to the advancements in technology that today form an elementary level tool in the research and analysis of biological sciences. So, even though the links between chemistry and biology have been known for donkeys of years, those between physics, maths and biology still need to be explored.

Background icture source: http://longwallpapers.com/science-lab-wallpapers-widescreen/

Been there...
Done That...

(alumni articles)

Career prospects in Clinical Research

Roma Khot
MSc Clinical Research Intern
Tata Memorial Hospital
Ex-Xavierite
Batch of 2015

In the past decade, India has become a booming market for the pharmaceutical industry. In view of the growing population and widespread prevalence of diseases such as cancer, diabetes, cardiovascular ailments etc, clinical research plays a key role in the enforcement and development of new drugs to combat these problems.

Clinical research helps determine the parameters of safety, toxicity and efficacy of a new chemical entity. Pharmaceutical companies, Contract Research Organisations(CROs) and Government research grants fund this research, which takes place through patient oriented trials owing to the requirement of a huge amount of manpower and monetary support.

So, one might ask, how to make a career out of this ever-growing field of research?

A Bachelors qualification in any of the Biological sciences: Botany/Zoology/Life Sciences/ Microbiology/Biochemistry is imperative for this course. Medical and Paramedical graduates are also eligible. A one-year (part -time) diploma in Institutes such as Institute of Clinical Research India (ICRI) is available, while a full-time MSc is available in ICRI as well as in establishments like Tata Memorial Hospital in Mumbai.

Clinical research aspirants have a huge arena of work profiles to choose from. Physicians with appropriate training, experience and expertise in their respective areas of speciality are appointed as *Principal Investigators* and they take all the medical decisions in a clinical trial. Non-medical graduates who are interested in patient interaction and site (hospital) related activities can opt for the position of *Clinical Trial Coordinator (CTC)*. While for those who are interested to join the corporate world, a certain hierarchy is followed, wherein the head in charge is the Medical Director, followed by the Head of Clinical Operations under whom the Project Manager operates and in turn supervises the *Clinical Research Associates (CRA),* which is the entry level position in this field. As the level of scrutiny on the safety of drugs available over the counter is increasing, the post of *Pharmacovigilance Officer* is simultaneously gaining importance. The national regulatory body as well as ethical guidelines have undergone various amendments to keep up with the current scenario of clinical research in the country. Thus, a *Regulatory Affairs* team has become a necessity in pharmaceutical companies. The Data Management Team has become an indispensable aspect of clinical research as it maintains the level of quality as well as authenticity of clinical trial data and performs various other functions such as creating databases, conducting data quality audits by integrating with the *Quality Management* Team. Other work profiles include *Medical Coding* for adverse events and medications as well as *Medical Writing* for scientific or regulatory submissions.

Clinical research is a multi-billion dollar industry worldwide. Since most multinational companies are collaborating with India in their drug development and patient research programmes, it has become a lucrative industry, opening new avenues for employment opportunities in India.

Curiosity– A tiny step to becoming successful in research

Manivel Lodha
MSc Infection and Immunity (2016-17)
University College, London
Ex-Xavierite
Batch of 2016

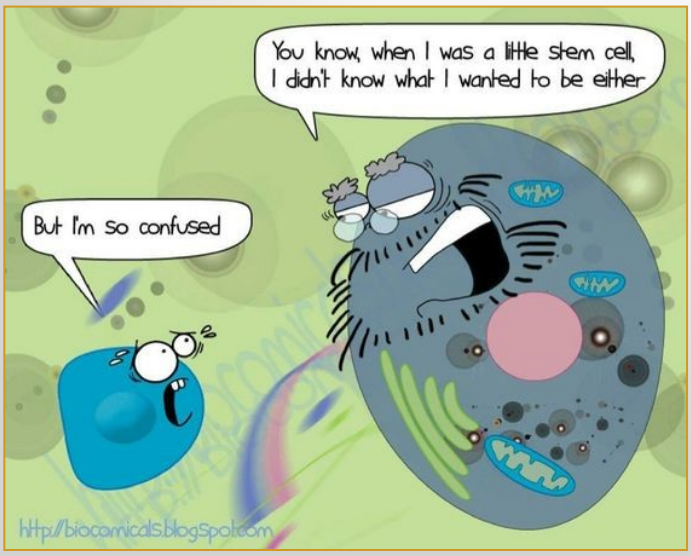
I joined the Microbiology Department at St. Xavier's College (Autonomous) in 2013 for my undergraduate dual degree in Microbiology and Biochemistry, after making a sound decision to continue studying biological sciences, my interests in which were purely based on my passion and curiosity for the same. My interest in studying microorganisms developed during my 12th grade where I was introduced to the highly diverse world of microbes whose capabilities stunned me. Learning about vaccines and the basis of diseases kept me on the medical side of biological sciences and led me to pursue my undergraduate degree at Xavier's to further understand the nature and functioning of microbes.

My time at St. Xavier's College has had a huge impact on my career progression and my personal development. I think it was the first time where I was so involved in the activities of an institution, not only within the Microbiology department, but also within a wide array of inter-collegiate festivals and volunteering organisations. This participation has surely helped me hone some basic, yet important 'life skills'. Being apart of the Microbiology department was a fantastic experience. The vast, yet well-organised syllabus, helped me gain knowledge about almost every possible sub-field in Microbiology, most of which I had no idea about. The best aspect of being a part of this department was the amount of conceptual and theoretical knowledge I gained, especially about the immune system, whose complexity was breath-taking and eventually became one of my prime interests. The practical training on the other hand, no matter how stressful it was, had a significant impact on my career. I cannot be more grateful to the department for teaching me not only about the importance of laboratory discipline, but also about the practices that are absolutely essential for conducting scientific research, which complemented the well-equipped laboratory we worked in.

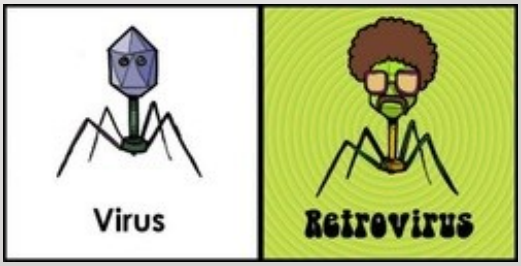
It was during my third year where I was exposed to modules in medical microbiology and immunology, which heavily revolved around the themes of disease pathogenesis and the functioning of the immune system, in both infectious and metabolic disorders. It was this aspect that caught my eye and made me want to take it ahead with me as a part of my career. My undergraduate projects at the department along with an internship at Tata Chemicals Ltd., helped me understand the fundamentals of science and that patience, determination, dedication and passion are the strongest pillars for research. This understanding eventually motivated me to enrol in University College London for my Master's Course in Infection and Immunity. My interest in studying host-pathogen interactions and virology, both conceptually and in terms of the state-of-the-art research brought me to London. I am currently on the verge of completing my Master's degree with my dissertation project revolving around the Human Cytomegalovirus, one of the most important herpes viruses, characterised by a life cycle of 'latency and reactivation'.

In these two years, I have studied the importance and contributions of host interferons in the attainment of virus latency-which portrays one of my primary interests in infectious diseases and a common theme in virology i.e. **"The paradox of the virus being dependant on a host, yet the host being a hostile environment."** I'll also be starting an internship project on HIV replication in TH_{17} immune cells, where the virus has 'learnt' how to use a host transcription factor, RORγt, showing an amazing ability of a simple RNA virus to hijack the host immune system for its own benefit. I think, in the context of infectious diseases, it is very important to keep in mind that pathogens and hosts are at a constant stage of war and no matter in how many ways our immune system learns how to tackle this menace, pathogens eventually evade these responses and sometimes hijack the host cells for their own benefit, bringing us back to square one – a concept known as the **'Red Queen Hypothesis'**, which forms the root for scientific research in the context of host-pathogen interactions.

Developing an early interest in science along with dedication, passion and patience are the most important things required to undertake research. It is also very important to keep in mind that one will never know everything! The amount of scientific knowledge out there is vast and the primary requisite to excel here is by being updated about research, by keeping in constant touch with the right people and always asking questions!!



If you were an immune response, you would be an acute inflammation.



Bringing Food to Your Fork

Gargi Banerjee
Ex-Xavierite
Batch of 2016

Do I still worry about 'lab journal completion?' I still do, even after a year of graduating from St. Xavier's and it only gets tougher than before. However, it is indeed true that Xavier's gives you 'roots and wings'. While we are constantly put to test, in preparation for the 'real world', we learn life skills way beyond the academic syllabi. Putting those skills to use, I decided to test myself by interning in France, working on protein complexes in *Saccharomyces cerevisiae*. That being my first international experience, it was both challenging and inspiring in its own way. The Microbiology department at Xavier's always emphasizes on autonomous working along with group effort- something that helped me greatly during my internship. In any field of study, one must be individually efficient while the success of the project depends on the entire team working together.

" 'Technology' relates to the research, quality and supply related concerns of sustainably feeding the planet, while 'Management' relates to efficiency in diverse teams, change management and business administration."

After graduation, I chose to club two of my likings together- love for food and science. I chose Institut Superieur d'Agriculture (ISA), Lille in France to pursue 'Masters in Sustainable Food Technology and Management'. Having completed one of the two years of study, I found the course to be tailor-made to suit the dynamic shifts in the food industry. 'Technology' relates to the research, quality and supply related concerns of sustainably feeding the planet, while 'Management' relates to efficiency in diverse teams, change management and business administration. All processes of a food item from farm to fork are dealt with in this course. I like the course because it gives a wide overview of the food sector and simultaneously gives in-depth knowledge of a preferred subject with the three mandatory internships built into the course. France over other destinations was chosen due to the specific course, previous experience and ease of student life. It is a socialist country and people's welfare (in terms of insurance, fees, lodging, etc.) is a priority. Student life is enjoyable as one can meet several new people, try new food, travel (budget-friendly too!) etc. If you try to learn French, life will be easier. Basically, you have to learn French to survive in France.

The sectors of food, health and environment will always be relevant to mankind, no matter what era it is. The constant push for healthy and safe food for the ever expanding masses, in less agricultural area and at affordable pricing is a complex task but surely doable. Although food technology is stereotyped as the study of processed food and factory work (which it is), it also deals with empowering farmers with better farming methods, helping markets devise channels for unsold food, putting in place ISO rules and HACCP plans etc. Microbiology is a study that is relevant in all fields, including the food and beverage sector and the emphasis on safe food is now more than ever before.

With pathogen mutations and food handling mistakes sprouting frequently, understanding a macro issue at a microscopic level is an asset. To continue further experimentation on yeasts, I interned at Lowlander Beer Co., Amsterdam which works on beer development with spices and different yeast strains. The craft beer market is a growing one and working here strengthened my research skills while putting my class study of team management to use.

"With pathogen mutations and food handling mistakes sprouting frequently, understanding a macro issue at a microscopic level is an asset."

There is such diversity in the food sector in India and globally, that the scope for a career in this field is huge. Both academia and the industrial sector appreciate people who are versatile, zealous to learn, with a wish to impact change. Although we find the several Unit Tests, presentations, projects, SIP, ECC, semester examinations etc. a little overwhelming sometimes, they really do make us stronger and better individuals in the long run. I have immense faith in the fact that the college prepares you for life and no matter what a Xavierite chooses to do, she/he will excel in it.

From Microbiology to Management: The Road Rarely Taken

Adityesh Mitra
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PGP 2016-18
Ex-Xavierite
Batch of 2016

TY of St Xavier's was a journey of self-discovery for me. I was very active in college activities throughout my three years, but I decided to go one step further. In TY, I became the OC for the Raga department in Malhar (having never worked for the department before), landed a summer internship at TIFR (being the first undergraduate student to do so) and also launched my CAT preparation for MBA side by side. Managing all 3 activities, with usually two or more running in tandem was not an easy task. I do not claim to be someone who is overtly intelligent or an overachiever. However, I do believe in working hard to achieve goals that I have set for myself. The journey began one summer afternoon when I was sitting in the Micro lab and waiting to give my OC interview. The AC was cooling the room, however the burners ensured that we perspired to the requisite levels of a humid Mumbai summer. I discreetly pulled out the application, made an excuse about using the washroom and left for the interview! Having given the interview and feeling pleased as punch for having successfully "evaded" practicals- imagine my shock and surprise when the very next day, I was called by Vivien ma'am to explain myself for the following-

1. Avoiding practicals and failing to show up after the interview
2. How was I planning to manage OC'ship with my internship (she already knew about this)

After being unsuccessful in explaining the former and mumbling about balancing extra-curricular with ummm extra-curricular, I won her trust and faith in going ahead with the ordeal. The TIFR internship also stretched into my classes when I was back, and with the 75% attendance rule being strictly enforced, I had to negotiate a timetable acceptable to the department as well as the college. Essentially, this made my monthly schedule for June look something like this -

1. Wake up for morning classes- I can imagine your horror at the same!
2. After attending 2 lectures, take a cab to Colaba and TIFR where I was to spend the rest of the day
3. The Micro department and I had a pact that I would not be seen in college for Malhar work until 5:00 PM in the evening (a rule which I religiously obeyed by doing a lot of work online)

Could things get more hectic you ask? Yes-I reply. Unknown to the Xavier's community at large, I was also planning to sit for management entrance tests like CAT, XAT etc. Being completely clueless about these competitive exams, I enrolled for a test series and lecture program at TIME. These tests were conducted on weekdays as well as weekends at different slots (generally in the evening) which ensured that there was a 4th bullet point to the above

4. Attend a lecture/ give a mock exam at the coaching institute near Churchgate

Things got better after July and August which saw the completion of TIFR and Malhar respectively. In my opinion, the TIFR internship helped me identify the career options in Science and how my ultimate ambition of working in the Public Health Space of India fit in with the same. I realized that while having the technical knowledge, to set up

Public Health in India, management knowledge was crucial. This made me focus my aim on attempting management examinations.
Management examinations are different from other educational exams in India in certain criteria. Firstly, you do not compete with your own age group. Management education is mostly pursued by people with work experience and roughly the average age of an MBA student is 24 years. Secondly, the criteria for getting a final seat does not only rely on your examination score. It also looks at interview performance, past academics (10th, 12th, graduation) as well as relevant work experience and extra-curricular activities (Malhar and TIFR worked wonders here).
Knowing about the entrance exams and their various patterns was critical to succeeding in them. I shall attempt to provide a few details about the more popular ones -
CAT- It is the entrance exam used for admissions to all IIMs and a few other colleges as well. It sees ~2 lakh people attempting it.
XAT- It is the entrance exam used for admission to Xavier's management colleges. These include
XLRI, XIMB etc.
SNAP- It is the entrance exam used for admission to Symbiosis Management schools
NMAT- It is the entrance exam used for admission to NMIMS (down with Umang, up with Malhar)
TISSNET- It is the entrance exam used for admission to TISS.
All these exams started towards November end and I finally gave my last exam in the first week of January. Fortunately, I cleared all the examinations and got invited to the interview rounds. The competition escalates at this level as you have really bright minds from IITs, NITs, SRCC as well as professionals who have worked in top banks and consulting firms vying with you for the same seat. The interview schedule happened to be grueling for me as well. For one, I had missed roughly 20% of my classes and was on the borderline in attendance. Fortunately, the department professors as one insisted that I pursue my interviews and not miss out on any of them due to the attendance calculations. I can never be more thankful to them for the same! Interviews started in January itself and extended up to March. The interviews were grueling as they tested a candidate on general knowledge, ability to write coherently on myriad topics as well as their ability to have an interesting conversation. They are taken by the professors of the institute to which you have applied and needless to say, they mean business- literally and figuratively! I answered questions from the southern-most point of India to the meaning of the reverse repo rate and how I can use it for banking. Owing to extensive reading, I managed to clear this round as well and got admission into IIM Bangalore which is famous for 3 idiots as well as being the top-most management institute in the country.
In terms of giving career advice, I believe it is extremely important to be clear about what one wishes to
do. That can help give direction to your career journey as well as streamline the efforts you can put into the same. It is also extremely important to keep those close to you informed about your progress- help can sometimes come from the same, especially when you most need it. Looking at different careers, especially those which go off the beaten path requires conviction as well as lot of effort. It is therefore crucial that one sets aside time to introspect on the same.

"Crystal violet and safranin colonies gazed up at them, each clamoring for space,

However only by utilizing the fine-focus could they identify the apt one for them!"

The Express-way to Success

Viveka Roychowdhury
Editor
Express Pharma and Express Healthcare
Ex-Xavierite
Batch of 1990

'What feels like the end is often the beginning.'

And so as your BSc is coming to an end, it is but natural for you to ask, 'What next?' And since this is India, it is not just you, but your whole family (third cousins included) as well as inquisitive uncles in your building and assorted aunties in the train.

So while there are those who are the picture of confidence and know what they want to become, there are those who have to first decide what they don't want to be. Figuring this out is also a good way to start narrowing down the options. Or like me, to start with an MSc in the quest of exploring science, while simultaneously experimenting with other career options, such as journalism, which fortunately worked out well in my favour.

It has been more than two decades since I last did a Gram stain, so it will be safe to say that I have neither kept in touch with microbes, nor the theoretical aspects of Microbiology or Biochemistry, my two majors at St. Xavier's. But as the editor of two publications, EXPRESS PHARMA and EXPRESS HEALTHCARE, I write a great deal about them and the havoc they wreak. Whether it is multi drug resistant tuberculosis (MDR-TB), anti-microbial resistance (AMR), the rising cases of nosocomial diseases, the seasonal outbursts of swine flu or dengue; my team of journalists tracks these stories, as well as the people trying to beat these microbes. What are the latest medicines and techniques available to treat MDR-TB? How can hospital managements and doctors reduce AMR? We contact pharmaceutical companies and reach out to them, asking them to focus on medicines for cardiovascular ailments, rather than for diseases endemic to tropical countries, like Kala Azar.

The field of medicine and healthcare does not need just good doctors. It needs clinical and medical microbiologists as well who play a crucial role in diagnosis in many path labs. It needs research scientists to work on finding the chinks in the microbes' array of defences and then design a new drug that attacks this chink. I would like to think that my publications, my team and I play a small role in highlighting these important issues, the achievements and the potential of the work being done in these fields.

So I guess my message to you all is to keep your minds open to all possibilities. Identify your strengths and interests and see how these can be aligned with the skills your course has equipped you with. Thanks to Wikipedia and Google, you now have all the information at your fingertips to research more options. Meet people whose choices intrigue you and find out what makes them tick. Connect with them on LinkenIn and learn from their choices and experiences, be it their areas of specializations, the companies/ universities / research labs they are/were part of.

"We're not expected to have all the answers, but we are expected to keep trying."

But above all, as the Bard of Avon said, **'To thine own self be true.'** Admire them but don't ape them if it's really not your passion.

An Interview with Judann Ambrose

Judann Ambrose
Ex-Xaverite

Judann Ambrose is an alumna of St. Xavier's college, Mumbai. She achieved a dual Postgraduate degree – Master of Science in Biotechnology and a Master of Business from Macquarie University, Sydney, Australia. Judann recently took up an exciting new role at ***Takeda Pharmaceuticals*** *as* ***Director of Commercial*** *to launch a product in their Gastro Intestinal disease area. She has over* ***10 years of bio-pharma industry experience,*** *holding various local, regional and global commercial roles across 3 continents – Australia, Europe and North America. Judann has gained strong launch expertise in neuroscience, cardiovascular and rare genetic neuromuscular diseases over these years.*

Prior to this new role at Takeda, she spent 8 years at Biogen, and in her most recent role as ***Associate Director, Global Marketing,*** *she led the global and regional cross-functional operations teams to launch* ***SPINRAZA*** *(an antisense oligonucleotide) in record timelines across several geographies.* ***SPINRAZA is the first drug approved for the treatment of Spinal Muscular Atrophy in the US, EU and Japan.*** *Additionally, she translated the clinical data from this program into a suite of unique branded and unbranded stakeholder materials and led the development of the tactical plan for launch year as a part of the brand plan. Judann also championed the managed access efforts to broaden access to SPINRAZA across the globe by developing innovative access mechanisms and developing the filing launch sequence strategy.*

Prior to that, she spent 3.5 years in Switzerland in the ***European Commercial Operations team,*** *responsible for ensuring pre-and post-launch readiness for Biogen's multiple sclerosis portfolio. Judann joined Biogen in their Australian affiliate to set up their Strategic Insights and Analytics function. She started her career as a consultant at* ***IMS Health*** *where she was placed onsite at* ***Novartis Pharmaceuticals*** *to support the launch of their cardiovascular portfolio. She was an achiever even as a student, which clearly proves that there is no substitute to hard work to achieve success. We are honored to have had the opportunity to conduct an interview with her, wherein she has enlightened us about several career prospects for Microbiology students, as well as has shared her priceless life experiences with us.*

Please tell us something about yourself

I am Indian by heart (specifically Mumbaikar), Australian by nationality and a US permanent resident. My parents and my brother are the people whom I value the most. They are the reason I have been able to achieve everything that I have. I live with my husband in Boston, US and we love exploring new cities, foods and cultures! My motto in life is this quote from Bill Bradley **"Ambition is the path to success. Persistence is the vehicle you arrive in."**

How did you come to this decision of pursuing a "Dual Masters in Biotechnology and Business" from Australia?
That is one question which I am frequently asked. I was very sure about what I wanted to pursue. I left India only because I knew that I wanted to pursue a unique degree that would give me that edge in my career. The dual Masters degree at Macquarie University was one of its first to be offered in the world at a time when Biotechnology was taking off. So I left India with a purpose to pursue my career goals and not just for the sake of leaving India. When I was in my final year, I had a couple of options in front of me. The one common path would be to take up a purely scientific route and pursue research & drug development. I decided not only to pursue a Masters in Biotechnology but add onto it a Masters in Biotechnology. Pursuing a dual degree gives me more options and is a degree that many employers are often impressed with. My goal was to enhance my strong scientific background with sound business acumen so that I can bring innovative treatments from the lab to the patients.

How different was it to pursue a dual Masters degree in Biotechnology and Business than a pure science degree?
It is not different at all. It certainly isn't easy to do 2 masters degrees but it definitely challenged me and I love challenges. It continues to give me an edge in this competitive biopharmaceutical industry. I feel, it served as an enhancement of knowledge for me and helped to build my scientific expertise. Just as research is one option after your undergrad in Microbiology/ Biochemistry, Biotechnology is another option to do your postgrad in, just as you would do a masters in life sciences. In fact, having the foundation in Micro/Biochem sets you up nicely for the postgrad degree in Biotech. Biotechnology is nothing but the use of living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." What was also really unique was, as a part of this dual master's degree, I was the only student in my class to be selected to work in a research lab for a year whilst completing my masters. In addition, as part of my business degree, I got to do an internship conducting commercial assessments at a quantitative biological reference standard start up, **Biotechnology Frontiers** (a bioMérieux company). This was a great link back to my Microbiology expertise!!!

In what aspects is studying abroad different from studying in India?

Studying abroad is extremely different and time management becomes really important. The way you study abroad is entirely different from how we do in India. You cannot do last minute stuff. It's not like you have just one exam at the end of the year. We have about 4 subjects per semester and there are individual projects, group projects and exams at the end of each semester and then you move on to the next 4 subjects. The workload and topics per subject are very extensive. There is a lot more self-study required. They train you for what it would be like to work in the real world and how to apply your knowledge practically.

What kept you strong and motivated to keep going throughout those 2 years in a foreign land?
As I have mentioned earlier, if it wasn't for my family and friends, I wouldn't have gotten this far. It's so important to have a solid support system around you. My parents and my brother believed in me and motivated me through the tough times. The beginning was difficult as

I was living so far away from my parents and I used to miss them a lot. But one has to be prepared and be aware of the fact that in spite of missing family and home, you have to get up the next day and study, because you have gone there to achieve something. I had a sense of purpose to graduate and have a very successful career in the Bio-pharma industry. This goal kept me focused despite all the challenges.

What is that one purpose that you would want to fulfill in life?

I would love to be the CEO of a small to mid-sized Biotechnology company with a strong collaborative team of people, who would work together to bring innovative treatments and improve the lives of patients in need.

Is there anything you would want to advice students of our age?
My advice to students would be, to **find a purpose** and **persist no matter what**. In doing that, remember the following:

1. **Don't doubt yourself**. It is the fear that prevents us from achieving our goals. To quote Ralph Waldo Emerson, **"Trust thyself: every heart vibrates to that iron string."**
2. There is **no alternative to hard work.**
3. **Be kind to people**. People never forget the way you make them feel.
4. If you haven't already started, read books/journals that will help you achieve your goals and speak to people who are currently in the jobs you want. **Never stop learning**.
5. **Be sincerely grateful** for the education you are pursing at St. Xavier's, and most importantly for being a part of Micro/Biochem degree, as it is one of the most rewarding experiences of my life and for being mentored by the most outstanding teachers in the world (Tr. Miriam, Tr. Amonkar, Tr. Sangeetha and Tr. Karuna). Learn as much as you can from them…. I for sure am grateful to have learnt from them.

Wish you all every bit of success!

The World Changers!!

Dr. Shilpa Verekar
Head of Technical Projects PAN India
Merieux Nutrisciences

About Professor Shilpa Verekar

From the field of Research, to being a Quality Analyst, to St. Xavier's as a Microbiology Professor, and now to her next endeavor as the **Head of Technical Projects PAN India at Merieux Nutrisciences, Mrs. Shilpa Verekar** was a part of our department in the academic year 2016-2017. She is an exceptional educator and a practical realist. Her abundant experience in diverse multiple industries, light hearted wit, approachable teaching attitude, thorough knowledge in the biotechnology industry and application based approach, has left a definite impact on all her students. Let us see what makes her feel that microbes are the **World Changers** of today.

Imagine a world without antibiotics, bread and wine. Thanks to the fungi that make these things for humans. Without fungi, human life would have been so different.

Fungi are multifaceted, the most diverse microbes, ubiquitous in nature and have, for centuries, provided us with a variety of useful products, from cheese to alcoholic beverages, organic acids, pigments, enzymes, food and lately antibiotics, and small molecular weight compounds with a variety of pharmacological activities. Fungi has revolutionized the studies in pharmaceutical, food and agricultural industries. They plays an important role in recycling organic matters, mycoremediations and as bio fertilizers. They have opened up new dimensions at the global level in the field of biotechnology. On the other hand, fungi have changed the economy of the country and are also responsible for severe conditions like famine. Importance of some of the fungi who have changed the world are described below.

Penicillin:

Starting in the late 19th century, scientists and physicians were in the hunt of antibacterial properties of different types of moulds including *Penicillium*, but they were unable to discern what process was causing the effect. On the morning of Friday 28th September 1928, a Scottish scientist Alexander Fleming could finally isolate the effects of *Penicillium* mould, independent of earlier observations.
A serendipitous accident, wherein in his laboratory in the basement of St Mary's Hospital in London (now part of Imperial College), Fleming noticed a Petri dish containing Staphylococcus that was mistakenly left open which was contaminated by blue-green mould from an open window and formed a visible growth. There was a halo of inhibited bacterial growth around the mould. Fleming concluded that the mould released a substance which repressed the growth of the bacteria and caused its lysis. Fleming coined the term "Penicillin" to describe the filtrate of a broth culture of the *Penicillium* mould. Penicillin was greatly used during World War II. It was then produced by drug giant Glaxo. As a result of the use of penicillin, the death toll from infected wounds in soldiers dramatically decreased.

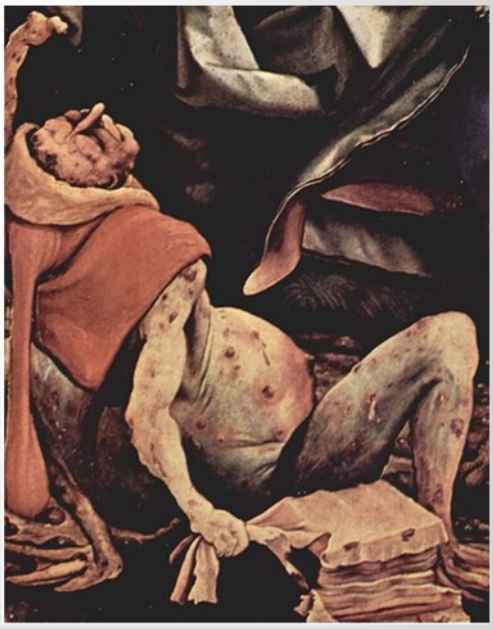
***Penicillium notatum*: Source of source of Penicillin.**

Statins

Cholesterol is essential for the functioning of all human organs, but it is also the cause of coronary heart disease. Akiro Endo, a Japanese biochemist, working for the pharmaceutical company Sankyo, began the search for a cholesterol-lowering drug in 1971. They identified Mevastatin (ML-236B), a molecule produced by the fungus *Penicillium citrinum* that lowered cholesterol levels in hens, dogs and monkeys. Clinical trials were performed in humans which gave positive results. Statins laid a foundation for development of cholesterol lowering drugs from fungi, as later on many more drugs on similar lines of statins were developed. Cholesterol-lowering statins are amongst the biggest-selling medicines in the world, generating billions of revenue for pharmaceutical companies.

Ergot rot:

St Anthony's Fire was one of the things that made the Middle Ages a horrible time to live in. It is caused by *Claviceps purpurea*, also known as the ergot fungus, which grows on cereal grains, infecting the ovaries of plants. This fungus was a medieval mass murderer. When it gets cold, the fungus sends out a dark black spur. Ergot produces alkaloids, which affect the human system. At first, the symptoms are mild; a person suffering from ergot poisoning can expect fatigue, nausea and diarrhea. The symptoms worsen when the blood vessels shrink, depriving the limbs of necessary oxygen and nutrients, and letting them essentially die.


Ergot affected human

The disease got its name because people would pray to St Anthony, and visit abbeys and other sacred sites associated with the saint, in an attempt to cure themselves. The largest outbreak happened in France in 1944. Forty thousand people across France died. The medieval farmers were aware of the fungus infestation, but a few had the resources to store the grain, and during storage, the fungus would spread, and many couldn't afford to turn down any food whatsoever. Even today, desperation due to starvation and bad quality control leads to occasional outbreaks of ergot poisoning.

Late blight of potato:

A million people are said to have died of hunger in Ireland in the late 1840s, on the doorstep of the world's richest nation. The Irish population had grown rapidly, following the introduction of potato. Irish population was solely dependent on potato, as no significant alternative food existed. The potato crop was derived from a small supply of tubers that survived the lengthy trip across the sea to Europe. In the early weeks of summer in 1845, the weather had changed, with temperatures 1.5-7 degrees below the average, accompanied with rainfall. In just a few weeks, the vigorous green potato vines became blighted, thereby decaying the mass vegetation. When the tubers were dug from the ground, some were rotted, but many appeared to be sound. Later, however, these potatoes too rotted away in the storage bins. Throughout Europe, the potato crops failed, but the disaster was worst in Ireland because of the nearly complete dependence of Irish peasants on potato for their food. The culprit was Phytophthora infestans, a fungus, which causes the serious potato blight.

Famine Memorial in Dublin

Over one million were starved to death and another two million were forced to emigrate from affected countries. The Great Famine is memorialised in many locations throughout Ireland.

Mycotoxins :

Turkey X disease was the turning point for the use of the term “Mycotoxin”. In the 1960s, about 100,000 young turkey died near London due to peanut meal which was contaminated by fungus *Aspergillus flavus*. The first signs of Turkey X were neurological symptoms and coma, which would result in death. The cause of the death was due to mycotoxin (Aflatoxin) produced by the fungus.

Aflatoxins are poisonous carcinogens that are produced by certain fungi like *Aspergillus flavus* and *Aspergillus parasiticus* which grow in soil, decaying vegetation, hay, and grains. They are regularly found in improperly stored grains and spices. When contaminated food is processed, aflatoxins enter the general food supply where they affect both humans and animals. Children are particularly affected by aflatoxin exposure, which leads to stunted growth, delayed development, liver damage, and liver cancer. Adults have a higher tolerance to exposure, but are also at risk. USFDA (United States Food and Drug Administration) action levels for aflatoxin present in food or feed is 20 ppb to 300 ppb.

***Aspergillus flavus*: source of Aflatoxin**

Since fungi are the most diverse group of microorganisms, one has to be very careful, because on one hand, they are responsible for causing major losses, whereas on the other hand they are useful. Our planet earth is full of these microscopic organisms with each one of them associated with a strange story or unexpected beauty.

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MSc Project Abstracts

MSc External Projects

Name of the student/s	Title of Project	Name of the guide	Name of the Institute
Abdul Kareem Ansari	Evaluation of pretreatment of polymeric black tea polyphenol on lung carcinogenesis in male A/J mice model	Dr. Mahimkar	Advanced Center for Treatment Research and Education in cancer (ACTREC)
Ansari Sufiya	Effect of ATPase activity of 14-3-3γ protein in centrosome cycle.	Dr. Sorab N. Dalal	Advanced Center for Treatment Research and Education in cancer (ACTREC)
Ravela Da Cruz	Studies on *Aeromonas* food isolates	Dr. Vandan Nagar	Bhabha Atomic Research Centre
Brenda D'sa	Cloning of cDNA encoding *Geraniol 10-hydroxylase* in T/A vector from *Nothapodytes foetida*	Dr. D.P. Fulzele (Guide) Dr. Suchita Kamble (Co-guide)	Bhabha Atomic Research Centre
Fleur Fernandes	Molecular screening of 'Vel', a High Frequency Antigen among Indian blood donors	Dr. Ajit C. Gorakshakar	National Institute for Research in Reproductive Health (NIRRH), Parel, Mumbai
Stina Fernandes	Expression, purification and characterization of canine HtrA2, a pro-apoptotic serine protease, and its variants	Dr. Pradip Chaudhari and Dr. Kakoli Bose	Advanced Center for Treatment Research and Education in cancer (ACTREC)
Jovil Gomes	"Anti-tumour Effect of Betulinic Acid on Thyroid Cancer Cell Lines".	Dr. Archana Damle.	Radiation Medicine Centre (Bhabha Atomic Research Centre).
Lata Gunda	Development of hairy roots of *Ophiorrhiza sp* using different strains of *Agrobacterium rhizogenes*.	Dr. D. P. Fulzele	Bhabha Atomic Research Centre
Ankur Jadav	"To increase the storage stability of 'Ready to bake chapatti' and 'Ready to cook rajma' using a combination of gamma irradiation and heat treatment"	Dr. SahyogJamdar	Bhabha Atomic Research Centre
Ashish Jagtap	Debittering of casein hydrolysate using immobilized membrane fraction of *Lactobacillus rhamnosus*	Dr. Sahayog Jamdar	Bhabha Atomic Research Centre

MSc External Projects

Rupali Koshti	Osmotic Stress Response of *Salmonella enterica* serovar Typhimurium and Relative Gene Expression Studies	Dr. Sashidhar	Bhabha Atomic Research Centre
Mansi Lotlikar	'Validation of 1p36.33 and 8q24.3 locus alterations in Oral cancer and to study CD44v6 expression in a subset of HNSCC'	Dr. Manoj Mahimkar	Advanced Center for Treatment Research and Education in cancer (ACTREC)
Jennifer Nazareth	"Biochemical estimation of ascorbate and Genetic Diversity Analysis in Groundnut (*Arachishypogaea L.*) By using PCR based molecular Marker's".	Dr. Suvendu Mondal.	Bhabha Atomic Research Centre.
Domnic Noronha	Impact of Radiation Processing and Storage on Volatile Compounds of Cauliflower (*Brassica oleracea*)"	Mr. Jasraj Vaishnav	Bhabha Atomic Research Centre
R. Rajkumar Ragupathi	"Studies on the Effect of Epithelial Cell Lysate and Anti TB Drugs on the Growth of Mycobacteria Internalized in A549 Cells".	Dr. Mukti Kanta Ray.	Radiation Medicine Centre (Bhabha Atomic Research Centre).
Ashlin Roche	"Effect of mutant 14-3-3γ with gain of ATPase function (D129A 14-3-3γ) on desmosome assembly".	Dr. Sorab N. Dalal.	Advanced Centre for Treatment, Research and Education in Cancer (ACTREC).
Faiza Sayed Zaheer	"Biochemical and Molecular Characterization of Mutants and Genotypes of Chickpea (*Cicerarietinum* L.)"	Dr. Archana	Advanced Centre for Treatment, Research and Education in Cancer (ACTREC), Tata Memorial Centre
Shweta Singh	*In vitro* plant regeneration by somatic embryogenesis and *Agrobacterium* mediated genetic transformation studies in Finger millet *(Eleusinecoracana*(L.) Gaertn.)	Dr. Ashok Badigannavar	Bhabha Atomic Research Centre
Shivpoojan V. Tiwari	"Designing Mammalian Expression Vector for Co-expression of DUOX2 and its Co-factor DUOXA2 for Enhancing Radiation Effect of Breast Cancer Cells"	Dr. Abhijit De	Advanced Center for Treatment Research and Education in cancer (ACTREC)

MSc External Projects

Name of the student: Mansi Lotlikar

Title: Validation of 1p36.33 and 8q24.3 locus alterations in Oral cancer and to study CD44v6 expression in a subset of HNSCC.

Abstract: Oral squamous cell carcinoma (OSCC) is a multistep and multifactorial malignancy arising due to accumulation of multiple genetic alterations regulated by genetic predisposition and environmental factors such as tobacco and alcohol abuse. OSCC is often associated with late diagnosis, poor prognosis and low survival rates. Prognosis can be improved by identifying the correlation between these genetic alterations with survival and tumour stage along with discovery of new molecular markers. In this study we validated the Copy Number Alterations at 1p36.33 and 8q24.3 locus by Interphase-Fluorescent *in situ* Hybridization in Leukoplakia (n=5) and OSCC samples (n=78). Gain at 8q24.3 correlated with progression of pre-invasive lesion (leukoplakia) to OSCC, tumour stage and nodal metastasis, while 1p36.33 gain was correlated with survival. The validation study was to conclude that copy number gain at 8q24.3 locus is a signature chromosomal alteration associated with progression of Leukoplakia to OSCC, while 1p36.33 copy number gain is linked to survival of the patients, both of which can be of prognostic importance.

Additionally, Immunohistochemical (IHC) staining was carried out to study the expression of CD44v6 in advanced HNSCCs samples (n=38). Our analysis revealed strong cytoplasmic and membranous expression of CD44v6 in 73.7% HNSCC cases at various sites. This observation has added to its potential of being used as a biological marker in prognosis and treatment planning of oral cancers.

Overall, this study validated the gain of 1p36.33 and 8q24.3 in OSCC, additionally with confirmed over expression of CD44v6 in advanced stage HNSCC.

Name of the student: Jennifer Nazareth.

Title: "Biochemical estimation of ascorbate and Genetic Diversity Analysis in Groundnut (*Arachishypogaea L.*) By using PCR based molecular Marker's".

Abstract: Groundnut is preferred as food crop due to its oil content (48-50%), protein content (20-30%), presence of antioxidants biological active molecules like, polyphenol, flavonoids, isoflavonones, vitamin E (tocopherol) and vitamin C (ascorbic acid). The present study aims in estimating ascorbic acid content in groundnut genotypes which are available at Bhabha Atomic Research Centre (BARC), and to study genetic diversity of 95 groundnut genotypes at BARC. The ascorbic acid content differed significantly among the genotypes. It ranged from 94.34 μg/g to 248.51 μg/g of seed, with an average of 145.56 μg/g seed over two years. The genotype TG 35 had the highest ascorbic acid content and TG 60 had the lowest ascorbic acid content, respectively based on the two season's data. The phenotypic coefficient of variability for ascorbic acid content was 22.51% and the broad sense heritability 64%. To see whether this variation of ascorbic acid content is also reflected in genotypic variability, we have studied genetic diversity in 95 groundnut genotypes using 34 MITE and 8 SSR markers. These 34 TE primer pairs amplified 72 bands/alleles, of them 58 (80.5%) were polymorphic. The polymorphic information content (PIC) varied from 0.22 to 0.80. All the eight SSR primer pairs amplified 27 bands/alleles, of them, 22 (81.5%) were polymorphic. The PIC varied from 0.16 to 1.00. The percentage of polymorphism among the MITE and SSR primer pairs ranged from 50.0 to 100.0%. A dendrogram (based on jaccard similarity computed from combined MITE and SSR data) depicted two main clusters divided at 41% Jaccard's similarity. Rust resistant genotypes were grouped into a separate cluster A. Further these MITE markers detected a high genetic divergence ranged from 21.0% to 98.3% among the pair of tested genotypes. Present work able to identify contrasting genotypes which are genetically dissimilar and will be used for trait based improvement (such as ascorbic acid content) in future.

Name of the student: Ashlin Roche.

Title: "Effect of mutant 14-3-3γ with gain of ATPase function (D129A 14-3-3γ) on desmosome assembly".

Abstract: Desmosomes are calcium dependent adherens like junctions that link intermediate filaments to the cell surface and help in facilitating strong cell-to-cell adhesion. Desmosomes are highly complex membrane domains and confer stability and high tensile strength to tissues.14-3-3 proteins belong to a family of highly conserved proteins and play an important role in many cellular processes. It has been demonstrated that 14-3-3 proteins have ATPase activity and a mutation of a conserved aspartate residue in the 14-3-3 proteins (D129A) results ina gain of function in ATPase activity.14-3-3γ, is required to initiate desmosome formation and the knockdown of this protein leads to a defect in desmosome formation due to a defect in the transport of plakoglobin to the cell border. In order to check if the mutant 14-3-3γ protein (D129A) has any effect on desmosome formation Western blotting was performed to determine if expression of this mutant led to a change in the levels of the desmosomal proteins. In addition, immunofluorescence assays were performed to determine the localization of plakoglobin in cells expressing the mutant protein. Based on the results obtained through Western blotting and immunofluorescence it was concluded that 14-3-3γ (D129A) does not affect desmosome formation.

MSc External Projects

Name of the student: Abdul Kareem Ansari

Title: Evaluation of pretreatment of polymeric black tea polyphenol on lung carcinogenesis in male A/J mice model

Abstract: Lung cancer is one of the major cause of cancer mortality in India and worldwide. Approximately 1.6 million deaths are recorded annually due to lung cancer. Lung cancer has poor survival rate. Lung cancer are diagnosed at later stage or once they are metastasized in body, necessitating the study of chemoprevention using synthetic and natural compound to suppress/delay or reverse the development of invasive carcinoma . According to recent studies, consumption of dietary polyphenols are associated with protection against lung cancer. Majority of studies are done on green tea for its health benefits and chemopreventive properties from time to time. Black tea, second most consumed beverage worldwide are less exploited. Polymeric black tea polyphenols are major constituent in black tea. With male A/J mice evaluation of level of inflammation and cell proliferation in lung and liver tissues, using immunohistochemistry method by antibody specific to PCNA and COX-2. Result shows cell proliferation of lung and liver tissue is significantly reduced in polyphenol + carcinogen control group as compared to carcinogen group. Tumor promoting inflammation, a hallmark of cancer shows reduction in polyphenol + carcinogen treated group as compared to carcinogen group. Chemopreventive properties of PBPs are evaluated by significant decrease in proliferating index. Evaluation cyclooxygenase-2 shows reduction in level of inflammation by immunohistochemisrty.

Name of the student: Ansari Sufiya Mohd Azam

Title: Effect of ATPase activity of 14-3-3γ protein in centrosome cycle.

Abstract: The genetic material of the cell must be properly copied and equally divided during the partitioning of the cell. This cyclic process that gives rise to a multi-cellular organism is known as the cell cycle. The cell cycle is a highly regulated process that ensures that the process of cell division alternates with the process of DNA replication. To ensure that this alteration is maintained, the centrosome division cycle is coordinated with the DNA replication cycle so that the centrosome divides only once during the cell cycle. Loss of 14-3-3γ, a cell cycle regulator leads to premature activation of cyclin B/ cdk1 complex through cdc25C leading to centrosome amplification during the S phase, increased aneuploidy and an increase in neoplastic progression. Recent reports revealed the ATPase activity of 14-3-3γ proteins wherein a mutation at 129th aspartate to alanine (D129A) resulted in a gain of ATPase activity. A mutation at the 56th arginine to alanine (R56A) did not have any effect on ATPase activity. However, the R56A along with the D129A mutation resulted in loss of ATPase activity. Expression of the 14-3-3γ D129A mutant in HCT116 derived vector control and 14-3-3γ knockdown cells lead to the presence of a single centrosome during mitosis.

Electron microscopy can reveal the phenotype of the single centrosome. Thus pcDNA 3.1 puro constructs for mOrange, mOrange with 14-3-3γ wildtype and mOrange with 14-3-3γ D129A were prepared, transfected into HCT116 cell line, kept in puromycin selection and processed for electron microscopy. GST and HA tagged constructs of 14-3-3γ D129A were prepared to check in-vitro and in-vivo interaction of this mutant with centrosomal proteins. Also pCMV construct for 14-3-3γ R56A mutant was prepared to study its effect on the centrosome.

Name of the student: Jovil Joseph Gomes.

Title: "Anti-tumour Effect of Betulinic Acid on Thyroid Cancer Cell Lines".

Abstract: Betulinic acid (BA) is a plant derived phytochemical that can induce mitochondrial pathway of apoptosis specifically in cancer cells but not in normal cells. It also inhibits angiogenesis and the migration of the cancer cells, thus preventing the cancer cells from metastasizing to other parts of the body. These properties of Betulinic acid makes it an attractive anti-cancer agent. The anti-cancer properties of BA have been studied and it has been proved to be very effective on different cancers such as melanoma, breast cancer, neuroblastoma, colorectal, head and neck cancers and many others. Our results on thyroid cancer cell lines depicts that BA is cytotoxic and induces apoptosis in thyroid cancer cell lines. The Cytotoxicity of BA on thyroid cancer cell lines was proved by performing MTT assay, which helped in establishing the IC_{50} values. DNA fragmentation assay, which is the hallmark of apoptosis was performed to prove that BA induced cell death was through apoptosis. Wound healing assay and Gelatin Zymography was performed on thyroid cancer cell lines, which proved that BA inhibited the migration and expression of Matrix metalloproteinases (MMPs), which help the cancer cells in invasion. The present studies show that BA induced apoptotic cell death and inhibited the migration and expression of MMPs in thyroid cancer cell lines, suggesting that BA can be a very effective and promising agent against thyroid cancer.

MSc External Projects

Name of the student: Ravela Da Cruz

Title: Studies on *Aeromonas* food isolates.

Abstract: *Aeromonas* species are recognized as etiological agents of a wide spectrum of diseases in humans and animals. In developing countries, the potentially pathogenic *Aeromonas* spp. are very common in drinking water and different types of foods and cause wound infections, septicemia, meningitis, ophthalmitis, endocarditis, aspiration, pneumonia, and biliary tract infections. The specificity of the genus-specific primer designed was checked using RT-PCR method (C_t and HRM values) by amplifying *gcat* region of standard *Aeromonas* strains and non-*Aeromonas* isolates and the average T_m value was found to be in the range of 83-88. The minimum detection limit of *Aeromonas* enabled us to determine the minimum amount of DNA that can be detected by Q-PCR which was found to be0.022ng/µl.
Quorum sensing is a means by which bacteria can control the gene expression in response to the cell density. It enables the regulation of a variety of bacterial physiological functions including biofilm formation, bioluminescence, virulence factors and swarming which some of the major functions that are known to contribute to bacterial pathogenesis. The use of quorum sensing inhibitors would be of particular interest in treating bacterial pathogenicity and infections. In this work, we have tested caffeine, vanillin, catechin and curcumin as quorum sensing inhibitors by using *Chromobacterium violaceum* CV026 as a biosensor strain. We observed that these compounds did not show antibacterial activities at low concentrations but were seen to inhibit quorum sensing. Live-cell imaging techniques are essential to gain a better understanding of microbial functioning in natural systems, for example in biofilms. Autofluorescent proteins, such as the green fluorescent protein (GFP) are valuable tools for studying microbial communities. In this study we tried to transform *A. hydrophila* 839^T with a plasmid encoding green fluorescent protein (pBBR1MCS5) obtained from *Pseudomonas aeruginosa* PA-O1. Transformation was carried out by chemical method, using $CaCl_2$ and heat shock and also by electroporation exposing the cells to a current of 2500V for 5 ms.

Name of the student: Brenda D'sa

Title: Cloning of cDNA encoding *Geraniol 10-hydroxylase* in T/A vector from *Nothapodytes foetida*

Abstract: *Nothapodytes foetida* (family *Icacinaceae*) commonly referred to as 'Stinking Tree' is an endangered tree endemic to the Western Ghats in India. It produces camptothecin (CPT), a mono terpenoid indole alkaloid (TIA) and is considered as one of the richest sources of this alkaloid. CPT is a potent inhibitor of DNA topoisomerase I and has applications in treating ovarian, small lung and refractory ovarian cancers. Geraniol 10-hydroxylase (G10H) is an important enzyme involved in the biosynthetic pathway of monoterpenoid alkaloids. Being a cytochrome P450 monooxygenase, G10H hydroxylates geraniol at the C-10 position to generate 10-hydroxy-geraniol which is the first committed step in the biosynthesis of TIA's. G10H is thought to play a key regulatory role in TIA biosynthesis.
In this study, cDNA was synthesized by semi-quantitative reverse transcriptase polymerase chain reaction using the RNA extracted from the leaf tissue of *N. foetida*. Using available database for *G10H* sequences in other plants, specific primers were designed. PCR was carried out using cDNA of *N. foetida* to isolate *G10H* fragment. Further, the fragment was isolated, purified and then cloned into T/A vectors. The constructs were then transformed into competent *E. coli* cells and the clones obtained were confirmed by PCR with *G10H* specific primers followed by plasmid isolation and restriction digestion with two restriction enzymes flanking the gene.

Name of the student: R. RajkumarRagupathi.

Title: "Studies on the Effect of Epithelial Cell Lysate and Anti TB Drugs on the Growth of Mycobacteria Internalized in A549 Cells".

Abstract: Tuberculosis is the serious health problem with high mortality rate in today's world, it is a disease which mainly affects the lungs of the host. Causative agent is Mycobacterium tuberculosis, which is a rod-shaped bacterium and obligate aerobe which multiplies well in the lung region. The infection starts after inhalation of droplet nuclei containing the bacterium, once inhaled the bacterium reaches the lungs and primarily infects the lung cells like alveolar epithelial cells, alveolar macrophages, fibroblast etc. The prime reason for infection is due to the attachment of the bacterium to the cells through cell receptors. Initially, the first cell which comes in contact with Tb bacilli are the AECs which is found in the lining of alveoli, they play role in gas exchange and in inducing an immune response against the entering pathogens. Mycobacterium tuberculosis bacterium is capable of multiplying inside A549 lung cell line which is an Alveolar Epithelial Cell (AEC). Cell line A549 used was lysed and the lysate was used to check the infection rate of TB bacilli on A549 cells. H37rv strain of Mycobacterium used to study the effect A549 cell lysate in the infection and the effect of antibiotic Rifampicin on TB bacilli growing within the cells. By using radiorespirometry estimation the growth index showed less infectivity in presence of cell lysate, antibiotic rifampicin when used in different concentration showed a varying growth rate of TB in different concentration. The growth of TB bacilli increased as the concentration of rifampicin was diluted. The actual mechanism by which the cell lysate decreases the infectivity of TB bacilli is yet to be explored.

MSc External Projects

Name of the student: Fleur Fernandes

Title: Molecular screening of 'Vel', a High Frequency Antigen among Indian blood donors

Abstract: Vel is a High Frequency Antigen (HFA) found on RBCs of most individuals. This antigen is coded by SMIM1 (Small Integral Membrane Protein 1) gene. A 17 base pair nucleotide deletion results in the Vel negative phenotype. Such individuals lack the Vel antigen on their RBC surface. Vel negative phenotype is extremely rare. If Vel negative people encounter the Vel antigen during pregnancy or blood transfusion, they get sensitized and form anti-Vel. Clinically anti-Vel causes Hemolytic Transfusion Reactions and Hemolytic Disease of the Newborn. Hemagglutination has been routinely used for determining blood group antigens. However, there are certain limitations. As the molecular basis of the Vel blood group is now known, molecular methods can now be used for determining the Vel antigen.

810 random Indian blood donors from Mumbai, India were enrolled for this study. Blood grouping was carried out using standard tube technique as per manufacturer's instructions. DNA was extracted from blood samples using the phenol-chloroform DNA extraction method. PCR-RFLP was standardized for determining the Vel genotypes of the donors.

O was the most common ABO blood group and accounted for 37%. RhD negativity was 5%. Among the 810 donors, one heterozygous Vel positive individual was identified while the remaining donors were homozygous Vel positive. No Vel negative homozygotes were found. The allelic frequencies of the 'V' and 'v' alleles were 0.9994 and 0.0006 respectively. Vel positive heterozygotes accounted for 0.12%. These frequencies were in Hardy-Weinberg's equilibrium. The frequency of the V allele in the present study was highest when compared to Caucasians and Thais.

This is the first study in India on molecular screening of Vel genotypes among blood donors. A simple PCR-based technique was standardized for determining the Vel genotypes. One heterozygous Vel positive donor was identified. Family studies of this individual should be carried out in order to identify possible Vel negative homozygotes. Also, a larger number of donors and other ethnic and tribal groups should be screened to identify rare Vel negative individuals. Blood from such individuals (Vel negative) should be cryopreserved for future use.

Name of the student: Fernandes Stina George

Title: Expression, purification and characterization of canine HtrA2, a pro-apoptotic serine protease, and its variants.

Abstract: Cancer is an unrestricted multiplication of cells that eventually leads to tumor formation. Evasion and/or resistance of apoptosis are hallmarks of cancer. Activation of signal transduction pathways for apoptosis in cancer cells is a crucial aim of anticancer therapies currently used in clinical oncology such as chemotherapy, γ –irradiation or immunotherapy.

Among the various death-promoting factors, a serine protease - high temperature requirement A2 (HtrA2) -has taken the limelight as a key player in apoptosis. HtrA2 is a trimeric multidomain and multifunctional protein, conserved from prokaryotes to humans and is involved in mitochondrial homeostasis and apoptosis. It has been also implicated in cancer and neurodegenerative disorders.

Human HtrA2is well characterized and its role in apoptosis been elucidated. HtrA2proteolytically cleaves natural inhibitors of caspases to unleash a caspase cascade. Therefore HtrA2 can be a possible target for anticancer therapy by stimulating HtrA2 mediated apoptosis. Just like in humans, the canine ortholog of HtrA2 (cHtrA2) can be targeted for therapy since spontaneous cancers occur widely in canines and can be used as a better model to study disease progression. Understanding the intricate structure and function of cHtrA2 is therefore very significant.

HtrA2 comprises an N-terminal region, a serine protease domain and a regulatory protein-protein interaction or PDZ domain. The residues in the peptide binding groove of PDZ (YIGV) when mutated shows loss of substrate binding and subsequently catalytic activity. Similar studies were performed in the canine counterpart where Glycine 230 of YIGV was mutated to Alanine (G230A). Using molecular biology, protein engineering and biochemical tools, this mutant of canine HtrA2 (cHtrA2) was generated, purified and characterized.

The biophysical properties were analyzed using Circular Dichroism spectroscopy and its interaction with generic substrate β-casein was probed using pull-down assay and with peptide ligand using Isothermal Titration Calorimetry (ITC). These studies on the protein and its domains will allow characterizing structural/functional properties and conformational stability with a much better understanding of the molecular mechanism of its action.

MSc External Projects

Name of the student: Lata Laxman Gunda.

Title: Development of hairy roots of *Ophiorrhiza sp* using different strains of *Agrobacterium rhizogenes*.

Abstract: *Agrobacterium rhizogenes* causes hairy root induction (disease) in plants. The neoplastic roots developed by *A. rhizogenes* infection shows characterized high growth rate and genetic stability. These transformed root cultures can produce higher levels of secondary metabolites comparable to that of intact non-transformed plants. Hairy root cultures thereby holding immense potentials in production of valuable secondary metabolite in many plants and for pharmaceutical industry. *In-vitro* plant biotechnology and hairy roots showed valuables finding presented by Philip R. White in the 1930's obtained indefinite growth of excised root tips. Such cultures have allowed deep study of plant metabolic pathways production of valuable secondary metabolites, enzymes with industrial or therapeutically applications. Transgenic root system offers tremendous potential for introducing additional genes of interest along with the *Ri T-DNA* genes for production of useful metabolites, alteration of metabolic pathways and compounds of interest. Furthermore potentiated hairy root cultures are explored for discovery of new pathways and metabolites as well as increasing the secretion or biosynthesis of metabolites since different biotechnology strategies such as genetic engineering. Present work highlights some of the past significant progress for exploiting potential utilization of hairy roots cultures as chemical factories for producing biologically active substances. In this, hairy root cultures of *Ophiorrhiza* sp. are developed using different strains of *A. rhizogenes* such as A4, ARqua1 and outlines future perspective to produce improved camptothecin (anticancer agent) levels than that of plants.

Name of the student: Ankur P. Jadhav

Title: "To increase the storage stability of 'Ready to bake chapatti' and 'Ready to cook rajma' using a combination of gamma irradiation and heat treatment"

Abstract: In the recent times, due to several reasons, consumption of prepared food has increased widely in developed and developing countries. "Ready-to-eat"/ "Convenience" foods are therefore, in great demand in these countries. Convenience food is commercially prepared for ease of consumption. These kinds of food are nutritious and readily available for consumer. These foods are processed before or after packing and then stored at lower temperatures or at room temperature. In the current study, efforts were made to increase the shelf-life of "Ready-to-bake" chapatti (unleavened flat bread) and "Ready-to-cook" rajma (kidney beans). The above food items are partially cooked and then processed by hurdle technology (combination of two or more approaches to eliminate the pathogens). After a combined treatment of gamma rays and heat treatment, the product was stored for a period of time with continuous assessment of microbial count and sensory evaluation along with colour and texture analysis at different storage periods. No microbial contamination observed at the end of the storage period (i.e. 2 months for rajma and 40 days for chapatti). The texture and colour analysis showed no significant difference in the freshly prepared and our products. It can be concluded that the shelf-life of both the products was extended using combination treatment. The product was microbiologically safe and aesthetically sound and can be addressed to specific target groups like working women, school children, army, astronauts, travelers and immune-compromised patients.

Name of the student: Ashish Siddharth Jagtap

Title: Debittering of casein hydrolysate using immobilized membrane fraction of *Lactobacillus rhamnosus*

Abstract: Debittering of casein hydrolysates was carried out by enzymatic treatment using encapsulated membrane fraction (MF) of *Lactobacillus rhamnosus* as a source of aminopeptidase (AP).The membrane fraction was obtained after disruption of the cells of Lactobacillus by enzymatic and by sonication and the culture was lyophilized. An enzymatic assay is carried out to determine the activity of enzyme aminopeptidase present in membrane fraction (MF) of *L.rhamnosus.* For significant debittering of casein hydrolysate the MF was immobilized and packed in to the double jacketed chromatographic column ,the hydrolysate was passed through it and by organoleptic analysis the bitternes index of casein hydrolysate and its debittered product was determined. Further studies revealed that the activity aminopeptidase with respect to different substrates i.e. β-napthylamide derivatives of various amino acids were determined. The effects of immobilization were also performed by stability studies with respect to pH and time.

The casein hydrolysate and debittered casein hydrolysate were subjected to study the functional properties like foaming properties and emulsifying properties. From the studies it was revealed that after treatment of casein hydrolysate the foaming capacity and foaming stability was improved. The emulsifying activity index in case of debittered casein hydrolysate is more and the emulsion stability of both CH and DCH is same stating that it can be used as an emulsifier. The RP HPLC profiles of casein hydrolysate before and after treatment showed some of the peaks in the hydrophilic regions suggesting the decrease in hydrophobic peptides responsible of bitter taste.

MSc External Projects

Name of the student: Shweta Singh

Title: "*In vitro* plant regeneration by somatic embryogenesis and *Agrobacterium* mediated genetic transformation studies in Finger millet *(Eleusinecoracana*(L.) Gaertn.)"

Abstract: Many different factors constrain the regeneration and transformation in finger millets. Finger millet is recalcitrant to tissue culture regeneration because of its poor response to in vitro regeneration after transformation. A rapid and reproducible protocol was made for in vitro plant regeneration by somatic embryogenesis and *Agrobacterium* mediated genetic transformation in Finger millet genotypes ML-65 and GPU-48. Effect of plant growth regulators, NaCl (Salinity stress) and amino acids on somatic embryogenesis and regeneration was investigated in finger millet genotypes ML-65 and GPU-48.

Matured seeds were cultured on Murashige and Skoog medium in combination with different auxins and cytokinins concentration and combinations. A high callus induction frequency and good quality callus, in terms of color, texture and regeneration potential was obtained on MS basal media supplemented with 2 mg/l 2,4-D in combination with 0.5 mg/l BAP. Finger millet genotype ML-65 was tolerating salinity stress up to 150mM NaCl concentration. Genotype ML-65 is a better strain to get high callus induction frequency as compared to genotype GPU-48. Putative transformants were successfully established under controlled green house condition by *Agrobacterium* mediated transformation. Calli and leaves of putative transformants were assayed for the transient GUS expression. GUS expression was observed in transformed tissues. Six out of 7 transgenic plants were expressing P1301 vector.Genetic fidelity (somaclonal variation) of in vitro derived plants and control plants were analyzed by SSR markers. All the regenerated plants showed similar banding patterns and were in accordance with original mother plant.

Name of the student: Rupali. R. Koshti

Title:Osmotic Stress Response of *Salmonella enterica*serovarTyphimurium and Relative Gene Expression Studies

Abstract: *Salmonella enterica*serovarTyphimurium a well-known food poisoning agent was checked for its survival strategy when stressed with 30% NaCl(8M) under aerobic and anaerobic condition. To challenge its survival rate; studies were carried out using *rpoS* mutant strains of wild-type, as this alternative sigma factor is known to induce protection in stressed condition. Stationary phase wild type cells grown in LB and M9+0.4% glucose survived at least for 24 hr. under stressed condition as oppose to wild type log phase cells which survived till 3 hr. Similar analysis with mutant strains showed decrease in % survival, confirming essential role of rpoS gene in induction of stress-regulatory rpoS-dependent genes. However anaerobic condition showed varied results for both wild type and mutant log phase cells with increase in % survival upto 6 hr. Relative gene expression analysis of mutants with respect to wild type cells in different media put forth dependence of kdpA, kdpB, kdpC gene on rpoS and proV, proW, proX being independent of rpoS in stationary phase mutant cells. However log phase mutant showed down regulation of most of the genes; as it's an active growth phase of the cells where transcription of stress regulatory genes is not required.

Name of the student: Shivpoojan V. Tiwari

Title: "Designing Mammalian Expression Vector for Co-expression of DUOX2 and its Co-factor DUOXA2 for Enhancing Radiation Effect of Breast Cancer Cells"

Abstract: Dual oxidase 2 (DUOX2) is a glycoflavoprotein belongs to NADPH oxidase family. It is a plasma membrane-targeted hydrogen peroxide generator containing peroxidase-homology domains. As H_2O_2 generator it forms a stable complex with its maturation factor Dual oxidase Activator A2 (DUOXA2) and re-locate from endoplasmic reticulum to the cell surface for its functional maturation and activation. Hence co-localization of DUOX2 and DUOXA2 at the cell surface membrane is mandatory requirement for the fully functional H_2O_2 generating system. In this study, we demonstrated membrane localization of DUOX2 in MCF7 breast cancer cell line by overexpressing DUOX2 and DUOXA2. We tagged DUOXA2 with a reporter protein TurboFP635 (Katushka) in order to visualize co-localization of DUOXA2 with DUOX2 at the surface of the BC cells under the microscope. Moreover to mimic the natural expression system we also attempted to overexpress DUOX2 and DUOXA2 in breast cancer cell line under a single promoter by utilizing ECMV-pIRES vector system.

Generation of reactive oxygen species (ROS) from DUOX2 is known to have significant roles in thyroid hormone biosynthesis and innate immunity in normal physiology. However in cancer cells increased ROS induces oxidative stress which further increases upon radiation exposure and can lead to DNA double-strand breaks causing genomic instability and apoptosis. So, radiotherapy is one of the prime treatment modality to eradicate devastating breast cancer cells, although it often causes severe side effects due to the off target effect.

Therefore current focus is to minimize the dose of radiation by identifying genes/agents that may show radiosensitization. So, in the present study an attempt was made to radiosensitize MCF-7 BC cell line through alteration of DUOX2 gene expression by development of the bicistronic overexpression system in vitro.

MSc External Projects

Name of the student: Faiza Sayed Zaheer

Title: "Biochemical and Molecular Characterization of Mutants and Genotypes of Chickpea (*Cicerarietinum* L.)"

Abstract: Chickpea is an important legume grown worldwide. Mutagenesis is widely used to induce mutations in chickpea to widen the genetic base in this crop and to develop genotypes of agronomic importance such as early maturity. In addition, morphological mutants generated through mutagenesis are important genetic repository that is useful in studying the basic developmental genetics of the plants. In the present study, attempts were made to characterize some of the chickpea mutants generated though mutagenesis using ionizing radiation, particularly gamma rays and electron beam irradiation of a chickpea cultivar 'Vijay'. An early maturing mutant generated through electron beam irradiation was compared with the parental genotype using simple sequence repeat (SSR) markers. Both genic and non-genic SSR's were used. Of the 142 SSR's screened 9 (7 non-genic and 2 genic) showed polymorphism between parent and the early mutant. These polymorphic markers were also compared with other early maturing varieties to reveal the genetic differences at these loci. Two of the polymorphic marker bands were also cloned for sequence analysis. Additionally, a morphological mutant showing defects in leaf development with elongated leaves and pods as compared to the parental geneotype was also characterized. The expression of three genes known to regulate leaf development viz. *Rotundifolia 4* (*Rot 4*), *Rotindifolia 3* (*Rot 3*) and *Angustifolia*(*An*) was studied in the mutant using quantitative real time polymerase chain reaction (qRT-PCR). *Rot3* and *An*genes were found to be downregulated in the mutant as compared to the parent. Phytic acid is an important anti-nutritional factor present in legumes including chickpea. In the present study, harvests of two segregating F2 populations derived from two different crosses having contrasting phytic acid contents were also analysed for phytic acid content in the seeds. Transgressiveseggregants having very low phytic acid were obtained. The results obtained in the present study will be useful in selection of genotypes having lower phytic acid content with higher yield in an ongoing chickpea breeding program

Name of the student: Domnic R. Noronha

Title: Impact of Radiation Processing and Storage on Volatile Compounds of Cauliflower (*Brassica oleracea*)"

Abstract: Ready to cook products are those which are being processed minimally in such a way that they can be consumed readily. Radiation technology can be employed in order to protect the food from pathogenic microorganisms as well as to increase its shelf-life, however the treatment might induce formation of volatiles responsible for off-flavor, thus it is necessary to analyze the volatile formation from irradiation of cauliflower.

The aim of the present study was to analyze aroma profile of minimally processed cauliflower samples after subjecting it to gamma irradiation dose of 0.5kGy and a parallel study on impact of storage on the aroma profiles was conducted. Since 0.5kGy dose of radiation was found to be suitable for extension of shelf life while maintaining sensory and microbial properties acceptable

Fresh Cauliflower pieces were packaged into plastic trays and were irradiated at 0.5kGy dose. These were stored for a period of 21 days, and were subjected to aroma analysis periodically at 0,7,14 and 21 days. Volatile extraction was done by Head Space solid-phase microextraction (HS-SPME) and volatiles were analysed by GC-MS .

A total of 33 volatile compounds were identified in non-irradiated and 0.5 kGy irradiated samples which were found to belong to chemical classes of acids, alcohol, aldehyde, esters, furan, ketone and S-containing compounds. S-containing compounds were detected as major volatile compounds in all experimental samples. Though the content of several compounds increased after irradiation, content of major S-compounds such as methanethiol, dimethyl trisulfide, dimethyl tetrasulfide, dimethyl methyl (methylthio) methyl was found to decrease after irradiation processing.

Radiation processing didn't bring any adverse qualitative changes in the volatile constituent of cauliflower till 21st days storage. Application of low dose irradiation was found to be suitable for maintaining aroma quality of minimally processed cauliflower.

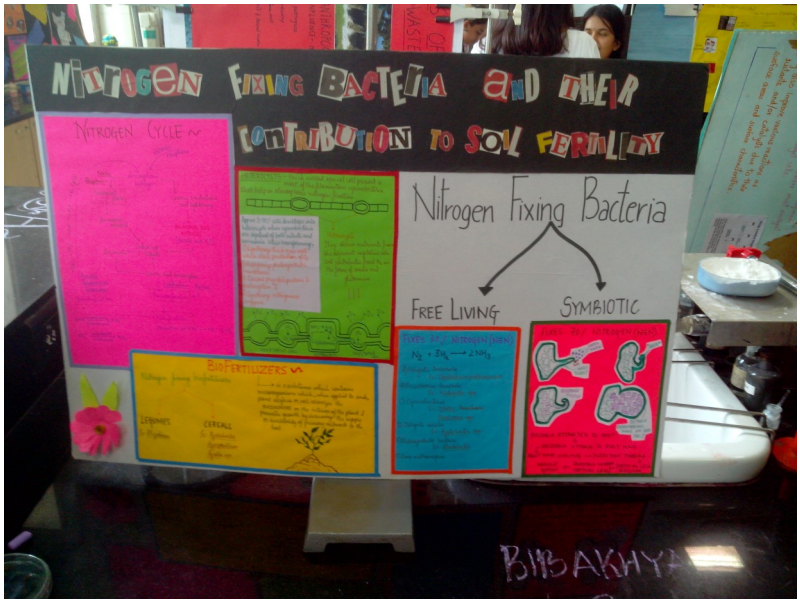
MSc Internal Projects

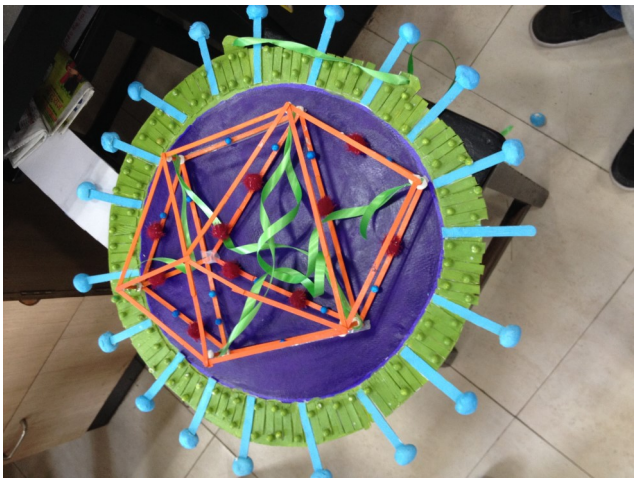
Sr.No.	Name	Title of Project	Guide
1	Abdul Kareem Ansari, Sufiya Ansari, Shweta Singh, Brenda DSa, Stina Fernandes	Microbial Degradation and Detoxification of Azo dyes.	Dr. (Mrs.) Pampi Chakraborty
2	Ashish Jagtap, Rupali Koshti,Jenifer Nazareth, Dominic Noronha, Ruby Paulose	Isolation and Extraction of Biocolour from Microorganisms and it's Application	Dr.(Mrs) Aparna Talekar
3	Ravela Da Cruz, Fleur Fernandes, Jovil Gomes, Lata Gunda. Ankur Jadhav	Plant growth promotion bacterial consortium for the cultivation in Organophosphate rich soils	Dr. (Mrs.) Pampi Chakraborty
4	Mansi Lotlikar, R. Rajkumar Raghupathi, Ashlin Roche, Faiza Sayed Zaheer, Shivpoojan Tiwari	Bacteriophage therapy: A Potential Remedy Against Bacteria Causing wound Infections and Biofilms	Dr.(Mrs) Aparna Talekar

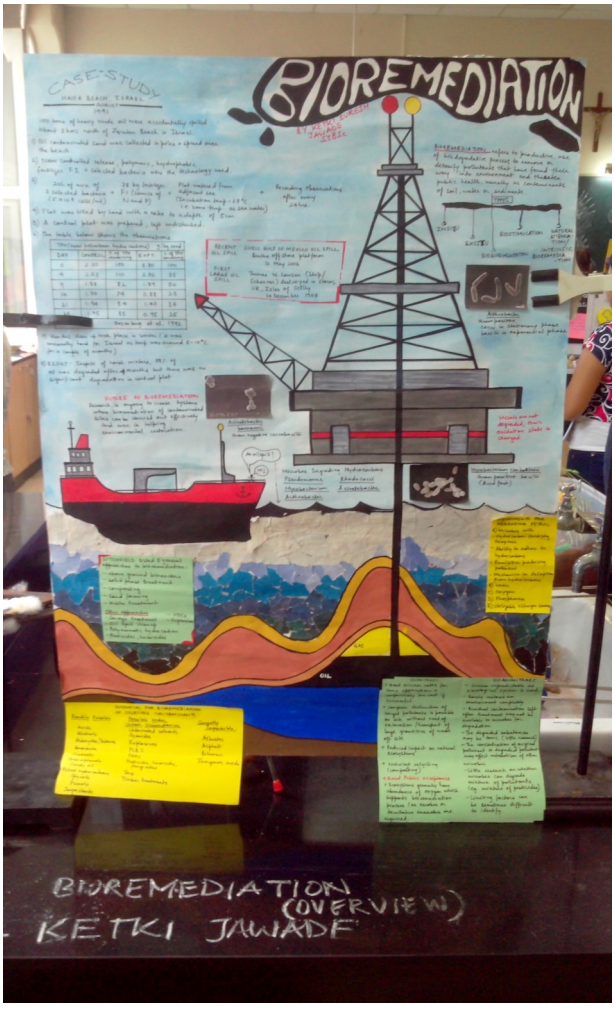
It's not just about science!

(events)

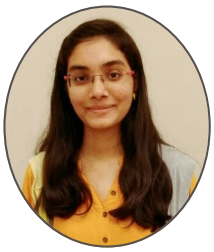
Game of μ'bes - Exhibition 2016







Game of μ'bes - Exhibition 2016



Rimjhim Bali
FYBSc 2016-17

On our first day of college, we, the FYs were invited to attend "**The Game of μ'bes**",an exhibition organized by our SYs to familiarize us with the department and the various fields of Microbiology. It was a two- day event. We were really excited to see the exhibition and curious to meet our seniors.

We witnessed the inauguration of the exhibition by our respected Principal, Dr. Baptist Agnel Menezes. That was the first time we entered the laboratory and were thrilled to see many colourful exhibits. Following this, we were divided into groups and directed towards different tables. The exhibition covered various fields of Microbiology like medical, agricultural, environmental, food and general topics which covered different lab techniques and topics related to general awareness .

In the beginning, we were given a brief introduction about classification of organisms, their history, the various types of media, methods of control of microbes and different techniques. It was for the first time that we observed growth of microbes on different media and the growth patterns of colourful organisms looked beautiful. It was beyond our imagination that a "colony" of microbes is seen as a visible mass on media while a single cell is microscopic. It was a new experience to observe stained microbes under the microscope.

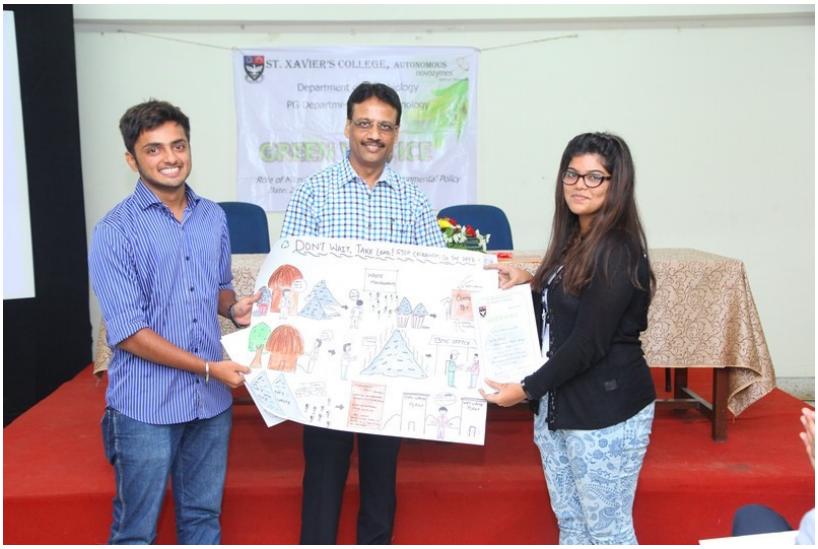
We then moved on to the Medical Microbiology section which covered different diseases and their diagnostic techniques, toxicology and effect of antibiotics on microbes. We got to know about a lot of new facts about common diseases and disorders, which we were unaware of till then.

Agricultural microbiology focused on the role of microbes in the field of agriculture, comprising of genetically modified crops, Nitrogen fixing organisms, *Agrobacterium* gene transfer etc. Food and Industrial Microbiology covered both positive and negative effects of microbes. Microbes can be helpful in fermentation processes like wine production, but can also cause food spoilage, hence certain preservation methods are employed to keep microbial population under check.

Environmental Microbiology introduced us to some new terminologies like Bioterrorism, Bioremediation, Aquaponics and Microbial interactions.

It was a great experience as we got to learn new things. However, there were a few concepts that were beyond our understanding at that time, but the SYs were enthusiastic and patient enough in helping us understand those concepts. The beautiful exhibits and attractive models made the learning process interesting and easier. The exhibition was a great initiative by the department in making us feel more comfortable in the new environment. We were amazed to see that the organisms which we cannot even see play so many roles. At the end of it, we learnt an important lesson of never underestimating the potential of small organisms, as every organism plays an important role and it should be appreciated.

Green Voice



Green Voice was an event organized and hosted by St. Xavier's College, Mumbai under the guidance of Dr. Vivien Amonkar, the former Head of the Microbiology and PG Biotechnology Departments, with constant support of the principal, Dr. Agnelo Menezes. The event began with a panel discussion, highlighting the topic, "**Role Of Microbial Biotechnology In Environmental Policy"**. Eminent personalities from different sectors of science came together and enlightened the students with their personal experiences, highlighting the often neglected problems in science, which they will have to find solutions to in the future. Mr. G.S. Krishnan, Regional President of Novozymes, who were also our event sponsors, short listed the various sectors where microbiology and biotechnology play an important role. He used examples from daily lives to enable students to understand the urgent need of their significance and efficient implementation. He emphasized on designing products that would meet the demands of the local people and the struggle to make the masses understand the benefits of biotechnology. For example, for the Indian population in particular, the detergent composition should be designed in a manner that is effective against curry stains, as it is one of the most important ingredients in the Indian cuisine. He also stressed on the conversion of biomass into biofuel, specifically ethanol, to ensure that the waste material is also utilized productively, which supported the often quoted adage, "Waste is not waste until it is wasted." He made us aware about a newer avenue in science-The Industry-where one many years of practice come into play. Next in the panel was Mr. Vishal Jajodia, an industrialist from Vapi, Gujarat. His relentless and sincere efforts have helped him scale new heights of success. He focused on how various policies are laid down in the constitution, but have not been implemented till now, which results in utter unrest in the society. His mantra in life is to have faith in yourself, which when supplemented with sincere hard work, can help you to turn your dreams into reality. His life was an apt example for everyone and an inspiration for budding scientists and researchers sitting in the crowd. Ms. Jyoti Mhapsekar, an environment activist, who has worked with Trimurti Sangathana for the past many years was also a part of the panel. She focused on certain areas which need immediate attention in the present scenario. For example, she expressed her disappointment with the government's new policy of incineration of wastes, as it leads to air pollution, which further deteriorates the quality of the environment.

She focused on the different measures, which we as responsible citizens of the country should take; like dumping grounds should be gotten rid of, and as citizens we should take a strong stand in front of the government about matters like this, as dumping grounds lead to seepage of harmful toxins into the ground, further polluting the soil and water table. Wastes at the local level should be segregated properly to ensure the safety of the people involved in waste management processes. She made us realize that on humanitarian grounds, it is our duty to treat everyone as equals and not risk the lives of people who are involved in waste collection and disposal sectors.

Prof. Mukesh Pandya, the former Head of the Microbiology department of Jai Hind College, made students aware about

the importance of in depth knowledge of science in the real world. His life experiences were an inspiration for everyone,

and he remarked that feeding on knowledge and passionately following a subject would surely make one successful. His experience as a professor, and even in the industry, gave everyone an overview of how practicality and confidence can help one reach places.

Dr. Agnelo Menezes, our principal, motivated the students to use their knowledge as science students and enter the policy making system of our country, in order to be a part of the change that we as citizens wish to witness. He spoke about the importance of welfare of the society and focussed on the aspect that money does not and should not take the topmost position in one's priority list, as it is our duty to think about the welfare of our fellow country mates also. The panel discussion was followed by a poster making competition, which culminated into a valedictory function to

appreciate the hard work and creativity of participants from various colleges of Mumbai. Mr. Chandrashekhar Chore, Deputy Commissioner of BMC, also graced the occasion with his presence.

Mr. Ovais, the H.R head of Novozymes, encouraged students to initiate small changes at home, which would ultimately

lead to bigger changes in the society. For example, by avoiding the use of plastic bags and discouraging others from using

them as well, can contribute immensely towards the betterment of the society. The Green Voice event opened students' minds towards the need of proper policy making and its efficient implementation to ensure a healthier environment.

"When hard work paid off..." Dr. Sachin's talk And Michronicle 2015 Release

'The Michronicle' is the annual magazine of our esteemed Microbiology Department. Its contents include scientific articles written by microbiology students, internship summaries, research projects, achievements of our faculty members, events hosted by our department during the academic year and more. Each year, the magazine release is accompanied by cultural activities organized by our students and faculty members. These events range from pop quizzes to dance performances to talks by our distinguished alumni or guest lecturers.

The 2015-2016 edition of the magazine was released on August 24th 2016. The Michronicle team, along with our faculty, organized an insightful talk by our valued alumnus **Dr. Sachin Rajan,** who was also the chief guest of the event. Dr Rajan works as an advisor at the CEO/CXO level in multinational corporations. He did his BSc. from St. Xavier's College, Mumbai, followed it up with an MBA and finally returned to the field of healthcare. In his talk, Dr. Sachin Rajan spoke about a career beyond science, such as pursuing an MBA and then working in a pharmaceutical company as a health manager. This talk made our students realize that studying Microbiology opens up several career doors in diverse work domains. This event was attended by all the teachers and students of our department and also by our Principal, Dr. Baptist Agnelo Menezes.

Post the talk, our intrigued students had an interactive session with Dr. Rajan, where he answered all our questions. Then the Editor-in-chief of the magazine, Ms. Wynola Williams gave a short introduction of **'The Michronicle',** which was followed by her heartwarming thank you speech to the faculty as well as her team. Then our respected Principal gave a short speech, after which the magazine was officially released. Gift wrapped copies were given to our respected Principal, our esteemed chief guest and our beloved Head of Department Dr. Vivien Amonkar.

Following this, the teachers of the department said a few words and then Ms. Enid Mendoca, our in-house soulful singer sang a song for the audience. Soon after the performance, the audience was directed towards the foyer where refreshments were served. All the SY and TY students read the the magazine while conversing with each other. These interactions left everyone with a feeling of satisfaction, which eventually made the event a success.

Pleasant Surprises...Dr. Swaine Chen's visit (Genome Institute of Singapore)

St. Xavier's College, Mumbai's departments of Microbiology and Biotechnology were graced by the visit of the eminent scientist, Dr. Swaine Chen, M.D., Ph.D., on Friday, December 2nd , 2016. This one-and- a-half- hour session was attended by students of both the departments. Dr. Chen graduated from Stanford in 2004 and is currently a senior research scientist at the Genome Institute of Singapore and an assistant professor at the National University of Singapore, Yong Loo Lin School of Medicine. He is also part of the American Society of Microbiology and the Indian Journal of Microbiology. Although his schedule did not include coming to Mumbai, he took a special detour to visit our departments as he holds them in high regard. The reason behind his special visit was ourvery own biotech alumnus, Varnica Khetrapal, who was his Ph.D. student and has done us proud by her work in his laboratory. The session titled 'Definitive elucidation of virulence mechanisms: Lessons from *Campylobacter* for understanding why bacteria cause disease?' was held in the MMR. By asking a simple question, he opened a Pandora of possibilities about the causes of Urinary Tract Infections (UTI), the pathogenicity of microbes involved, and the molecular methods employed nowadays to prevent such infections. He demonstrated how the collaboration of experimental and computational methods has enabled us to pinpoint that only one gene of *Campylobacter jejuni* was responsible for abortions in sheep in the U.S. His experimental methods involved using Guinea pig model assays to check for abortions, by comparing the assay results with closely related non-pathogenic strains and by using natural competence to obtain these results but he did not stop his investigation there; his laboratory colleagues went ahead to develop methods to create definitive genetic mutations which would remove these disease-causing nucleotide sequences. They not only mutated the laboratory strains, but also the clinical ones. Their strategies included the use of molecular negative selection with inducible toxins to select the clinically relevant *Escherichia coli* and *Salmonella* strains. This method was different from the previous negative selection methods, as it involved no strain modifications in E. coli. Thus the design allowed allele-specific transfer between arbitrary *E. coli* with no help from the phages. The advantage of the method was that it made it possible to carry out definitive genetic experiments between the laboratory and clinical strains of *E. coli* and other *Enterobacteriaceae*. After his presentation, an interactive session was organized in which he answered all our questions. This session enabled us to understand his designs even better, as many of us were curious to know about the strategies he implemented in his research. Hence, this was a very informative and innovative talk that will be helpful for us in planning our projects in the semesters to come.

"Mutation is the substrate on which evolution acts."

-Swaine Chen

Some Goodbyes are hard to say... Professor Vivien Amonkar's Farewell

"Students …now take a fresh sheet of paper" is a statement that any student who has been taught by Professor Dr. Vivien Amonkar would recall without hesitation. Professor Vivien, the former Head of the Microbiology and the Biotechnology Departments, graduated from St Xavier's College, Mumbai (autonomous) and taught microbiology in the very same college for over 30 years. She is highly reputed and revered in college, and had contributed significantly during the transition of the college towards autonomy. According to her students, being the perfect combination of beauty and brains, Vivien ma'am was referred to as "Future goals" by several students. Professor Vivien Amonkar retired in 2016 and a grand farewell ceremony was held in her honour.

The ceremony began by Vivien ma'am being accompanied by fellow Microbiology department professors to the Multi media room (MMR) and was graced with applause and appreciation. The event was organized by the UMAX (Undergraduate Microbiology Association of Xavier's) team. The ceremony began with kind words from fellow UMAX members, enriched by a beautiful melody and delightful speech from, the former principal, Reverend Father Frazer Mascarenhas, which was followed by an enlightening speech from the current Principal Dr. Agnelo Menezes. The ceremony, then proceeded with a humorous sketch, organized by the second year students, highlighting Professor Vivien's teaching mannerism and regular phrases. Following the sketch, was an emotional video montage consisting of Third year and M.Sc students expressing their feelings and gratefulness of having being taught by her. This sequence of events led to only a few dry eyes in the room, Professor Vivien being teary eyed, addressed the crowd with thoughtful words, immense gratitude and a heavy goodbye.


NO SMOKING

From a Student to a Teacher

Prof. Miriam Stewart
HOD, Microbiology
Alumna 1979 - 1984

Professor Dr. Vivien Amonkar has been closely associated with St. Xavier's College, Mumbai since June 1973, when she joined the first year of Inter-Science as Vivien D'Mello. She graduated in Microbiology in 1976 and pursued an MSc by research in Microbiology, under the guidance of the then Principal Dr. Lancelot Pereira S.J. and obtained a part-time job as a Demonstrator during this period. As a student, Vivien involved herself in several college activities like the SSL and the COSIP program of the college. After completing her Masters in 1979, she was immediately taken in as a faculty member in the Department of Microbiology and I was fortunate to be a part of the first FYBSc batch of senior college she officially taught. In April 1980, she married her college sweetheart, Nihar Amonkar.

Vivien is an excellent teacher and guide, her forte being Biochemistry. She ensured that all her students were equally involved in classroom sessions and understood the concepts well. There was never a dull moment during her lectures. She evolved into a great teacher and an educator, and was sought after by the Microbiology faculty of other colleges for her expertise in the subject and her innovative methods of teaching.

The period 1988-1990 was both momentous and difficult for Vivien when she became a mother for the second time, obtained her PhD under the guide ship of Dr. Lancelot Pereira S.J., and assumed Head ship of the Department of Microbiology in 1989. As the Head of the Department, Dr. Vivien Amonkar introduced several good practices to enhance student learning. The Annual Exhibition, which encouraged peer learning and bonding between junior and senior students, internships, project work, programs that encouraged social responsibility in students, collaborations with other Microbiology Departments in India and abroad and with industries, were all her brain-child. This helped our students to attain quality education and many were accepted in top institutes and universities in India and abroad. She used her expertise to help several college committees she was placed in during her tenure.

Dr. Vivien helped start the Postgraduate Department of Biotechnology in 2007 and undertook headship thereafter. Here too, the department flourished under her headship and the best students enrolled for their Masters in Biotechnology.

She was invited several times to take up the post of Vice Principal of the college, which she finally accepted in 2005. She assumed the post of **Vice Principal-Science** and later was made the **Vice Principal for Academic Improvement.** Along with the then Principal Dr. Frazer Mascarenhas S.J. and a very able committee, she ventured into the realm of **Autonomy practices** for our College. Vivien spearheaded the change, gathering relevant information and attending seminars all over India and abroad, so that the best practices could be put together to enable the college to become Autonomous. She was indeed the **Architect of**

Autonomy in our college and the University of Mumbai. Her expertise has become an invaluable resource for so many colleges which are at the brink of Autonomy. She was invited to join the IQAC committees of several colleges to share the resources she had gathered. During her tenure as Vice Principal, she was fortunate enough to welcome several dignitaries, President Obama and his wife Michelle, Senator Hillary Clinton and His Holiness, the Dalai Lama amongst others.

During and after serving for six years as Vice Principal, she continued as **Head of the Microbiology and Biotechnology Department** and introduced several programs for the benefit of the students and staff. Few of the several Initiative programs introduced are Palindrome, a Biotechnology fest, International Conference to celebrate the 75th and 80th Anniversary of the Microbiology Department, Staff Educational tour to University of Bath, UK, Alumni dinners to bring the past and present students together, seminars on Entrepreneurship , Food Microbiology, Pharmaceutical Microbiology, Consortium and Green Voice on Environment and Policy. She roped in Alumni with her charm and ability to remain connected and collected over a crore of rupees for the Microbiology Department. Thus, with the Principal's consent, she renovated both the Microbiology and Biotechnology laboratories into sophisticated and well equipped ones, perhapsthe best in the Mumbai University. Vivien's dynamism, her ability to multitask, make quick and correct decisions, her dependable, friendly and compassionate nature, her ability to be sensitive to the needs of both teaching and non-teaching staff, her positive outlook to every problem, her good interpersonal relations and her loyalty to the college, stood her in good stead as she played the several roles she was entrusted with, to take the college to the greatest of heights. In 2016, a few months before she retired, the University of Mumbai conferred the title and post of "Professor" to Dr. Vivien, a post which was long overdue and well deserved. We, in the department celebrated and were very proud of her achievement. It was the crowning glory of an illustrious career.

We miss Vivien's vivacious smiling face, her unbiased decisions, her eye for detail and the smallest mistakes in our question papers, and the Superwoman she is. We pray that God blesses her in the years of her retirement and may she keeps herself healthy and busy with what she likes doing most, enriching young minds.

‘A breather which we all wait for; needless to say, the professors too’ - A Micro Break - Khandala Seminar

Our excitement was building up right from the moment we got to know that this year’s Khandala seminar was clubbed with the industrial visit to Sula Wines, Nashik. This visit was like a cherry on top of a ‘chocolate’ cake. After having a lovely family time during Christmas vacations, this trip helped us in extending the holiday mood for a few more days. Finally, it was time for all our excitement to turn into reality.

After a tiring day at Xavier’s, exhausted souls of SYs and TYs boarded the bus. With the screech of the bus, it seemed like everyone gained back their energy. The journey started off with the song ‘Chalte Chalte’, continued with ‘Ajeeb Dastan hain yeh’ and finally ended with ‘Yellow’. These antakshari sessions were interrupted with some aww moments; admiring the tunnels, observing curves of the mountain roads and the rapture of viewing the bright green scenery outside.

We reached our destination, ‘St. Xavier’s Villa’ at around seven in the evening and headed to our rooms. After freshening up, everyone gathered for evening snacks and tea. This was followed by a review session of the department by the students. Several aspects were discussed right from the methodology of learning, to syllabus, to laboratory facilities and the future scope for improvement in these areas. The session ended with fun activities organized by the UMAX committee, which also helped us imbibe qualities like team building and group discussion. Twenty years down the line, when we will swipe through these pictures and try to recollect these memories; be it the late night ‘antakshari’ sessions at khandala, or the early morning call for breakfast by our beloved Miriam Ma’am, these incidents will fill our hearts with emotions and we might be tempted to reach out to our phones and have a long conversation with our last bench class partner or with that friend who we used to have those never ending conversations with in the foyer. Next morning we had a brief session on the internships done by our TYs. This was an enriching interaction for all of us. After lunch, we had the best time of our seminar- UMAX had organised a treasure hunt event. All of us, including our teachers were divided into four groups and the task involved solving clues to reach to the ‘Bible of Microbiology’ (Prescott). The game extended till late evening until one of the teams could actually solve the last clue and find ‘Prescott’ camouflaged onto the blackboard.

This was indeed a tiring day and everyone planned to take some rest, since next morning we had leave for Sula wines. But our adventurous minds didn’t stop us from exploring the villa in the unusual beauty of the dimly lit night. It was as if Tagore’s ‘When I go Alone at Night’ is not anymore a mere imagination! The bus journey from Khandala to Sula Wines was rather a peaceful one. We woke up to find that we had halted at a highway dhaba to have lunch. Finally we reached Sula Wines and were charmed by the beauty of the place. A guide accompanied us through our visit. This was a big opportunity for us to actually observe the processes involved in the making of wine, right from the crushing step to the fermentation step. The huge fermenters

and the barrels used for ripening of wine were things which we had never seen before.

Although the tour was small, we got to see the practical application of our theoretical knowledge. The trip was a memorable one and we are already waiting for next year's industrial visit.

Bidding Adieu... TY Farewell

Pyjama attired students, fellow male students draped in sarees and the Emoji Awards are only a few words to describe the farewell ceremony of the Third year Microbiology students and M.Sc part II students of the year 2016. The farewell ceremony was held in the St. Xavier's College hall, organized by the second year microbiology students.

The farewell started off with a gracious and traditional dance, followed by an energetic and thrilling performance to the infamous "Thriller" by Michael Jackson with a fusion of Bollywood music. The event was then followed by video montages, made by the Second and the Third year students, consisting of Foyer and Post Laboratory session scenes, leaving the audi-

ence cackling with laughter and mixed emotions of nostalgia and farewell.

The event then proceeded with one of the best events of the afternoon , which was a time based 'Fashion Diva show', in which a time frame was allotted to the students and they draped a fellow male student in a sari, of course followed by a ramp walk. This was followed by an inspiring and motivational speech from Professor Vivien and Professor Miriam with a slight tinge of sentimentality, then a light break with delicious bites.

The Emoji awards, was another interesting event organized by the second years, but delivered by the third year students. This was a personal and interactive event, which involved cardboard cut outs of whatsapp emojis being awarded to fellow classmates by the third years, resulting in hilarious encounters and merriment.

The farewell ceremony then approached the end, with a few students expressing their gratitude and thoughts about the Microbiology department, followed with wise words and blessings from all our professors. The ceremony then came to an end with a small dance session, fellow students taking pictures for college reminiscence and bidding adieu.

Other Events

1. The Department, under the leadership of Faculty member Ms. Sangeetha Chavan, initiated the task of Solid waste management in our college with a talk on "Solid Waste Management in Mumbai" by Ms. Sindhu Iyer of Stree Mukti Sanghatana on March 8th, 2017 in the SCAVI. The talk was attended by our MSc students.

2. DBT Star 2017 grant: Our department was one of the seven departments awarded the DBT Star 2017 grant for the purchase of instruments and chemicals. We purchased several new instruments; viz Multichannel pipettes, variable pipettes, Loop Sterilizers, High-end electrophoresis apparatus, Microscope with camera and the Fire buoy.

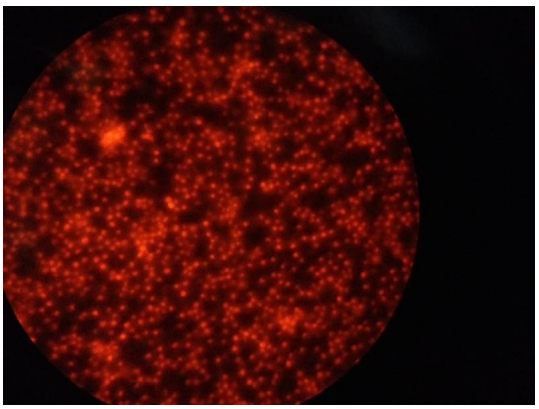
3. Career Guidance seminar was held on the 28th of April, 2017 for BSc and MSc students. Three speakers were invited. Gillian D'Souza for Science writing in India.

4. Mrs Asha Sridhar for Careers in the Food Industry, and Mrs Yogita Narwekar for Entrepreneurship. The talks were very inspiring and informative and students obtained immense information about careers in each of these fields.

Honour's Programme

Co-ordinator - Ms. Sangeetha Chavan

CLASS	ACTIVITY
FYBSc	**Workshop on Antimicrobial effects of plants, herbs and spices - April 1st week** **Participants - 7 FYBSc students** Students studied the antibacterial effects of aloe vera, clove, onion, garlic, ginger, pepper, cumin, turmeric, capsicum, fennel, cinnamon using ditch plate, agar cup and disc plate techniques. Students used powders of the plants, herbs, spices, prepared their water and solvent extracts to check their antimicrobial activity. **Conducted by - Prof Miriam Stewart for 2 credits.**
SYBSc	**Project - Study of cytotoxicity of chemicals - April 1st week** **Participants - 19 SYBSc students** Students were trained in animal tissue culture technique and they also studied the effect of chemicals on tissue culture. **Conducted by - Dr. Pampi Chakraborty for 2 credits**
TYBSc	**Lecture series - Intellectual Property Rights - July** **Participants – 11 TYBSc students** Students were made aware about the different kinds of patents, patent laws of various countries, misuse of patents etc., which would help them become aware and responsible scientists in future. **Conducted by- Dr. Biswaprasun Chatterjee for 1 credit**



Staff Achievements

A. Compilation by Faculty of the Department of Microbiology:
BIOSAFETY GUIDELINES FOR MICROBIOLOGICAL WORK in St. Xavier's College, Autonomous, Mumbai, which was released on 21st June, 2016.

B. Papers published

1. Gokarn K, Sarangdhar V and Pal RB (2016). Ethanol extraction method for DNA isolation from *Mycobacterium smegmatis*. Int. J. Curr. Res., 8(9): 39013-39015.
2. Gokarn K, Pal RB, Sarangdhar V (2016) Cloning of *Mycobacterium smegmatis* Exochelin MS genes fxbA, fxbC and exiT in *Escherichia coli*. Mol. Biol., 5:176, doi:10.4172/2168-9547.1000176. Impact factor 2.
3. Gupta PK, Chakraborty P, Kumar S, Singh PK, Rajan MGR, Sainis KB (2016). G1-4A, a Polysaccharide from *Tinospora cordifolia* Inhibits the Survival of *Mycobacterium tuberculosis* by Modulating Host Immune Responses in TLR4 Dependent Manner G1-4A, a Polysaccharide from *Tinospora cordifolia* Inhibits the Survival of *Mycobacterium tuberculosis* by Modulating Host Immune Responses in TLR4 Dependent Manner. PLoS ONE 11(5): e0154725. doi:10.1371/journal.pone.0154725. Impact factor 3.2.

C. Paper presented
Stewart, M., Padalia, U., Rawat, K.P., Sarma K.S.S., 'Study of the survival of *Candida albicans* exposed to Gamma irradiations' at the National Conference on 'Fungi from Diverse Habitats and their Biotechnological Applications' which was organized by Satish Pradhan Dnyanasadhana College, Thane, College of Arts, Science& Commerce on December 2nd and 3rd, 2016 and she won the first prize for her presentation.

D. Resource person: Professor Dr. Vivien Amonkar
1. Higher Education Pedagogy for the 21st Century' for the young Faculty of St. Joseph's College, Bangalore - 7th June, 2016.
2. day Seminar cum workshop on 'Higher Education Pedagogy for the 21st Century' for the Faculty of the Philosophy Department, Loyola College, Chennai - 8th and 9th June, 2016.
3. For guiding faculty in framing syllabi and starting programmes under Autonomy, a talk was conducted at Nagindas Khandwala College of Commerce, Arts & Management Studies and Shantaben Nagindas Khandwala College of Science, Malad, Mumbai on 23rd June, 2016.
4. Experience sharing on Autonomous Status' at the RUSA Sponsored Consultation Meeting on Autonomy on Sept 23, 2016 at St. Xavier's College, Mumbai.

Staff Achievements

E. Subject Expert : Professor Dr. Vivien Amonkar

1. Vice Chancellor's Subject expert- Microbiology: Selection Committee- CHM College- 20th June 2016.
2. Governing Body nominated Subject expert- Microbiology: Selection Committee- Professor Stage, Sophia College-18th August, 2016.
3. Vice Chancellor's Nominee, Selection Committee, Teacher Fellowship- Faculty Development Programme, CHM College - August 29th, 2016.

F. Seminars, Workshops and Conferences attended

Conferences attended :

A 2 day National conference by Satish Pradhan Dnyanasadhana College, Thane on 'Fungi from Diverse Habitats and their Biotechnological Applications' in association with Mycological Society of India on December 2nd and 3rd , 2016 was attended by Prof. Miriam Stewart.

Seminars and workshops attended

(i) 'Techniques and applications in Immunology'- organized by Department of Biotechnology, Jai Hind College was held on 29th June to 2nd July 2016 (sponsored by Lady Tata Memorial Trust), which was attended by Pampi Chakraborty.

(ii) Young teacher's seminar on Sensitization to Jesuit Ethos & Classroom Culture was held on 20th July, 2016 at St. Xavier's College and was attended by Dr. Aparna and Dr. Pampi.

(iii) Google drive workshop was held on 10th August 2016 at St. Xavier's College and was attended by all Department faculty.

(iv) Young Teacher's Seminar on Strategies for Optimizing Survival, with special reference to Classroom and Teaching was organized on 16th September, 2016 at St. Xavier's College, Mumbai. The resource person was Fr. Terence Quadros S. J. and the session was attended by Dr. Aparna and Dr. Pampi.

(v) Participation in M I G Lecture Series on 'Tuberculosis : Captain of All the Men of Death' was organized by Mumbai Immunology Group, held at National Institute for Research in Reproductive Health (ICMR) Parel, Mumbai, on the 13th of October, 2016 was attended by Ms. Miriam Stewart.

(vi) St. Xavier's College Staff Seminar on Stress Management was conducted on 4th October, 2016 by Fr. Charles Rodrigues S.J., titled 'Take a Break…. Before the Busy-You Breaks' was attended by all staff members of the department.

(vii) Dr. Pampi went for a Workshop on Bio-informatics to Khalsa College on the 28th and 29th of January.

(viii) A Workshop on 'Latest techniques on proteomics 'was held at Jai Hind college on the 8th, 9th, 10th and 11th February 2017, which was attended by Ms. Sangeetha Chavan.

Staff Achievements

(ix) NAAC Sponsored Seminar titled ' A New Dimension to Teaching, Learning & Evaluation' was held on the 1st of March, 2017 at Jai Hind College and was attended by Ms. Sangeetha Chavan.
(x) A one day seminar titled, 'Adapting to change' was organized by the college on 10th March 2017, and was attended by all staff members of the department.

G. Selection to the BOS of Microbiology
Miriam Stewart was appointed as subject expert in Microbiology on Ad hoc subject board (BOS) of Mithibai College in September 2016.

H. Member of IQAC committee: Prof. Vivien Amonkar was a member of the committee of Nirmala Niketan college of Home Science.

I. Ms Sangeetha Chavan was appointed as an external examiner for the 5th Semester TYBSc practical examination at Jai Hind College.

J. College Committees
(i) Dr. Vivien Amonkar was a member of the Institutional Biosafety Committee and Committee of Custodians of Answer Papers.
(ii) Ms. Miriam Stewart was the Convenor of the Infrastructure Committee and Committee of Custodians of Answer Papers.
(iii) Ms Sangeetha Chavan was Member of the Scholarship Committee, End semester exam committee and was Department Honour's Programme Co-ordinator.
(iv) Ms Karuna Gokarn was member of the Discipline Committee.
(v) Dr. Aparna Talekar was member of the Institutional Biosafety Committee.
(vi) Dr. Pampi Chakraborty was member of the Cleanliness Committee.

Our Shining Stars

- Saanjbati Adhikari, from the FYBSc, was one of 10 students in the country to be chosen for the POBE – 2017(Project Oriented Biological Education) programme under the JNCASR fellowship programme.

- Ms Neha Banwani and Mr. Avirup Sanyal, both from SYBSc, were awarded the JNCASR Summer Research Fellowship for the Programme 2017.

- Ms. Priya Khetan, Ms. Bibakhya Saikia, Mr. Avirup Sanyal and Mr Ritvik Chandavarkar, all from SYBSc, were awarded the Indian Academy of Sciences, Summer Internship Programme- 2017.

- Ms. Geervani M. was awarded the Indian Institute of Science Education and Research- Kolkata (IISER-K) Summer Internship Programme – 2017.

- Ms.Sanchi Dali obtained and internship with National Institute Of Immunohaematology, Mumbai.

- Ms. Rebekah D'Cunha won the second prize at the Poster Competition at the Green Voice seminar held by the Department and was awarded an internship by the sponsors Novozymes, Bangalore.

Another feather in their Caps

(SY Summer Internships)

NAME OF STUDENT	TOPIC WORKED ON	PLACE OF INTERNSHIP AND NAME OF GUIDE	DURATION
Avirup Sanyal	Studied the effect of selection for high dispersal ability on the resistance to bacterial infection and larval activity in laboratory populations of *Drosophila melanogaster*	Population Biology Lab, IISER Pune Dr. Sutirth Dey	April – May 2016
Mubasshira	Food Microbiology, Quality Assurance Medical microbiology	Taj Sats Air Catering Limited Cardinal Gracious Hospital, Vasai	Oct 2016 April – May 2016
Shreeya Tavkari	Food Microbiology, Quality Assurance Microbiology lab	Taj Sats Air Catering Limited Breach candy hospital Mumbai Dr. Aruna Pujari	Oct 2016 May 2016
Chadni Sanyal	Nanoparticles and their role as Biosensors	Bhabha Atomic Research Centre, Bombay Dr. Shilpa N Sawant	April – May 2016
Priya Khetan	Medical Microbiology and Serology	Microbiology Department, Jaslok Hospital	April – May 2016

"All we need is somebody to bind on" says who?

Ketki Suresh Jawade, Tinci Thomas Kalapilla - worked on Catalase
Chadni Sanyal, Shivani Dharmadhikari and Anish Ittoop John Vazhapilly - worked on phenolase

"Life could not have had a random beginning …..the trouble is that there are about two thousand enzymes, and the chance of obtaining them all in a random trial is only one part in 10 to the 40,000 power, an outrageously small probability that would not be faced even if the whole universe consisted of a single organic soup" - Fred Hoyle

We participated in the enzymology workshop organised under the aegis of Star College Scheme at Ramnarian Ruia College, Mumbai.

We chose to participate in this workshop because we liked the approach it was focusing on. We further benefited from it as it provided us with the widest possible set of skills which would definitely help us in future. We were given the opportunity to execute our own ideas regarding enzymes, which was supplemented with intensive reading and in depth understanding about the topic.

We now know that enzymes are biological catalysts that accelerate biological reactions. But how do we define a reaction? Through this workshop, we also tried to answer certain questions like, the reasons and mechanisms behind occurrence of reactions, modes to assess whether a reaction has occurred or not and the methods to measure the speed of reactions etc.

As student experimenters, we worked on the enzymes 'catalase' and 'phenolase' for a period of 5 weeks (April-May 2017) using potato as the source and focused on crude extraction, standardization of substrate, enzyme activity, purification and protein estimation. Catalase catalyses the decomposition of hydrogen peroxide to water and oxygen. It is a common enzyme found in all living organisms exposed to oxygen. It protects the cell from oxidative damage by relative oxygen species. Catalase is a tetramer of four polypeptide chains, each chain has over 500 amino acids. There are four porphyrin heme groups (iron) that helps catalase to react with H2O2. The presence of catalase can be tested by adding H2O2 on the source and observing bubble formation.

Since catalase has high specific activity, the result can be observed with naked eyes. Catalase is important as H2O2 is a harmful by-product, and to combat this problem, it has to be converted into less dangerous substances. Apart from this, catalase deficiency increases obesity, fatty liver and type 2 diabetes. Studies have also revealed that low levels of catalase results in greying of hair in humans. Hydrogen peroxide is naturally produced in the body, hence if there is deficiency in catalase production, hydrogen peroxide won't be broken down which will bleach hair inside out.

Polyphenol oxidase or PPO or phenolase on the other hand, is a member of the oxidoreductase group of enzymes. It is a copper containing enzyme catalysing the oxidation of phenolic compounds. There are two different reactions of the said enzyme. First, it catalyses the o-hydroxylation of monophenols to o-diphenols and then oxidises the o-diphenols to o-quinones. O-quinones are reddish-brown pigments. This enzyme is ubiquitously present in plants, fungi, animals and even in bacteria. We started off with the extraction process using phosphate buffer (freshly prepared), followed by filtration and centrifugation where the supernatant was used as the crude enzyme extract. Standardisation of catechol was done with the range being 0.2-1.0 mM (millimolar) and absorbance reading was taken at 276nm and 277nm simultaneously. The crude protein estimation was done by the Lowry's method as per the standard protocol. Appearance of quinone was then measured at 420nm and 480nm respectively (said lambda max). Then we went on to purify our enzyme using the ammonium sulphate precipitation method. Repetitive saturation and centrifugation was performed, followed by dialysis by continuously adding fresh buffer each time so as to increase the efficiency of the process. As per the requirement, the appearance of quinone was re-measured at wavelengths mentioned above. Lastly, the purified protein was estimated using the Lowry's method.
We worked under the guidance of Dr. Ravindra Phadke. This workshop was an immensely enriching experience as it gave us hands - on - training at relevant laboratory procedures and taught us how to troubleshoot possible problems one can face during experimentation.

Where Experience is Currency: Internship Experiences

Mubasshira
Place: Quality Assurance and Microbiology department, Sky Chef Catering Services, Mumbai
Experience: I had done an internship at Ambassador's Sky chef Air Catering Services in the Quality Assurance and Microbiology Department, during which I was assigned a couple of major projects. I had an opportunity to put my theoretical knowledge into practice. I was testing food samples as per the standard protocols, procedure of maintaining hygienic conditions etc. We checked the complaints of food from our clients, the procedure of which demanded skills and understanding. It was difficult for me in the beginning. However, my seniors and mentors were always ready and willing to share their knowledge and wisdom to guide me through.

Rebekah D'Cunha
Place: Novozymes South Asia Pvt. Ltd.
Experience: Internships are wonderful opportunities for gaining discovery, knowledge and experience in a certain field. I was lucky enough to receive a chance at Novozymes, to widen my view and to acquire information and skills in some applications of Industrial Microbiology. This internship was offered to me by a representative from Novozymes during the **'Green Voice'** program, which was related to biotechnology and sustainability, after winning second place for a poster making competition. Novozymes is a company that sells bioengineered microbial strains and majorly, enzymes. They use microbes to produce the enzymes they require and are constantly in search of more efficient enzyme producing microbes. They also use biotechnology to produce strains which will grow quickly and produce an enzyme optimally. These enzymes are used in making food, beverages and detergents, in leather and textile treatment, pharmaceuticals etc. However, their work doesn't stop after loading their products in containers. Scientists at Novozymes work in labs to monitor and assess the products that are used by the consumer, especially according to the customers' requests. And this is where I found myself interning - the grain processing unit within the Food and Beverages department of the Technical Services labs. Our unit assisted customers like breweries and sweetener producers. I was trained to use many instruments and softwares such as the HPLC instrument (analysis of ethanol and sugar content), the Rapid Visco-Analyzer (viscosity measurement) and the Leco protein analyzer. Additionally, I was trained in various manual methods such as liquefaction of grains, saccharification of whole mash, starch content analysis, ethanol quantification by weight loss (loss in carbon dioxide) and so on. This internship helped me understand many things beyond the manufacture of biological products - sales, monitoring and helping to optimize the usage of products, quality control and quality assurance.

Priya Khetan
Name of the institute: Bioinformatics and Medical Virology
Rajendra Memorial Institute of Medical Sciences (RMRIMS)
Name of the guide: Dr. Ganesh Sahoo
About the project: The internship I pursued in the summer vacation of 2016-17, was organized by Indian Academy of Sciences. In the Virology department, I worked with several viruses such as Hepatitis A,B,C,E, Varicella Zoster, Influenza A Virus, to name a few. The initial objective was to perform ELISA to diagnose a patient with a viral infection, isolate the RNA or DNA of the virus and run either Real time PCR or normal gel electrophoresis. I also worked with enteric viruses, Rotavirus and Adenovirus. My main objective was to determine the antiviral activity of Silver Nanoparticles synthesized biologically against the H1N1 virus. The silver nanoparticles were synthesized using Leishmania sp. and pure silver nitrate. Post which one study was performed, in which inhibition of the H peplomer of a clinically positive sample of Influenza virus was observed. The studies on this subject are still on going. In my time at the Bioinformatics department, I learned phylogenetic analysis in greater details and Docking, which is a tool used in Pharmacogenomics.

Bibakhya Saikia
Name of the institute: National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram
Name of the guide: Dr.N.Ramesh Kumar
About the project: Plant Growth Promoting Rhizobacteria (PGPRs) are known for their significance in promoting plant growth with several reported repercussions on the host plant. A similar plant growth promoting bacterium, L1E11 was isolated from the paddy field. It undergoes dual cultivation of paddy and shrimps and often involves continuous introduction of sea water to assist its growth. During its growth, it was shown to exhibit plant growth promoting activities such as production of Indole acetic acid, ACC deaminase and siderophore production. This isolate is an obligate aerobe, gram-negative rod, belonging to the class of Gramma Proteobacteria, phylum Proteobacteria. The colony morphology can be explained as circular with complete margin, mucoid, opaque and cream coloured on Zobell marine agar medium after 24hrs of growth at 37°C. The isolate having a higher ACC deaminase activity was manipulated to disrupt the ACC deaminase (*acds*) gene as a part of the routine lab study. The clones generated harboured kanamycin resistance and were the basis of the entire project where the phenotypic and biochemical differences were studied between the wild type and the clones, to see if any phenotypic difference was seen due to *acds* gene disruption. The clones provided were subjected to DNA isolations and 16s rRNA sequencing to confirm its similarity to the wild. Various biochemical tests were performed and utilisation of different sugars and amino acids, (known to be as root exudates) were checked as the sole source of carbon and nitrogen respectively. Similarly, utilisation of various plant polysaccharides like pectin, xylan and cellulose and activities like production of biofilm and indole acetic acid were also checked to verify the persistence of the ability in the clones as that of the wild

Ritvik Chandravarkar
Name of the institute: CSIR-IGIB, Delhi
Name of the guide: Dr. Shantanu Chowdhury
About the project: I did my internship through Summer Research Fellowship Program SRFP 2017 organized by I.A.Sc., Bengaluru . My project was based on the role of Quadruplexes in oncogenic promoters in the progression of cancer. The ability of Nucleic acids rich in Guanine to self-associate, has been speculated half a century before the discovery of the canonical form of DNA. The tracts of Guanine separated by other bases associate to form G-tetrads (G-quartets) using Hoogstein base pairing. These planar G quartets stack to form G-Quadruplexes(G4s). The formation of G4s has to be thermodynamically stable for spontaneous Hoogstein base pairing. They are formed spontaneously when G4 formation is thermodynamically stable against a weakened Watson Crick base pairing.
The rationale of this project was to study the factors that determine the stability of potential G quadruplex sequences. There are two explanations that can provide an understanding in search for the above factors. There could either be cations which can stabilize the G4 in vivo (as it does in vitro), which can also be performed by specific G4 binding proteins *or* by a greater tendency of the oligonucleotides of the potential G4 sequence to spontaneously form G4s even without/little influence of the above factors. Potential G-quadruplexes are commonly estimated by looking for consensus G rich sequence (GGG-N1-7)4(2).
Using Quadbase program and database of the University of California (Santa Cruz), potential G4 quadruplexes were determined in oncogenic promoters MYC, KRAS, FAS and AKT in the promoter region. Circular dichroism experiment of oligonucleotides of the promoter region of the above biologically significant G4s was conducted to obtain spectra to check the influence of factors by checking for G4 formation in presence of two monovalent ions : K+ and Na+ (aqueous chloride salts) in a set of concentrations and point mutations in potential G4 forming promoter sequences. Results obtained showed that G4 formation was influenced little (MYC) and greatly (AKT) by stabilizing cation concentrations. Point mutations strongly disrupted G4 formation.

Neha Banwani
Name of the institute: HIV-AIDS Lab at JNCASR, Bangalore
Name of the guide: Dr. Ranga Udaykumar
About the project: I did my internship through Summer Research Fellowship Program SRFP 2017, JNCASR. I was made a part of their ongoing project, which majorly revolved around synthesizing antibodies against HIV. *Lactobacilli*, since time immemorial, have been known to be colonizers of the human gut. It has been experimentally proven that, *Lactobacillus* form an intrinsic part of the gut micro biota and provide us with innumerable health benefits. The major aim of this project (of which my work was a subpart) was to enable the gut *Lactobacilli* strains to become competent enough to take up our recombinant plasmid (with a desired antibody gene), which would prevent HIV infection and proliferation.
The first step in this direction, was to transform *E. coli* MC1061 cells with the recombinant plasmid containing our gene of interest. *Gaussia luciferase* cassette was amplified from ptRKH3-Ldh-sLuc using the appropriate forward and reverse primers by normal Polymerase Chain Reaction (PCR). The vector backbone (VB) i.e. pNZ8048 and the amplicon were digested using appropriate restriction endonucleases, to produce complimentary overhangs. The VB and the insert DNA were purified and ligated together to obtain a recombinant plasmid.
E. coli MC1061 strain was used to make competent cells for incorporation of the recombinant plasmid, using traditional Calcium Chloride. Transformation of the competent *E. coli* MC1061 cells with recombined pNZ8048 containing the *Gaussia luciferase* cassette was performed. The transformants were screened to select colonies of the desired clones.

Avirup Sanyal
Name of the institute- Dr. B.R Ambedkar Institute of Biomedical research, North campus, Delhi University
Name of the guide- Dr. Vani Brahmachari
About the project- I did my internship through Summer Research Fellowship Program SRFP 2017 organized by I.A.Sc. Bengaluru .The ultimate product of the packaging machinery in the nucleus is a highly condensed complex structure known as Chromosome. Also, the association of DNA with histones creates a huge obstruction to the genetic information pathway, i.e. replication, transcription mechanisms as the transcription factors cannot access the DNA sequences, which is overcome by remodelling of the chromatin structure.
Ino80 is an essential protein during the early embryonic development of *Drosophila melanogaster*. It has been shown that the Polycomb response element and Trithorax Response element recruits the polycomb and trithorax group of proteins and regulate the transcription of 'HoX' cluster genes by either activating or repressing its expression. It is also known that IN080 binds to the PREs. A transgenic *Drosophila* was created to further investigate the transcriptional regulation by IN080 protein.
The objective of the short term project was to analyse the expression of the reporter gene, Lac Z and miniwhite using semi-quantitative RT-PCR in the third instar larval stage of following genetic backgrounds-

1. *+//+; Bxd.PRE//+; +//+; +//+*

+//+; bxd-PRE//+; dIno80$^{\Delta 3}$// +; +//+

I was also introduced to basic molecular biology techniques like Cloning, Polymerase Chain Reaction, DNA and RNA extraction, c DNA preparation, plasmid extraction.

SY Projects

NAME	Project Title
Abel Mathew Abraham	Isolation, Identification of *Azotobacter* from soil and testing production of siderophores
Banwani Neha Vinod	Identification of *Azotobacter* from soil and study the EPS production
Chandavarkar Ritvik Sandeep	Isolation of haloduric organisms from preserved Bombay duck
Choudhari Neha Pradeep	Isolation of *Azotobacter* from soil and melanin extraction
D Cunha Rebekah Emelina Cajetan	Isolation and characterization of amylase-producing halotolerant microbes from dried Bombay duck
Dali Sanchi Rajeev	Isolation and identification of halophiles for studying their role in phenol degradation
Dharmadhikari Shivani	Synthesis of gold and silver nanoparticles using cellulase from cellulose degraders isolated from soil
Dsilva Tracy Richard	Chitin degradation by ureolytic microbes isolated from soil
Fereira Lenisa Oneil	Study of urease positive *Bacillus* sp. isolated from soil showing keratinase activity
Fernandes Concetta George	Isolation and identification of cellulolytic organism and synthesis of silver nanoparticles using the crude enzyme
Jafri Moneza	Isolation of urease producers from soil and extraction of the enzyme
Jain Naincy Tarunkumar	Extraction of crude cellulose enzyme by isolating a cellulose degrading bacteria
Jawade Ketki Suresh	Isolation and characterization of antimicrobial-producing bacteria from Khandala soil sample
Kalappila Tinci Thomas	Isolation and characterization of antibiotic producing organism from soil
Kanodothankandy Lavanya Jitendra	Isolation of antibiotic producing bacteria from soil and its effect on drug-resistant organisms
Khetan Priya Rajesh	Isolation of antibiotic producing organism from soil and its effect on resistant organisms
Lucas Stefney Stanislaus	Isolation of antibiotic producing *Bacillus* from soil
Madakasira Geervani	Isolation of starch hydrolyzing bacteria from garden soil
Malik Simran Ajay	Isolation and identification of *Rizobium* sp. from *Trigonelle foenum* and study of production of siderophores
Mubasshira Mohammad Mazhar Ul Haque	Isolation of *Rhizobium* sp. and extraction of EPS
Panda Sharmistha Prasant	Production of fermentable reducing sugars from naturally available starch using starch hydrolysers
Paul Anusikha Ashish	Isolation of starch degrading bacteria isolated from soil
Pinto Sian Mario	A study of food spoilage organism *Candida krusei* from spoiled meat sample

NAME	Project Title
Riya Maria Reginald	Isolation and study of bacteria from spoilt moong bean sprouts
Rodrigues Renita Maria Ronald	Isolation and identification of spoilage organism from apple and applicative study of its beneficial usage
Roy Arkanil Gautam	Isolation of spoilage organism from milk and testing its beneficial effects
Sahni Savitri Bindeshwar	Identification of bread spoilage organism and study its probiotic activity
Saikia Bibakhya Bhaben	Siderophore producing nitrosifier
Sanyal Avirup Jyoti	Isolation and characterization of cysteine producing bacteria
Sanyal Chadni Bhaskar	To study the extent of biodegradation of azo dyes by the nitrifying organism - *Pseudomonas* sp. from soil
Sharon Alex	A study of isoleucine production from *Ceraibacillus quisquiliarum* isolated from soil sample
Tavkari Shreeya Prabhu	To study the synthesis of amino acids by gram negative organisms and their ability to support the growth of non-producers
Vazhapilly Anish Ittoop John	Isolation and identification of *Nitrosomonas* sp. and study of production of cellulose enzyme
Pereira Danisha	Analysis of *Sinorhizobium meliloti* isolated from root nodules of *Trigonell foenum-graceum*

Say Cheese...

(Picture Gallery)

The Michronicle Team

Picture credits: Abel Mathew Abraham

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Fun Facts

1) If you're like me, the word "mushroom" conjures up things like pizza and Mario power ups, but it turns out there are a few species that glow in the dark. The ones pictured above are Panellus stipticus, and they glow bright enough that it is visible even in low light (as opposed to pitch black.) You can even buy some glow-shrooms and grow them yourself. Most species don't glow as brightly as stipticus, and the glow can only be seen under a microscope or in pitch black, but Panellus looks like you could read by it.

2) Warner brothers made use of bacteria in the promotion of their film named "Contagion". They treated two large petri dishes with fungi and bacteria. These were then set in a storefront in Toronto. The organisms in the petri dishes grew to form the film name and biohazard symbols.

3) Take for example Tasha Sturm, a microbiology lab technician at Cabrillo College, who shared this image of her 8-year-old's handprint on a petri plate filled with Tryptic Soy Agar. Sturm shared the photo on Microbe World, writing in the comments that she'd taken the handprint just after her son returned from playing outdoors.

Several days and multiple rounds of incubation later, her son's handprint had flowered into large — and strangely beautiful — colonies of staph, micrococcus, yeast, fungi and more.

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