

2019
ISSUE NO. 9

St. Xavier's College was founded by the Jesuit community in 1869 as an educational institution, which will strive to form men and women who will build a more just and humane world. The institution at its 150th year stands on the foundation pillars of innovation, personal integration and inclusion. We celebrate the sesquicentennial anniversary of academic excellence, critical thinking, accurate expressions and dreams of thousands of young learners. The experiential learning through various programmes, courses and extracurricular activities help the learners to imbibe the true virtues set by the institution for their lifetime.

St. Xavier's College has been a forerunner in initiating new courses as per the need of the hour and the inception of the Post Graduate Department of Biotechnology in 2007 is an example of the same. The department is one of its kind which endorses the vision of the college of capacity building of students through its curriculum and experiential learning pedagogy. The student is well equipped with academic skills (Conceptual Learning and Skill-based learning), analytical skills, Communication Skills, leadership skills with a humane touch. Above all, it helps one to identify one's true potentials. It trains its student to become distinguished individuals with one's own voice and mind.

Truly - St. Xavier's becomes a way of life!



PALINDROME

2019

Paving the way of life

Issue No. 9

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St. Xavier's College (Autonomous), Mumbai

Disclaimer: All views expressed by the authors are either compilations of referred articles or personal

Editorial

As quoted by the brilliant scientist Rosalind Franklin, '**Science and everyday life cannot and should not be separated**'. Influencing most of the aspects of everyday life, science provides perpetual impetus for the improvement of society at various levels. Biotechnology has received importance in the last few decades due to its unprecedented potential to serve the humankind and environment. Through its impact on the society, Biotechnology is paving the way towards a better life.

With this inspiration, we are delighted to present issue 9 of *Palindrome* with the theme '**Biotechnology in Everyday Life**'. This annual publication is a result of contemplating and compiling the thoughts and creativity of the team and the authors. The magazine throws light on the topics which are varied yet greatly influence the community. It reflects and exemplifies the role of Biotechnology which has integrated into the humankind eventually. The advances and popular narratives of Biotechnology along with the allied fields have been put forth in this endeavour.

We are pleased to have noteworthy personalities like Dr. Rajendra Shinde and Dr. Sameer Phalke sharing their thoughts and giving insights on a few important questions to broaden the horizon of knowledge and stimulate the young impulsive minds. Adding further to this, the inspiring journey of our alumni is an appreciable source of motivation to the readers. The issue also highlights some activities done by the students of PGDBT for understanding the menaces to the environment.

The proceedings and final outcome of this magazine required guidance from many people. We owe our heartfelt gratitude to the faculty and non-teaching staff of the Post Graduate Department of Biotechnology who have always been a source of constant and unflinching support. We thank all those who have been a source of direct and indirect inspiration and help to us.

Happy reading!

- Editorial Team

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From the Faculty's Desk

"A subtle thought that is in error, may yet give rise to fruitful inquiry that can establish truths of great value"

— Isaac Asimov, Biochemist and Science Fiction Writer

Contemporary Biology intertwined with technology has broadened the horizons of traditional Biotechnology. The key segments viz, Biopharma, Bio-Services, Agricultural Biotechnology, Industrial Biotechnology, and Bioinformatics, are rapidly growing across the globe. Indian Biotech industry is on a growth trajectory and is currently ranked 3rd in the Asia – Pacific region as a Biotech destination. In the recent past, there has been considerable investment and input, in manpower development, in biotechnology R&D, and the Biotech industry.

St. Xavier's College (Autonomous), Mumbai is an institution dedicated to holistic education and capacity building of leaders in every field. From its inception in 2007, the PG Department of Biotechnology has carved its courses in alignment with the college mission to train learners for professional innovation and cultivate personal integration. The various life skills (scientific approach, technical expertise, effective communication, creative and critical thinking) along with intense conceptual learning acquired over a period of four semesters in the department have been instrumental in making each one the assets to the world of Biotechnology.

This year Palindrome 2019 magazine, in its 9th year of publication, is an expression of a well-coordinated effort by the students of Semester IV, 2019-20, right from deciding the theme, writing articles, compiling research projects, editing and designing.

It is a well-established truth that reading and assimilating the relevance of new technologies using an intriguing lens has become inevitable. This issue of Palindrome is a looking glass through which the impact of Biotechnology on everyday life can be seen. Current trends and technologies from the field bearing direct and indirect impact on human life have been curated meticulously for the benefit of the reader.

Congratulations to the editorial team for the unwavering efforts to bring out the Palindrome 2019 magazine!

Wishing the entire batch of 2019- 20 the very best in life.

Dr. Karuna Gokarn, Associate Professor and Head

Ms. Norine D'Souza, Assistant Professor

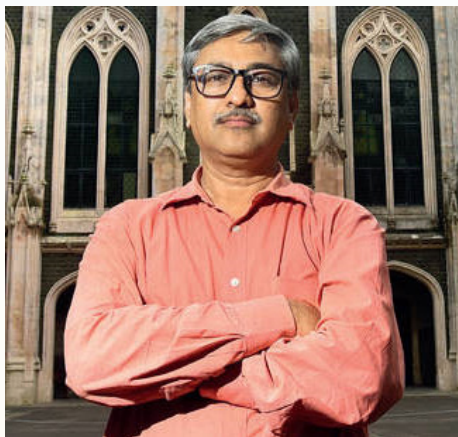
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"Your assumptions are your windows on the world. Scrub them off every once in a while, or the light won't come in."

— Isaac Asimov, Biochemist and Science Fiction Writer

In conversation with the Principal



Dr. Rajendra D. Shinde
Principal, St. Xavier's College (Autonomous),
Mumbai

1. What is the biggest challenge in bridging the gap between academia and industry?

There is a wide gap between the standard of education present and the industry's expectation. This gap is difficult to bridge by the current academia alone. As academic facilitators, we should design and implement a curriculum that will impart skill sets required by the industry. Collaboration with industry experts in designing and implementation will be a step forward in bridging the gap between academia and them.

2. What is your opinion about GM- Foods/Crops approval?

Acceptance of GM- Food/Crops is a contentious issue where one cannot express their view without repercussions. I would advocate the approval of these provided that it is safe, non- toxic and will not alter the human genetic makeup. Stringent toxicity, mutagenicity tests, appropriate field trials and safety assessments followed by appropriate labelling of the product is the need of the hour.

3. What is your vision about M.Sc. Biotechnology program?

The ongoing MSc. Biotechnology program is quite efficient in terms of exposing the students to the

skillsets required for research and Biotechnology based industries through their curriculum and research internship semester. Very few colleges provide this kind of opportunity to their students with St. Xavier's MSc. Biotechnology department being one among them. Further, improvisation can be brought about by diversifying the kind of industries the students are exposed to. My experience as an interview panel member for DBT Training Programme is that there are multiple schemes and scholarships available for students to join the industry as interns but the number and knowledge base are not adequate across the country. Upskilling of students can be brought about by increasing the percentage of skill and innovation-based syllabi in their current syllabus. In future, if we become a university, Biotechnology department will play a major role by progressing further for the betterment of the students.

4. What is your message to the budding biotechnologist?

Discover, invent and bring in innovations in the previous inventions which will be beneficial to mankind.

The heart of our department



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Transitioning world

Finding Your Patronus

“Volumes of history written in the ancient alphabet of G and C, A and T.” -Sy Montgomery

DNA has the capacity to distinguish one individual from another but it also has the capability to connect an individual to his ancestry. DNA ancestry testing was discovered in mid- 80's and since then has played an instrumental mental role in many criminal justice cases, to identify the victims of various disasters. More and more technologies have been developed to make DNA typing more sensitive and informative.

DNA testing is based on the principle of detecting specific locations in the person's genome. These regions are Short tandem repeats (STR) which are repeated different number of times in different people. STRs are present between gene-coding regions. The number of repeats in each STR is compared to sample taken from crime scene and further the probability of DNA from suspect matching the sample is calculated. Autosomal DNA tests can provide large amount of data while mtDNA and Y-DNA tests are also available. Y-DNA test helps to track the direct male line in the ancestry. A mt-DNA test can be taken by anyone. mt-DNA is passed on from mother to child and hence can be used to trace back direct female line. Both these DNA remain almost constant over generations unlike at-DNA. Development of Next Generation Sequencing (NGS) has made it possible to read many small fragments of DNA at the same time giving results quickly and at lower costs. Due to NGS, number of regions used for STR analysis was increased from 13 to 20 in 2017.

For many years, DNA tests have been carried out under the guidance of medical practitioners either in the labs or at the hospitals, wherein they collect the sample, test it and interpret the results. However, in order to give a personalized touch to this process and also to increase the outreach to the general public along with saving on time, DNA testing kits have been developed. There are multiple companies which offer genetic testing kits. Users of these kits can waive the visits to healthcare provider and carry out testing at their own will. This retains the confidentiality of the data. Also, the DNA sample collection methods in the testing kits are non-invasive.

Benefits of DNA testing are innumerable, in terms that it creates awareness amongst the people about the genetic diseases. It also gives individualised information on various health risks and other traits. Vigilant decisions about one's health can be taken in case of prediction of any health condition.

Though DNA testing has numerous pros and may have unravelled many mysteries, it comes with a huge risk and uncertainty to some extent. Risk in terms of confidentiality, the data from DNA labs are stored at DNA data banks, any misuse of the data will put the confidentiality of genetic identity of a person at risk. Uncertainty pertaining to sample collection which might be degraded, contaminated or insufficient for any analysis; if collected from a crime scene. Uncertainty can also be

introduced through poor lab techniques, machine and human errors.

Recent advances in DNA testing involve development of methods for analyzing mixture of DNA samples and translating DNA into appearances. Softwares are being developed which use probabilistic genotype matching for determining whether the two samples come from the same person. In the near future, we may use DNA from crime scene to create the descriptions of suspects from scratch via DNA phenotyping. But such technology needs further research and development before considering its role in the justice system.



Retrieved from: <https://www.the-scientist.com/news-opinion/us-government-considers-collecting-detained-immigrants-dna-66528>

-By, Nihira Deolikar and Manali Patwardhan (M.Sc. Part II)

'VACCI-NATION'

Vaccines have been preventing us from various infectious diseases since several decades and has saved lives all around the globe, it has been successful in eradicating small pox from the face of earth and also prevented diseases like Diphtheria, measles, mumps, influenza, tetanus and several other diseases, however recently, parents do not prefer vaccinating their children as well as themselves for any kind of diseases as they feel vaccination is unnecessary, ineffective and dangerous and also due to the misinformation about its side effects spread by the social media. This has led to a fear among people on getting vaccinated, however getting vaccinated has reduced the rate of disability, disease and death substantially. Based on a comparative study carried out in US in 2016, it has shown 90% reduction in most of the diseases and also many of the diseases were either eliminated or showed reductions of 99% or more.

Along with individual protection to the people who are vaccinated, vaccines also provide community protection by decreasing the spreading of infection amongst the population. The Expanded Program on Immunization (EPI) was established by the World Health Organization (WHO) in 1974 to provide protection. Since then, many new vaccines have become available and global public funding for immunization, including the Global Alliance for Vaccines and Immunisation (GAVI Alliance), has increased accessibility to these vaccines.

Most of the new or underused vaccines, including hepatitis B (HepB) vaccine, Haemophilus influenzae type b (Hib) vaccine, pneumococcal conjugate vaccine (PCV), rotavirus (RV) vaccine, and rubella-containing vaccine,

are intended to be included in the routine childhood immunization schedule. Other new or underused vaccines, such as cholera vaccine, human papillomavirus (HPV) vaccine, meningococcal vaccine, yellow fever vaccine, and typhoid vaccine are intended for older or at-risk populations. Two oral cholera vaccines are currently available one of them is Dukoral which is manufactured by Crucell/SBL Vaccine, Sweden, and the other is Shanchol which is manufactured by Shantha Biotechnics/Sanofi, India. Both vaccines are killed, whole-cell, two-dose vaccines.

On September 2019 FDA has approved the first live, non replicating vaccine to prevent small pox and monkey pox in adults for adults 18 years or old of age. Inactivated polio vaccine has been introduced in India as a part of the Global Polio end-game strategy, to mitigate the risk associated with trivalent oral Polio virus (tOPV) to bivalent oral Polio virus (bOPV) switch. In the bOPV the type 2 component of the polio serotype has been eliminated as all the wild type Polioviruses has been eliminated. Rotavirus vaccine (RVV) has been introduced to reduce mortality and morbidity caused by Rotavirus diarrhea. India is committed to the goal of measles elimination and rubella control and to achieve the goal MR vaccine was introduced in the country through a campaign mode in a phased manner.

The Government of India has rolled out an Electronic Vaccine Intelligence Network (eVIN) system that digitizes the entire vaccine stock management, their logistics and temperature tracking at all levels of vaccine storage – from national to the sub-district. This enables program managers to have real time view of the vaccine stock position and their storage tem-

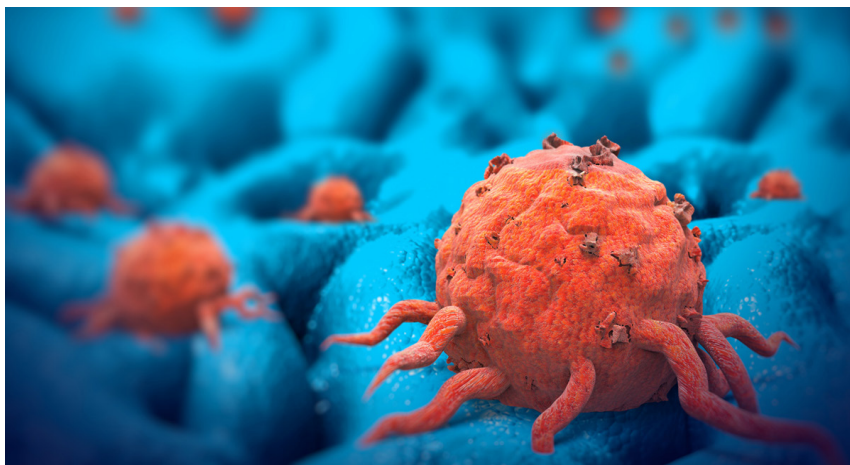
perature across all the cold chain points providing a detailed overview of the vaccine cold chain logistics system across the entire country. The government has also launched Mission Indradhanush in order to achieve a goal of 90% immunization.

The National Vaccine Advisory Committee (NVAC) has made some recommendations for assuring high levels of vaccine confidence which includes 5 major focus areas, tracking and measuring vaccine confidence; communication and community strategies to increase vaccine confidence, health-care provider strategies to increase vaccine confidence, policy strategies to increase vaccine confidence and lastly, continued support and monitoring of the state of vaccine confidence. Thus vaccines taken with proper guidance can provide immunity for the particular disease. The fear about vaccines can be eliminated by providing proper and authentic information about certain vaccines and creating awareness about vaccination.



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**-By, Vasudha Ramnathan and
Jheel Kavedia (M.Sc. Part II)**



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CANCER: Are we close to a cure?

With each passing year, statistics about the occurrence of cancer have made it evident that cancer has become a major public health problem and a leading cause of death and suffering across the globe. There are a total of 200 different types of cancer. The heterogeneity of cancer as a disease makes the effective treatment of cancer a major challenge. Removal of the cancerous tumor through surgery and treatment through radiation therapy, chemotherapy and hormonal therapy has been in action for many years. However, there is always a risk of relapse, unwanted side effects and many more complications. Due to technological advancements over the years, the diagnosis and treatment of the disease are becoming easier. Scientists all over the world have been majorly involved in developing therapies that provide more efficient treatment against cancer with very fewer side effects and complications. Few of the most recent developments in cancer treatment research have been proved to be more promising for better therapies as well as strategies to prevent cancer development.

Immune surveillance and immune escape have great importance in the evolution of cancer and in recent decades, the development of various

immunotherapeutic strategies has become a major field of research. One such immunotherapeutic strategy is the development of **therapeutic cancer vaccines**. In order to generate an antitumor response, the immune system is stimulated using tumor antigens. Various immunotherapeutic strategies which are extensively studied involve the use of autologous dendritic cells (DCs) that are pulsed with tumor antigens. In order to attain efficient treatment, both tumor-associated and tumor-specific antigens are targeted for vaccine generation. The DC-based vaccine sipuleucel-T, used in the treatment of prostate cancer was the first therapeutic vaccine to be approved by the FDA in 2010.

Nanobiotechnology or Nano-oncology is a rapidly developing area within nanotechnology which involves the use of nanoparticles for biomedical applications. One of the most advantageous applications of nanoparticles are active targeting, reduced off-target drug distribution and increased accumulation of drug at the tumor site. Also, the biocompatibility allows efficient reabsorption and elimination from the system. In recent years, nano-theranostics has emerged as a promising alternative for efficient cancer management which

involves the use of therapeutic as well as diagnostic entities that are loaded into nanoparticles for early diagnosis and treatment of cancer. Nanoparticles have also been used for photothermal therapy (PTT) of cancer-causing tumors, wherein the nanoparticles employ photoabsorbing agents which generate heat under near-infrared (NIR) laser irradiation, this results in the thermal ablation of cancer cells. **Immunotherapeutic bioresponsive fibrin gel** has been engineered that controls local tumor recurrence post-surgery and development of distant tumors. Calcium carbonate nanoparticles preloaded with an anti-CD47 antibody are encapsulated in the fibrin gel and scavenge H⁺ in the surgical wound which polarizes the tumor associated macrophages. The released anti-CD47 antibody blocks the “don’t eat me” signal in cancer cells. This causes the phagocytosis of cancer cells by macrophages.

Starving cancer cells to death is another approach for tumor treatment that has been emerged recently. As cancer cells have glucose requirements for their rapid growth and to fight against apoptosis, so by limiting the consumption of glucose has become an approach for treating cancer.

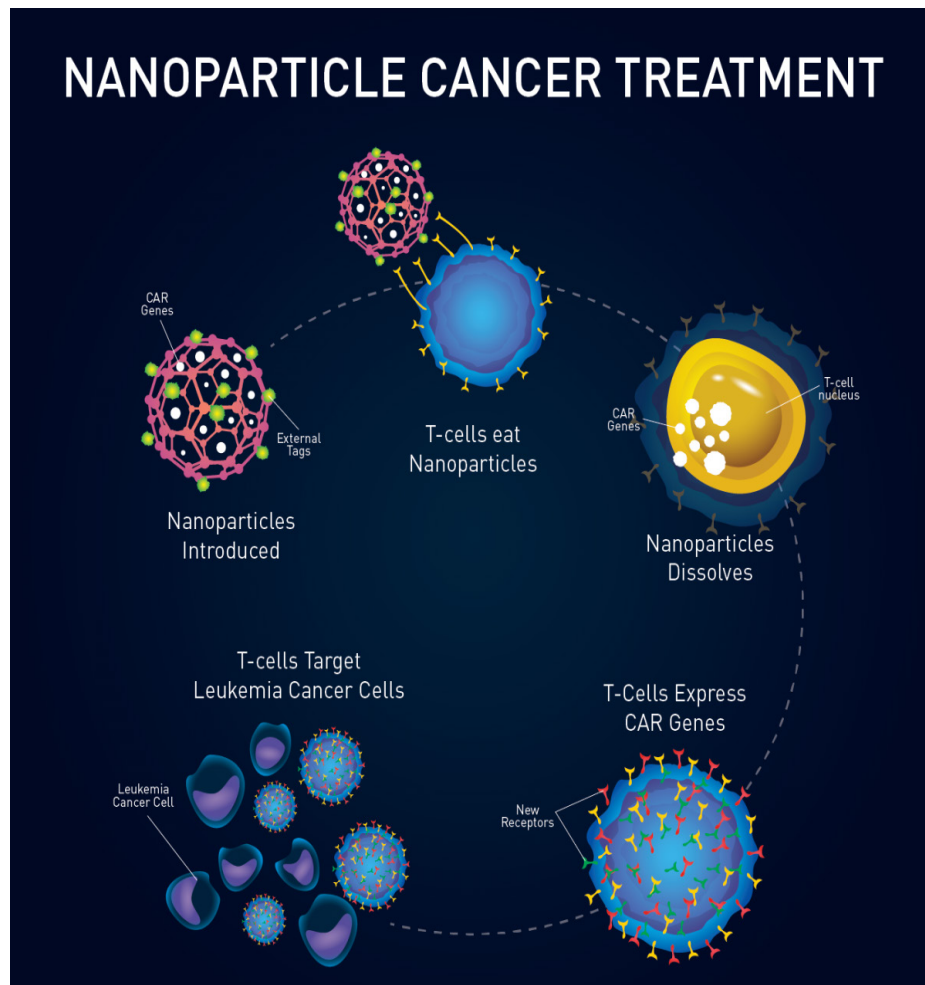
One of the challenges for precise tumor therapy involving targeted drug delivery is controlled release and activation of drug.

A biomimetic cascade named as **Mem@GOx@ZIF-8@BDOX** is engineered for tumor starvation therapy. This biomimetic cascade shows intelligent drug delivery systems for tumor precision therapy.

Cancer cells, due to their elevated demands for biosynthesis and energy production upregulate glucose metabolism and oxidative phosphorylation by majorly utilizing and depending on nutrients such as glucose and essential and non-essential amino acid. Glucose uptake is unregulated by various oncogenes like MYC and RAS. When subjected to a glucose-deprived microenvironment, the cancer cells evolve cellular mechanisms to adapt to low-glucose conditions. The proteins and cellular pathways that support the survival of tumor cells in the low-glucose-containing medium are identified and represented as potential drug targets since their inhibition is expected to selectively kill glucose-deprived cancer cells, but not normal tissues that do not experience glucose deprivation.

With further research and development of basic sciences and technologies, many approaches may appear in the market for the treatment of tumor, various cancers and many other diseases.

-By, Jennifer Adams and Neha Chandrakumar (M.Sc. Part II)



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FLOURISHING TECHNOLOGIES



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01

LIQUID BIOPSY: SEEKING OUT CANCER

“Cancer may have started the fight, but I will finish it.” – Anonymous

Scientists across the globe have carried out research for years altogether to develop an early detection system for cancer, that can significantly increase the prospects of an effective treatment. Shifting towards more advanced, less intensive, easier yet more accurate detection methods, a technique called ‘Liquid biopsy’ has been developed. Liquid biopsy is a technique that can be used to detect and monitor the progression of cancer from body fluids like peripheral blood. Circulating moieties like circulating tumor cells (CTCs), circulating tumor DNA (ctDNA), exosomes, and specific protein markers can be isolated from blood.

CTCs are intact cells that detach from carcinomas and are more often found clustered with fibroblasts or endothelial cells thus being protected from immune destruction. For the classification of free circulating cells as CTCs, the cells are identified based on immunocytological features, molecular markers, and biological activities. ctDNA is a fragment of DNA released from tumor cells during cell death, or during the metastatization process thereby generating malignancy. Since the amount of ctDNA in the blood is quite low, advanced technologies like Next Generation Sequencing help in identification of

mutations as well as amplification of ctDNA. Exosomes, released by tumor cells, help in the invasion of cancer, angiogenesis, and development of chemo-resistance of cancer. They carry specific protein markers & variants that vary with the type and stage of cancer and often protect the tumor cells from immune attack.

Guardant Health, Grail, and Biocept are some of the companies working on the development of commercial liquid biopsy tests. Scientists at John Hopkins University School of Medicine have developed a blood test called “CancerSEEK.” It identifies early-stage cancers and localizes them to an organ of origin, by identification of genetic alterations and protein biomarkers. Using two approaches involving Multiplex-PCR and a small but robust number of amplicons, rare mutations in the ctDNA are detected and identified. Reproducible detection of protein biomarkers is carried out using a single immunoassay platform. The test involves combined genomic and proteomic profiling, and displays median sensitivity of ~70% and specificity of over 99% for the different types of cancers tested. Despite its own drawbacks and loopholes to-be-filled, CancerSEEK “seeks out cancers” using “a single, multi-analyte blood test.”

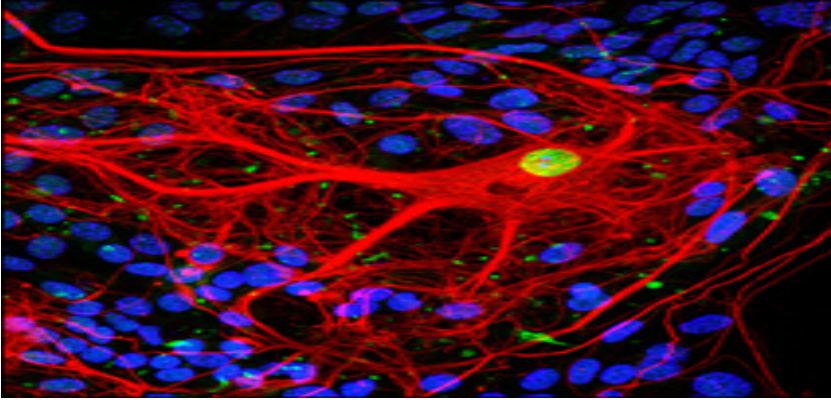
Due to its ease, liquid biopsies can be performed multiple times over a

course of time and hence aid in monitoring the progression of cancer, assessment of treatment efficiency, and tracking recurrent cancers. Although still under development, liquid biopsy is a robust, non-invasive, specific, sensitive and less costly technique. Various companies, institutes and organizations are coming together to provide funds and boost research so as to devise a liquid biopsy method that is cost-effective and feasible for use at all scales. The developmental stages of any ground-breaking research or invention face its own peaks and valleys, but the application of the final product and the change it brings in the society is worth it all.

-By, Bushra Khan (M.Sc. Part II)



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02 OPTOGENETICS

How does a brain work? How are memories stored? What part of the brain responds to fear? How changes in the brain effect emotional response? How neurological disorders can bring about changes in the neuronal activity? All such secrets of the brain can be unveiled through 'Optogenetics'. Optogenetics is an evolving technology which allows for analysis of the brain within a timescale of milliseconds.

Brain consists of a complex of neurons that communicate electrochemically to perform various functions. This neuronal communication discovery dates back to 1700s when Galvani, an Italian Scientist, observed frog's legs that were on sale, twitching during a storm. He then replicated his observation by electrically stimulating the legs using electrodes. Since then brains were functionally analyzed by similar stimulation experiments. However, this method led to non-specific stimulations of all cells at the site of electrode insertion.

In 2005, Deisseroth combined genetics and optical methods (optogenetics) to specifically stimulate or inhibit certain neurons just like turning a switch "ON" or "OFF". This method was a breakthrough in neuroscience as it not only allowed neuron specific stimulation but also for analysis in a freely moving animal.

In optogenetic studies, the target cell is genetically engineered to include gene that encodes for opsins. Opsins have

the potential to turn into signalling state from a resting state upon light absorption. And they are the photoreceptor molecules that stimulate signalling cascade upon G protein activation further producing physiological response. When neurons are exposed to light of the desired wavelength, the channels open up generating action potential causing the neurons to fire. The gene for light-sensitive protein- channel-rhodopsin2 (ChR2) was first isolated from green algae *Chlamydomonas reinhardtii*. This protein activates only in the presence of blue light, hence when made to express in the neurons, it allowed the neuron to be switched on as long as the blue light was exposed.

The method of optogenetics provides a way to study neural networks. It has moreover many applications such as 'Gene therapy' which involves delivering of the gene in the body at the affected site. And it was first approved in 2003 in China where wild type p53 was expressed in an oncolytic recombinant adenovirus for treatment of head and neck squamous cell carcinoma. Other than rods, Channelrhodopsin-2 (ChR2) is expressed in retinal neuronal cells which turns them as artificial photoreceptors. It has also been used in vision recovery. This involves expression of optical neuromodulators such as photochemically modified mammalian ion channels in residual retinal neurons or Channelrhodopsin-2. This expression may allow for sharpness of vision with greater and better spatial resolution

than obtained from recent prosthetic devices. In the substantia nigra, certain loss of dopaminergic neurons results in neurodegenerative disease known as Parkinson Disease. Neurons responsive to light are developed in Parkinson disease as a treatment for the disease as well as another option for the treatment of the patients here is Deep Brain Stimulation along with understanding how cell transplantation is done.

The recovery of the disease relies on the release of dopaminergic from implanted cells as well as the activity of neurons. A common neurological disease which is affecting 50 million people over the globe is 'Epilepsy'. This disease is of recurrent seizures and is characterized by functioning of various circuits that are overactive. Optogenetics was used for in vitro inhibition in region of CA1 and CA3 of hippocampal principal cells which was found to be sufficient for reducing seizure activity. Optogenetics has also been used in treating Spinal Cord Injuries in Clinical Neurology. Functional Electrical Stimulation are those electrical pulses here that helps to improve or restore the paralyzed muscles that are involved in upper and lower limb mechanism, breathing, and the bladder and bowel regulation.

**-By, Bayaan Sarang and Sana Boblai
(M.Sc. Part II)**

"MILASEN": BENCH TO BEDSIDE

What happened to Mila?

November 5, 2010, Mila came into this world perfectly healthy and sound, growing up to be an energetic, giggly little girl. At three, her parents noticed she was stumbling and her right foot began to turn inward. Then she turned four and things were getting worse, she started pulling her books close to her face at bedtime and at 5 years of age her condition needed medical attention due to her modest language and increased clumsiness. Initial treatments failed to give effective results. Months before she turned 6, conditions became worse when she was hospitalized due to loss vision, dysarthria, frequent falls and dysphagia. MRI, ECG and Skin Biopsy showed results indicating **Batten's disease**.

The Investigation

Batten's disease, a rare recessive condition affects the central nervous system and eyesight. In Mila's case, the mutation was observed in a gene called CLN7 or MFSD8 gene, detected by whole genome sequencing. The effect of the mutation was abnormal MFSD8 splicing and translation, detected by RNA sequencing and Reverse Transcriptase PCR. This leads to the production of proteins with altered structure or function, thus affecting the nervous system and vision.

Developing the hero: "Milasen"

An Antisense Oligonucleotide drug called MILASEN was developed at the Boston Children's hospital to combat Mila's condition. Initial testing of the drug began on the patient fibroblast cells which gave effective results according to computer based analysis. Mila's disease constantly progressed

due to which researchers filed for FDA permission, to initiate the clinical trials. Several studies on the drug were carried out after which Mila received the first dose of the drug. She slowly regained her motor skills indicating an improvement in her condition due to the action of the drug. However, neurological damage and reduction in the brain volume was observed indicating that the drug can be further modified to enhance its function.

Why Milasen?

Just like Batten's disease, many other neurodegenerative pathologies like Parkinson's, Alzheimer's exhibit varied clinical features among patients with the same disease. Apart from neurological diseases, conventional treatment provided for other diseases like cancer, diabetes shows difference in response among individuals due to variety of changes caused in the person though the disease is same. This makes us think whether one drug, common for all will be a better approach or a personalised medicine like MILASEN. Definitely, the later which refers to the designing of a treatment targeting a particular patient after careful investigation of the conditions prevailing in that individual, as already seen in Mila's case. Recently, a paper published in the journal of Science Translational Medicine, emphasizes the need for personalized medicines for the effective treatment of Parkinson's disease. Several studies are also being carried out to determine the effect of personalized medicines, using model organisms like fruit flies useful in understanding the disease condition in detail. Other than Mila's story, there are other success stories of personalized medicines like the development of drugs like Gleevec and Herceptin for treating cancer, encouraging advancements in Personalized medicines.

Personalized medicines for the untreatable, complex, and the impossible.

The story of the drug 'MILASEN' paves a path for many other specific drugs, bringing them from bench to bedside and emphasizes the need for the development of personalized medicines for treating rare and complex diseases yielding beneficial results. It presents a very good example of how advanced technologies and genomic studies conducted in the research field can be used to benefit the society by reducing the cost and time of the treatment. This encourages researchers to design specific drugs for diseases varying among individuals by studying the alterations caused by the disease in the genome and utilizing scientific knowledge as a weapon against evils like untreatable, complex and impossible, thus protecting mankind. Think practically, every individual has a different way of perceiving similar things, in the same way our bodies reaction varies though affected by the same disease, then how can all of us respond equally by a common treatment and therefore there is a need for an action which is specific for an individual called personalized medicines for an effective reaction.



Retrieved from: <https://www.technologyreview.com/f/612333/gene-treatment-made-for-a-single-child-cuts-a-hyper-personal-path-for-precision/>

-By, Bhavya Dawath and Sanjana Zende (M.Sc. Part I)

Listening to the nucleotides...

Government of India has passed a Bill (Bill No. 128 of 2019, THE DNA TECHNOLOGY (USE AND APPLICATION) REGULATION BILL, 2019) on 27th June, 2019 by Dr. Harsh Vardhan for DNA Barcode implementations in India. DNA technology will help to generate DNA (Deoxyribo Nucleic Acid) barcode which will have the genetic or genotypic information of the individual. Phenotype of a person shows the appearance of an individual whereas the genotype of a person shows the genetic constitutions of the individuals. Genetic information is considered more specific than phenotypic information. DNA Barcode will provide the basic information and genetic information about the individuals which is more significant. DNA Barcode has genetic information of a person partially from mother's genetics and partially from father's genetics. Genetic information can give clear idea about the individuals with respect to other individuals in the population.

DNA Barcode makes available genetic information of respective person under figure tips. This information can be used to prevent unsuspected diseases, unidentified deceased individuals, victims, , under-trials, Solve parental issue with accuracy, Prevent Pre-natal genetic disorder, Bodily substances from the missing and burned or damaged body can

be identified accurately, Phenotypic Identical individuals can be specified, and Victims can get justice in rape, kidnap, criminal, robbery and various such cases. Ease to find donor for organ transplantation, blood, sperms, eggs etc which will increases the survival rates and Pedigree analysis and cure certain hereditary diseases and prevention of that diseases for next generation. This will help to save time, accuracy and authenticity of the results. DNA technology has some of the issues such as Disclosed of genetic information to unauthorise group or individual can cause danger to certain group of individual or population, Negligence in the arrangement or analysis of the information which can mislead and cause life threat to the individual and Data can be hijack by the other nation which will cause great damage to the nation.

The governments should impose rules and regulations on every person who will be responsible for collection, storage and utilization of genetic information of individuals. DNA laboratory should have testing and analysis procedure, standards, requirements under accreditation from governments Boards and they should timely renew accreditations. DNA laboratory should have obligated environment, scientific and technical expertise. The genetic information should be stored, guard and should not release information. DNA Data should be well categorized so that there should not be any misunderstanding while analysing the data. Regional DNA Data Bank and National DNA Data Bank should co-ordinate and should maintain the confidentiality between them. The in-

formation should be used by authorities. Security codes needs to be kept so that no one can excess information.

Penalty of 3 years of jail and 1 lakh rupees will be imposed on a per-



Retrieved from: <https://www.genengnews.com/top-ics>

son who will disclose the information without the authorities. One who will contaminant the source of information or destroyed the analysed information or misplace the generated information will be imprisonment up to 2 years and 50 thousand rupees fine. The company/institution/individual, he who was present during the offence was committed has to prove their royalty otherwise they have to fulfil the penalty.

DNA technology helps us to understand various aspects of upcoming technology and also one should be aware about the consequence and benefits before sharing genetic information with other party. Genomes of the particular part of population can be used to know the phenomenon occurred in those specific populations. With genomes of population we can point out the danger in near future.

-By, Sushma Jakhad (M.Sc. Part I)



Retrieved from: <https://internetmedicine.com/2017/01/10/59718/>

India and Entrepreneurship in Biotechnology: Building a Bridge from Innovation to Industry

The Indian Biotechnology sector is growing at an ever-increasing rate of about 20% every year and holds a 2% share of the global biotechnology market. It ranks 12th among the top biotechnology destinations in the world and has around 800 companies with the second-highest number of USFDA approved plants. The Biopharmaceuticals sector boasts of a major 64% of the total revenue followed by Bioservices, Bioagri, Bioindustry, and Bioinformatics with 18%, 14%, 3% and 1% of total revenue, respectively.

How is our Government Aiding in the growth of the Biotech Industry?

In order to encourage innovation and entrepreneurship in India, the Indian Government has planned to launch a venture capital fund of Rs 1000 crore to boost R&D in the biotech and pharma industry. It also plans to make the Indian Biotechnology industry worth \$100 billion USD by 2025 and increase the number of start-ups to 1500-2000 over the next couple of years from the current 500. Furthermore, the Department of Biotechnology (DBT) along with the National Biotechnology Board (NBTB) and other international institutions are working cohesively to make India a global hub for excellence in biotech research and business.

What are the challenges faced by Biotech start-ups in India?

The majority of start-ups in India are

funded via various government grants while only a few are funded through private ones, mainly foreign investments. Although a lot of early-stage biotech start-ups are getting the funding they need, the real challenge lies after the first few years of the establishment of the company, i.e. in the scale-up and marketization. Apart from the obvious problems of funding and scale up, the biotech industry is also restrained by a “glass ceiling” of the heavy regulations and ethical guidelines levied on it. The companies often encounter problems while filing for patents and property rights; if the company’s management is altered, funding agencies like BIRAC reconsider their grants which threatens the very existence of the company. Furthermore, biotech usually involves working with a poorly understood natural organism/environment which brings a level of uncertainty. Hence, the strategies adopted by biotech start-ups appear to have a colossal impact on their growth. Unfortunately, due to the early stage of the biotech industry, there is no definitive research analysis to support a successful strategy. The impending “patent-cliff” which refers to the expiry of a patent and the ensuing loss of monopoly over the product costs various biotech companies a pretty penny. The biotech industry is driven by science and stringent regulations and is a high-risk, long-gestation venture making investors skeptical on whether their investment will be a bang for the buck. And although we

are witnessing unprecedented advances, the big question for biotech today is whether it will see a progress similar to that of the Information Technology industry which witnessed stellar growth in the past few decades.

Can Biotechnology become Indian economy’s next success story?

The Biotech industry represents a lot of untapped potential unlike most other industries that have reached their eventual inflection point. Alas, the biotech industry seems poised to take over the mantle from the glorified IT industry as it is predicted to reach a revenue of \$100 billion in 2025. With the meteoric growth in the pharmaceutical generics market and the expansion of bioinformatics, bioagri, and bio-services fields, biotechnology has driven the country to a newfound touchstone of innovation and excellence and is sure to witness a cornucopia of opportunities in the imminent future.

**-By, Ruta Divekar and Kush Gudka
(M.Sc. Part II)**



जैवप्रौद्योगिकी विभाग
DEPARTMENT OF
BIOTECHNOLOGY

Retrieved from: <https://www.dbtctep.gov.in/>



Image courtesy: Kendal Powell (2018) How to sail smoothly from academia to industry, Careers, Vol 555, Page 549-551.



Perfint Healthcare

A biomedical start-up that focuses on the production of robotic devices that aid in the targeted delivery of onco-drugs to various organs. Founded in 2005 by Nandakumar Subburaman an IIM Madras Graduate, the company's annual turnover in 2014 was nearly 100 crores. Their robotic arm Robio and an accessory to the CT scan which helps to carry out tumor ablation-Maxio are its main products.

Retrieved from: <https://www.justdial.com/Chennai/Perfint-Healthcare-Pvt-Ltd-Oppo-site-Dhanvanthri-Blood->

Lead Invent

The company is developing an adjuvant therapy alongside surgery which is considered better than the existing drugs therapy for Brain Cancer. It produces drugs for Leukoplakia. This company started as a basic research program at IIT which then flourished and the company was founded in the year 2007.



Retrieved from: <https://pitchbook.com/profiles/company/223404-94>



Achira labs

It is a biomedical based company founded in 2009, which has developed various affordable lab-on-chip medical testing kits. Co-founded by two IIT Madras graduates, their flagship product is an automated analyzer designed to carry out rapid quantitative immunoassays like immunodiagnosics, thyroid tests, and fertility tests. The time taken for each test in this device is merely 30-45 minutes.

Retrieved from: <https://achiralabs.com/>

Navya Biologicals

This is a biopharmaceutical company was founded in 2006 which manufactures drugs for fertility and cancer treatment. It also produces a commercial yeast cell line to carry out various onco-drug testing. This start-up was acquired by Shilpa Medicare.



Retrieved from: www.navyalife.com



Sattva Medtech

Vibhav Joshi, a BITS Pilani alumni, sparked the idea of building a next-generation fetal health monitoring device. This device is a mixture of sensors and algorithms. After initial prototyping, the company was founded in 2014 which was funded by Inn-Accel.

Retrieved from: <http://sattvamedtech.com/>

CLIMATE CHANGE: is it really the change we need?

"Climate change is no longer some far-off problem; it is happening here, it is happening now"
- Barack Obama

Cherishing a twilight crepuscular ray of sunlight in the summer, shining through a crack in high clouds and illuminating the dust particles on its way in the air or the cool williwaw in winter is what we used to perceive climate as. Alas, gone are those summers and winters! Now it is all about suffocating in the thick smog and suffering in the sweltering heat. "Be the change" or "Bring the change" are two phrases by which most of us live by in today's fast-paced world. The latter has had implications that have shaped humanity beginning from the great industrial revolution up to its most devastating self which we now refer to as the '**CLIMATE CHANGE**'. Earth's rising temperatures, changes in convection pattern of winds, extreme precipitation and rainfall, longer drought seasons, deforestation, decreasing reserve of freshwaters and loss of biodiversity are some of the aftermath caused due to climate change, transcending the boundaries of mother nature from the North to the South Pole.

The climate change, birthed from a new geological epoch referred to as Anthropocene by the scientists, is striding invincibly at this point of time than it has ever in the history of modern civilization. However frivolous the increase of 0.6°C over the past 110 years in the Indian average temperature might seem, it has surely alarmed many serious consequences in the near future. Be it through the polar vortex or the bomb cyclone, the frazil or the derecho, nature has warned us by giving many red signals to reverse the unhindered climate catastrophe. Climate change can be attributed to the long-term consequence of accu-

mulation and rise of greenhouse gases such as CO₂, CO, and CFCs due to the burning of fossil fuels at an alarming rate. Industrial processes such as fracking make use of high-pressure liquid for extraction of fossil fuels have also been identified as a contributing factor. In its assessment of climate change, the Intergovernmental Panel on Climate Change (IPCC) has asserted that global rates of human-driven changes have far exceeded the rate of climate change driven by geological or biosphere forces. It predicts that if we reduce all our anthropogenic emissions to zero then only we will be able to maintain a threshold of 1.5°C rise in global temperature and this will require unbiased and unprecedented changes in our pattern of consumption of fossil fuels.

Has climate crisis struck the natural mise-en-scène?

The unanticipated impacts of climate change have been devastating worldwide. Our country is witnessing this havoc for the last few years. Our country is witnessing this havoc for the last few years. The South Indian states have experienced extreme weathers from flash floods to drought and heavy rains to winds. In July 2019, massive floods across Kerala, Karnata-

ka, and Maharashtra have taken hundreds of lives away, whereas, in the same month, Chennai has seen the worst drought in the last 70 years. The Northeastern and coastal patches of



Bihar and Assam have struggled with floods due to torrential cloudburst lately. Orissa had to face Cyclone Fani, the strongest storms in the decade, while the Northern and Central was battered with deadly heatwaves with no rains.

The surprising winter season in the South may be attributed to the absence of moisture content coming from the Western Ghats, cloud cover, and humidity that radiates back the heat without absorbing it. Moreover, the weakening of polar vortex has caused the cold air to blow towards this part of the country. To intensify the situation, the record-breaking fires have ripped through the Amazon rainforest in Brazil in August 2019. These

'intentional flames' were the returns of deforestation and slash-and-burn.

Oceans absorb about 30% of the Anthropocene CO2 resulting in acidification which can increase the oxygen demand of organism, lead to calcification, eutrophication of water bodies and impact the intricate balance between diverse marine ecosystem. The increase in the pests, antimicrobial resistance, and infectious diseases have surely posed long term threats and deleterious consequences to human health. Apart from creating societal stress, it has the potential to cause considerable loss of landmass, especially along the coastal regions along with high morbidity and mortality rates. The fall in land productivity, shifting of forest borders, and damage to fisheries due to shifting of spawning areas to the higher latitudes are also included in the list. The decreased air quality, wildfire, storm surge, and damage to the infrastructures are greatly affecting the human well being. The CO2 speeding up in the plants has invaded our food to make them less nutritious which can cause micronutrient deficiency down the line.



Our best bet against climate change

"People of conscience need to break their ties with corporations financing the injustice of climate change"

- Desmond Tutu

Adaptation and mitigation are the forthright ways to tackle the climate crisis in an informed manner. NASA is making significant contributions to the global community by providing detailed climate data available. Through its various projects and initiative, it is making the world analyse, predict, and response to the changing faces of climate. Shifting the industrial paradigm to greener technologies might be more helpful than it seems! Along with reducing the carbon and gases emissions, the utilization of domestic and industrial wastes as starting material should be considered. This would also promote minimization of waste and help the circular economy to flourish.

Recently a lot of focus has been shifted towards strategies which are aimed at ameliorating the harmful effects of climate change. One such remedy is kelp which is brown algae growing in cool, relatively shallow water. This alga holds the potential to sequester atmospheric CO2. 18.5 million square miles of ocean is suitable for seaweed cultivation which holds the potential to offset the entire carbon emissions of the global aquaculture industry. The organisms modified through engineering might come to our rescue for absorbing the pollutants and cleaning nature without using chemicals. Reducing global food wastage will reduce our carbon footprint (our 'food-print'). These biotechnological solutions of alleviating the crisis will surely pave the way towards sustainability.

-By, Divya Gaud and Prashant Suvasia (M.Sc. Part II)

Retrieved from: https://www.supplychain247.com/article/companies_shifting_from_commitment_to_action_towards_sustainability/Foundation_for_the_Global_Compact

***"If change is inevitable, let's work to make it sustainable;
Let the seasons be summer, monsoon, winter,
Not the raging storms and melting Himalayan glaciers!"***

Meet Clean Meat!

A well-done alternative to anticipate when the environment's at stake

The year 2019 witnessed a powerful dialogue on climate change, with Greta Thunberg at the helm of the discourse. The UN Climate Action Summit 2019, concluded with a requisition to mitigate global greenhouse gas emissions. Amidst the various industrial and energy production sectors, a notable contribution to these emissions arises from livestock, a natural concomitant of enteric fermentation. The growth in world population and the surge in demand for meat consumption results in increased methane production by livestock. Thus, different alleviation strategies need to be developed which concurrently meets the demands of the people and is environment-friendly. However, the field of biotechnology might have realized a science-fiction dream as a solution to this problem: clean meat.

Clean meat, a phrase coined by The Good Food Institute, refers to the way it is produced: slaughter-free. At its core, it is the in vitro cultivation of muscle fibers of animal cells grown in a specific culture medium. An amalgamation of tissue engineering and stem cell biology, this cultured meat is prepared by harvesting either stem cells or specialized cells known as myosatellite cells from the animals and growing them in a stir-tank bioreactor. The culture medium nourishes the cells with appropriate salts, pH conditions, growth factors and the cells proliferate. Alteration in this environment induces the stem cells to differentiate into the muscle cells. Structure and texture of the meat are maintained by using a supporting medium called

scaffold. Collagen-based hydrogels are employed as scaffolds, over which the cells organize themselves and multiply.

Cultured meat is currently under development by various American companies such as Memphis Meats and JUST, Inc. Initially developed by Mark Post as a lab-grown hamburger, the



Retrieved from: <https://www.thrillist.com/eat/nation/lab-grown-meat-vegetarian>

meat has found its consumer base up till space. Aleph Farms, an Israeli company produced cultured meat on the International Space Station using a 3D bioprinter. This biotechnological product has evident environmental benefits. It not only reduces the natural resources required for animal agriculture such as feed and space but also methane emissions from livestock. It is animal cruelty-free; an innocuous biopsy is required to isolate the cells from the animals. Its production is efficient, precise and faster than the conventional method. It also minimizes the improbable chance of transmittance of food-borne pathogens. The process is achievable without any genetic engineering. The technology has a scope of revolutionizing the novel food industry by incorporation of beneficiary compounds such as omega-3 fatty acids.

Lab-grown meat faces a risk of consumer dissent due to its nature of production. Resolution of issues of process feasibility and scaling up of the production is underway but in comparison with its initial conception till now, substantial advancements have been made. The procedure, of getting the texture and the flavor of the cultivated meat similar to the conventional one, requires subtle adjustments in the ratio of muscle fibers and the fat content of the meat, which is imperfect. Ethical and regulatory constraints have impeded the product from hitting the market.

These challenges haven't dampened the vigour of research in this sector. The Good Food Institute has associated with the Institute of Chemical Technology, Mumbai and Centre for Cellular and Molecular Biology, Hyderabad to further explore the field of cell-based meat production. This burgeoning biotechnological sector has a bright future once it optimizes its process parameters and receives a general communal acceptance. Perhaps a day would arise in the future, where consumption of industrially produced meat would be the norm and the slaughter of animals for meat would be an absurd thought.

-By, Payal Karnik (M.Sc. Part I)

CRUISE TO MARINE ECOSYSTEM

Marine biotechnology uses the knowledge of science and technology to support marine life and maintain the natural ecosystem. Marine biotechnology has various applications such as - Marine aquaculture mainly consists of marine organisms such as fishes, algae, corals, seagrasses, and many more, an important source for functional food and ingredients, which can be improved using Recombinant DNA technology; marine natural products have biological properties, having a tremendous potent medicinal use; marine environment is a source for nutraceutical products and, is also a potent source for providing bioenergy; marine microbes have potent characteristics for bioremediation. This proves that biotechnology have enhanced the marine ecosystem and it proved to be a bonanza to marine biosphere.

Biotechnology has high potential to explore in the field of fish feeds and its by-products. More than 50% of the Indian population is dependent on fishes as its staple food. Hence, it is extremely important to maintain the ecosystem using various techniques such as genetically modifying the wild species to increase the protein content, flesh volume, nutritional value and simultaneously decreasing the risk to infections. To improve the aquatic conditions, bioaugmentation, a technique which uses the introduction of biological systems into the ponds that will degrade the accumulated waste and tox-

ic products, is used to make a health environment for aquatic life to sustain. Not only as fish feeds, but marine environment is a rich source for functional foods and ingredients such as carbohydrates, fats, lipids, minerals, and many more. Also, the marine source has potential effect against human pathogens. For example, drug, namely Vidarabine, isolated from marine sponge *Tethya crypta* is a potent anti-viral drug. Similarly, Ecteinascidin, isolated from *Ecteinascidia turbinata*, induces apoptotic effect on tumor cells and act as anti-cancer agent. Micro-organisms in the aquatic environment are exposed to extremely stressful conditions which helps them to produce secondary metabolites. The secondary metabolites isolated using biotechnology are erythromycin, rapamycin, tetracyclin, lovastatin, and many more.

Stressful conditions not only produced drugs, but are also helps the microbes to produce enzymes. For example, thermostable extremozymes, enzyme amylase, isolated from *Rhodothermus marinus* at 80°C can be used in various food industries while, Taq polymerase, isolated from *Thermus aquaticus* at 90°C can be used in Polymerase Chain Reaction (PCR) techniques. Similarly, organisms which are psychrophilic, *Antarctic bacterium* produces alkaline phosphatase which is used in molecular biological research. Many such enzymes and functional ingredients are isolated from barophilic, pH tolerant,

halo-tolerant organisms. Fish and fish by-products, anti-oxidants, antimicrobials and many more, are also used as topical agents in the field of cosmeceuticals. Biotechnology have ameliorated the use of modifying the genetic structure of the marine biosystem, which helps them to act as a biosensor for pollutions, oil spills, and many more. For example, Green fluorescent protein (GFP), encoded by *gfp* gene, is fused with a promoter which is active in presence of a particular pollutant and is introduced into the host fish. The green fluorescence will indicate the presence of pollutants in the marine habitat. The potential biomass source for bioenergy are photosynthetic microalgae and cyanobacteria which have been proved to be used in the production of bioethanol, biodiesel, and many more.

Hence, biotechnology is proved to be a link between the marine environment and for the benefit of the human population. Marine biotechnology is a consortium of providing medicinal agents, nutraceutical properties, cosmeceuticals metabolites, bioenergy, improving fish feeds, maintaining marine ecosystem, biosensing systems and many more. Therefore, it is rightly said by Jules Verne, "**The sea is the only embodiment of a supernatural and wonderful existence**". So, let's save our marine environment and conserve our natural species.

-By, Ishita Shah (M.Sc. Part I)



Retrieved from: <https://www.bu.edu/met/subject/biotechnology-clinical-research/>

THE HEALING POWER OF COLLAGENASE

Enzymatic therapy is now creating a new dimension in the field of biotechnology. Collagenases belonging to the family of metalloproteinases have several therapeutic applications including wound healing, burns etc. Various application of collagenase includes the following. Collagnase is mainly used for tissue separation, therefore they can be applied in diabetes patients where in the gland cells can be relocated or removed. Another application of collagenase is in production of ointments for burn patients which help in immune functioning.

The application of collagenase in ointments is cost effective than hydro gel application in burn patients. The new prospective application of collagenase is to provide sight to blind who are victims of acid attacks. The outermost layer of human eye cornea plays an important role in

focusing vision. When cornea is affected by chemical burns, the stem cells repair by dividing themselves. But when wounds occur in the stem cell niche their healing becomes difficult. Collagenases which are called as tissue softening enzyme can be applied in to the corneal burns which will soften the tissue and enable new cell formation. This has a potential to restore sight of acid attack victims.

Clinical trials of collagenase for corneal repair are being going on and it is believed to have a great potential in this area. The introduction of clinically approved collagenase for corneal repair will reduce the cost of treatment. Apart from corneal repair collagenase can also be applied in case many ophthalmology cases like scars of eyelid, conjunctiva or iridocyclitis. The existing drugs and tissue engineered products applied in burns

patients aim to provide a temporary cure in the area but application of collagenase based medicine will reduce the time required for the complete ailment and the cure will be permanent.

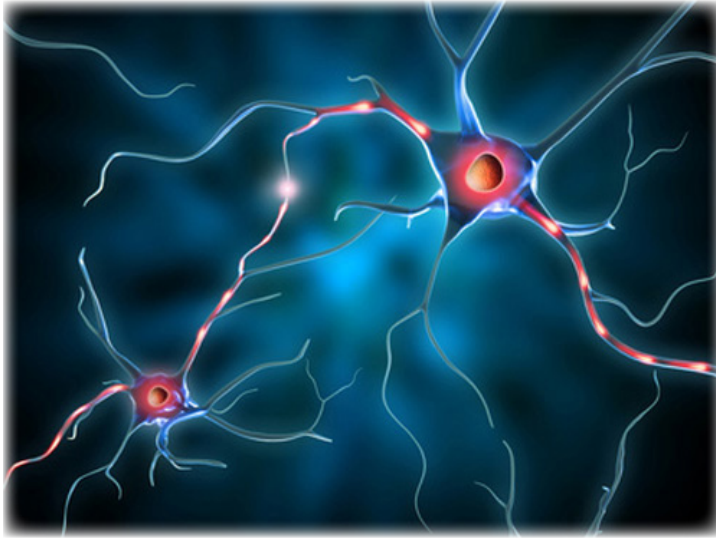
Biotechnology plays a major role in the production and extraction Of these collagenase and introduction of collagenase in various forms like ointments for burn patients. There are different classes of collagenase and each can be produced from different microorganisms.

Collagenase can be produced from different bacteria like *Clostridium histolyticum*, *Escherechia coli* and other vertebrate's likes crabs. Along with the production of this enzyme purification of the enzyme from all other cellular components is also important.

**-By, Minu Maria and Neha Dubey
(M.Sc. Part II)**



Answering Neurological Disorders



Retrieved from: <https://nysspt.com/physicaltherapy-services/neurological-disorders/>

Millions of people in the world are affected by Neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, Huntington's disease, Stroke, etc. Loss of function of central and peripheral neurons and eventual death of neurons result in neurodegenerative diseases. The treatments currently available are aimed at only relieving the physical and mental symptoms but are unable to cure the disease. Hence, development and use of new therapies to treat neurodegenerative disorders is the need of hour. Recently, therapies aiming at replacing the damaged neural cells by Neural Stem Cells (Neural Stem Cell therapy) have been developed. The term Neural Stem Cells was first described by Reynolds and Weiss in 1992. NSCs are multi-potent, tissue specific stem cells with self-renewal properties. They exist in early embryogenesis and in adult nervous system and can differentiate into neurons, astrocytes and oligodendrocytes. They are present in central nervous systems of fetus and adults. NSCs are generally found in the sub-ventricular zone (SVZ) and hippocampus. Induction of neuroectoderm during early mammalian development forms neural plate

stage of development, the NEPs divide into lineage restricted progenitor cell and multiply neural stem cells niche. Neural progenitor cells are non-stem cell type. They are unipotent, bi-potent or multi-potent. Neural Precursor cells (NPCs) are heterogenous population of NSCs and neural progenitor cells. NSCs can be isolated directly from primary tissues, by differentiation from pluripotent stem cells or transdifferentiation from somatic cells. NPCs are utilised to develop induced pluripotent cells.

The main function of NSCs is to maintain tissue homeostasis by replacing damaged cells. The NSCs in subventricular zone are important for maintenance of olfactory bulb, mood regulation whereas the NSCs in hippocampus are essential for learning and memory. Factors such as Wnt, Sonic Hedgehog (Shh), Bone Morphogenic Protein (BMP) antagonists, membrane-associated Notch signaling, leukemia inhibitory factor (LIF), transforming growth factor-alpha (TGF- α) and cytokines are important to promote their proliferation and maintenance.

NSCs have become an important therapeutic tool with potential to restore

function of neural cells by transplantation and replacement of damaged cells. The self-renewal property of NSCs is regulated by a specialised microenvironment called "NSC niche". The neural tube is a rich source of neuroepithelial progenitor cells (NEPs) and is the earliest type of NSC. During the later

function of neural cells by transplantation and replacement of damaged cells. Recently, a preclinical study, transplantation of human neural stem cell line in the murine model of Alzheimer's disease reported improved cognition, reduction in amyloid plaque and increased recruitment of activated microglia post transplantation. Thus, the preclinical development of human NSCs is an effective therapy for Alzheimer's disease. Transplantation of NSCs to repair spinal cord injury has also been studied. NSC therapy has not yet been approved although many clinical studies are currently ongoing to assess the safety of neural stem cell-based therapy in humans.

Recently, scientists at University of California, San Diego have successfully created miniature brains from induced pluripotent stem cells that mimics the developed 3D functional neural network of pea-size. The 3D mini brains are currently used to study the oscillatory waves emerging from the mini brain model during early neural network development. Thus, Neural Stem Cells have a promising future not only in stem cell therapy but also in research studies.

-By, Jhelum Chaubal and Khushboo Kothari (M.Sc. Part II)

The Prism of Biotechnology

About: Violet biotechnology or Purple Biotechnology deals with all the publication, invention, IPRs, and patenting aspects of biotechnology. It encourages new and innovative inventions in the field of biotechnology by providing protection against intellectual piracy and infringement.

Example: Granting of Patents to inventors with innovative products



Retrieved from -www.jatf.org

About: Brown Biotechnology is the branch of biotechnology that deals with management of arid lands and deserts. It focus on creating a beneficial impact on the arid landscape by using improved disease-free high-quality seeds and makes the rational use of water. Brown biotechnology is also called Arid Zone and Desert Biotechnology.

Example: Use of GMO's for better disease and drought resistance.



Retrieved from -
https://thezombiesthuffle.files.wordpress.com/2017/03/limbo_heade



Retrieved from -www.interactive-biology.com

About: Red biotechnology focuses on utilization of organisms for production of medicines and medicinal devices. It includes the production of vaccines, antibiotics, new drugs, molecular diagnostics techniques, regenerative therapies, 3D bio-printing

Importance/example: the development of gene pill wherein, the DNA is delivered to intestine. Post absorption, DNA is translated to the protein drug and then it exerts its action.



Retrieved from - www.thelabworldgroup.com

About: Green biotechnology deals with the development and use of environmentally-friendly solutions as an alternative to traditional agriculture, horticulture, and animal breeding practices. It refers to using biological techniques on plants with the aim of improving the nutritional quality, quantity and production economics such as production of disease-resistant or plants that have superior qualities, by means of genetic modification.

Example: Production of first and second generation bio fuels like bioethanol using various starch rich compounds like sugarcane, soy and castor beans. This is important to suffice the ever increasing demand of fuels which help in attaining sustainability in environment.



Retrieved from -www.mss-ct.co.uk/wp-content/uploads/2015/02/Vessels.jpg

About: White biotechnology relates to industrial biotech. It is involved in designing low resource-consuming processes and products, making them more energy efficient and less polluting than traditional ones. The technology uses living cells from moulds, bacteria, plants, yeasts and the process of fermentation to synthesize the products which are easily degradable.

Example: Sorona, corn based, made from 1,3-propanediol and phthalic acid (TPA), has improved characteristics and is environmental friendly.



Retrieved from- www.readersdigest.ca

About: Active genes in insects are used for application in agriculture and medicine.

Yellow biotechnology utilizes various insects to develop innovative new technologies in agricultural industry such as sustainable meat options and insect derived biological molecules. It is also known as Insect Biotechnology.

Example: Insect derived chitinase and cellulose.



Retrieved from- www.calacademy.org

About: Blue biotechnology has a variety of applications and it uses marine and freshwater organisms for development of novel drugs. It is also used to develop skin creams and cosmetics. Marine biotechnology also focuses on conserving marine flora and fauna and restoring aquatic wildlife.

Example: Marine organisms such as Algae can be used for biofuel production and food ingredients such as carrageenan jelly.

-By, Urjita Divekar and Aditi Pedgaonkar (M.Sc. Part II)

A ZOOTIC MENACE OF THIS ERA: NIPAH VIRUS

Nipah is the name of a deadly virus which claims lives of hundreds during each outbreak. This zoonotic virus was first identified in Malaysia leading to death of over 100 individuals. The virus is transmitted via air and flying foxes are confirmed to be the carrier. The fruit bats infect the fruits with their bodily fluids and spread the disease. The initial outbreak in Malaysia was disseminated by pigs which were indirectly infected by the bats. The symptoms that were observed due to the virus are fever, sore throat, muscle pain, and vomiting followed by mild encephalitis leading to brain seizures and then coma. The incubation period can be of few days to a long time between 4 days to 45 days.

According to scientists in John Hopkins Bloomberg School of Public Health, the chances of infection transmitting to a male individual suffering from breathing problems and aged person are higher than others. Due to the progressive development in the technology, efficient diagnostic tests are available. These include Reverse transcriptase-polymerase chain reaction, Enzyme-linked immune sorbent assay, cell culture for virus isolation, and Polymerase chain reaction. In India, National Institute of Virology in Pune are well equipped to carry out the diagnostics under stringent conditions like Biosafety Level-4; still the diagnosis is difficult due to the non-specific symptoms caused by Nipah.

Permanent cure for the infection hasn't been discovered but astonishing researches are being carried out throughout the globe. Live vaccines are being tested on mice infected with Nipah and rabies, chemically treated vaccines were developed which has the potential to inhibit virus replica-

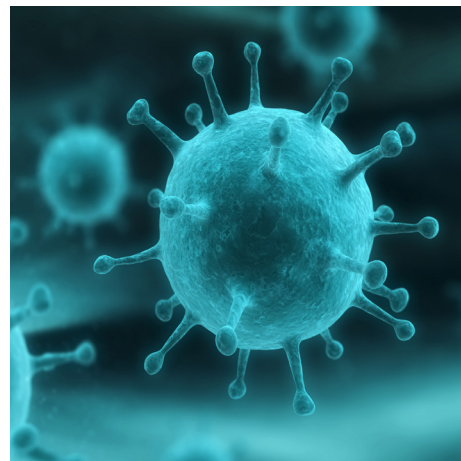
tion and Remdesivir, monoclonal antibody, which seems to be working on monkey models. After successful clinical trials, the treatment of Nipah virus seems to be closer than imagined.

India stood still when this deadly virus attacked Northern part of Kerala in 2018. Out of the 23 affected individuals, Kerala faced the death of 21 innocents. After the initial the confirmation of the virus by NiV, National Centre for Disease Control sent a multi-disciplinary team to Kerala and contact tracing was immediately started, surveillance in hospitals and community was strengthened. The swift action by the state government in coordination with Ministry of Health and Family Welfare (MoHFW) was commendable. The communication between the public and authorities was the key factor in controlling the spread of this menace. The return of Nipah in 2019 was met with the same strength by the health officials as they were expecting a probability of its return and the preparations helped them stop the virus in its tracks.

Prevention is the only tactic to keep away from the disease as there is a long till any treatment reaches the market. Some of the points to keep in mind is to maintain hygiene at all times even when not in contact with infected patients. Do not eat half eaten fruits or consume raw date palm sap or toddy which could have been eaten by infected animals like bats. Proper care should be maintained while handling or treating sick animals, here gloves and disposable clothing should be worn while slaughtering or treating animals so as to not catch any infection. WHO is on the forefront in providing the best technical support in affected areas of the world. Paying attention to eating habits is the best way to

prevent the spread. With the various technological advancements, recombinant vaccines are on the way to be a crucial treatment measure for Nipah Virus. Knowledge and awareness among the population is the only appropriate step towards the control and prevention of the deadly virus, Nipah.

-By, Drishya Unnithan and Neha Kumari (M.Sc. Part II)



Retrieved from: <https://www.id-hub.com/2017/09/05/future-preventing-treating-nipah-virus-infection>

Beauty & Biotechnology

Skincare and cosmetics are used around the world everyday by men and women alike to combat wrinkles, acne, fine lines and other signs of aging that we so dreadfully fear. In many cultures, healthy skin is perceived as a sign of youthfulness and vitality and people go to great lengths to maintain a younger looking skin. Queen Cleopatra used to bathe in goat's milk and honey every day to keep her skin younger looking and beautiful. Ancient Indians used a face mask made up of curd and turmeric to get that sun kissed glow. However, skin aging is an inevitable, complex biological process which can be attributed to a multitude of factor such as lifestyle, diet and stress. But the most important one being loss of moisture. Skincare industry is using many biotechnologically derived compounds to produce promising new skincare formulations. Fermentation is widely used to produce compounds such as collagen, ceramide, hyaluronic acid, kojic acid which are used more and more every day to design customized skincare concoctions. Hyaluronic acid is a glycosaminoglycan (GAG) is the major molecule responsible for moisture retention in the skin. It is found abundantly in the human skin and has various functions besides moisture retention such as, tissue repair, enhanced immune response and wound healing. It is hence identified as a key target by pharmaceutical companies to develop Hyaluronic acid based cosmetics and skincare. NASHA is a hyaluronic acid based gel that is used to improve skin elasticity and reduce skin roughness in the facial area. It is ad-

ministered in the form of an injectable gel which is strategically placed in the problem areas of the face.

Another key component responsible for healthy skin is Collagen. It provides structure and elasticity to the skin and is present in the form of fibers. The primary reason for breakdown of collagen is UV irradiation. Daily exposure to harsh sunlight can degrade the collagen fibers and can hence affect the youthfulness of the skin. Collagen can be taken externally in the form of supplements to replenish the damaged collagen. Collagen hydrolysate is being popularly used in skin creams which promise to reduce the effects of sun damage and improve the appearance of the skin by making it firmer, plumper and more youthful. Marine collagen is also a new type of peptide extracted from marine algae and sponges and is an excellent ingredient for the cosmetic industry. It has anti-aging and anti-wrinkling factors, it can be used for the development of creams or gels with high moisturizing action and it seems to protect against the UV radiation. It also promotes rapid wound healing and is also known to have antimicrobial properties.

Plants are also widely used for production of compounds which can largely benefit our skin health. Pycnogenol is a natural skin care supplement derived from Pine tree bark. It is a nutritional supplement supposed to benefit the skin by improving its elasticity. Studies showed that pycnogenol increased the amount of hyaluronic acid in the skin and helped to significantly improve its texture.

Skin care is ever evolving and is largely influenced by the social norms of beauty. And although there are infinite number of skin creams and face masks available in the market it is essential to maintain a healthy lifestyle and consume antioxidant rich food to maintain that youthful glow.

-By, Urjita Divekar (M.Sc. Part II)



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From academia to industry



1. Genomics has changed the face of diagnostics in recent years, what are the other fields that genomics could potentially be an answer to?

Genomics has revolutionized many fields of biology. Molecular diagnostics is just one of the aspects. There are many other areas where genomics has direct or indirect implications ranging from human health screening, identifying disease risks, treatment decisions, general wellness screening etc. Other than these there are multiple applications of genomics in agriculture/food industry, wildlife conservation etc. Understanding the genome sequences of rice, wheat and many other plants have tremendously helped us in crop improvement and plant breeding.

2. What is your take on personalized medicine being the answer to cure most of the diseases? How can a poverty-stricken avail these resources?

We often notice that different individuals respond differently to the drugs or therapies given to them for any particular disease. This is because of the fact that every individual has a different genetic and molecular composition which eventually regulates the response. Recent genetic/genomic/molecular studies in the last decades have identified several cases where the treatment decisions can be customized for an individual based on their genetic/molecular composition. Many population-based studies have identified several disease-associated genetic factors that can be considered while customizing the treatments. I am sure in coming years we will be able to understand the diseases better and personalized medicine can be more widely used for efficient disease management, however, whether we will have a cure for most of the diseases, only time will tell. There are a lot of efforts worldwide to reduce the costing of ge-

netic testing so that it can reach to all classes of society. I am sure a few years down the line with our



improved understanding of the genetic composition of populations and diseases would make personalized medicine within reach of all the social classes. One such initiative is GenomeAsia100K where we are generating the sequencing data from general Asian and South Asian population. This study would help in identifying the variants that increase or decrease the risk of specific diseases. I would recommend all budding scientist to read our recent article in Nature journal where pilot data from Genome Asia 100K was published <https://www.nature.com/articles/s41586-019-1793-z>

3. What are the niches currently present in the market that can prove to be promising research options?

Genomics in human health and diseases, Bioinformatics, plant genomics, microbiome studies.

4. What is the one quality/set of qualities that you look for in a promising candidate other than his/her technical skills? How can a biotech postgraduate get into your company?

Curiosity, ability to learn and a positive attitude are the major qualities I would look for in a promising candidate (of course other than

his/her technical skillset). Technical skills can be acquired but a positive attitude and dedication towards your work have to be inherent. If you think you are interested in the kind of work that we do in our company, approach our HR with your CV or try to get connected with scientists in our company through LinkedIn and inform them about your interest. If there are any open positions our company will take it forward from there.

5. In your opinion does 'Biotechnology in everyday life' have an influence in shaping society and what is the most challenging part?

Absolutely yes, biotech has a significant influence on shaping up of our society. Thanks to advances in the healthcare industry the incidences of several human diseases have been controlled. This has improved the global life expectancy. Biotech has improved crop yields, cut costs and reduce pesticide applications, making farming more efficient and productive in limited land area. This has improved the farmer's quality of life. Also, higher yields mean farmers can produce increasing amounts of food without increasing arable land and this has a major impact on protecting wildlife habitats.

6. What is the one message you would like to give budding biotechnologists?

There are endless opportunities for those who seek them. Keep yourself updated on the recent developments in science, don't stop learning, identify the areas that interest you and be dedicated to whatever work you take. Most importantly get connected with the people in the field of interest, networking is important in many ways.

Dr. Sameer Phalke
Senior Scientist, MedGenome,
India



I believe that the past molds you, the present teaches you and the future prepares you. St. Xavier's College has been a landmark milestone in my journey here on earth. Had I been an Arts student, it would have been my dream to study at Xavier's. However, I chose to pursue science and due to certain reasons, I landed up at Xavier's in 2012. It's safe to say that a non-existent, last resort turned out to be the most defining turning point. Xavier's taught me three important things: independence, teamwork, and being smart. I was privileged to be a part of the first batch under autonomy for Biotechnology. It's safe to say that our batch created history for every possible reason, but in those moments, we learnt the importance of standing together as a team. Many of us discovered many hidden talents;

working independently but unitedly taught us that each one of us have unique skillsets that can be used to achieve the bigger picture. Finally, it taught me how to be smart, and not cunning: I will be honest to reveal that it somewhat discourages me to see most postgraduates not displaying this particular quality when they work. Being smart did show me how to work quickly but also effectively. These qualities help mold me to be effective in my current status: the present. There seemed to be only one big option if I had to make a career out of biotechnology: pursue research and obtain a PhD. I started moving in that direction, but I began to understand that biotechnology, and in fact science, is more than just research. It was finally in Xavier's where I decided that I wanted to pursue a career in editing and that is why Xavier's is my home because it helped me understand more than what books may teach. It helped me truly understand science. I joined Crimson Interactive Pvt. Ltd. in August 2014. It is one of the leading players in the Science, Technology, and Medicine industry in the world. They edit articles from biosciences to medicine to arts & humanities to commerce & law. I thoroughly enjoyed myself at this company. Each day brought new challenges and things to learn. I feel privileged because most of the times I may be the first person apart from the author and his/her team to have a glimpse of the research conducted. I currently work with Cactus, the foremost player in the publishing industry in most of the Asian region. The current profile involves more analytical thinking, and it has been a challenge as well as a reward.

Editing teaches you important lessons. It teaches you to be concise and not exaggerate stuff. It teaches you to respect the research that the authors conduct and not criticize their poor language skills. It has helped me understand that I am not the teacher, but the learner. The future is indeed exciting. But, I would not like to dwell on my future plans but would rather want to shed light on how y'all can prepare yourselves for the future. If you wish to pursue a career in editing, you do not need extraordinary skills to be an editing expert. Basic language and grammar knowledge along with a strong foundation in science concepts would hold you in good stead. Let me assure you that jobs will never dry out in this sector. It is also one of the highest paying jobs. There are different types of editors too. Not all editors are involved in correcting the language of a manuscript. Some editors are even involved in artwork and formatting editing.

Before I end, let me assure you that a career in science is not dull and it will not be looked down upon. Research is not the last and only option. It all depends on an individual's interest. Identify what will bring you the most satisfaction and joy. If it is research, pursue it. If it is a data analyst, pursue it. If it is an editor, pursue it. **Do not set ordinary goals, push yourself to achieve and be the best.**

**-By, Nikhil Thangiah
Reviewer, Cactus Communications
Alumnus Batch 2012-2014**

Image retrieved from: <https://www.linkedin.com/school/st.-xavier's-college/>

A JOURNEY OF GRATITUDE



Master's years at St. Xavier's Department of Biotechnology were one of the best years of my career so far. I still remember my first day at St. Xavier's College which was a dream come true moment for me, filled with lots of excitement! The journey of four semesters began and was more like a roller coaster ride, each day was packed with new experiences. One of my most cherished memory is of spending extra hours in lab for performing experiments. My group and I used to discuss and execute different experiments with faculties which helped us to satisfy our scientific curiosity. This aided me to figure out my inclination towards pursuing research after Masters.

During the Masters, I thoroughly enjoyed the academics thanks to the faculty at St. Xavier's who worked hard to make the lectures simple and interesting, yet knowledgeable. I was fortunate to have dedicated and proficient faculties who motivated and encouraged us to perceive our respective careers. Moreover, here at St. Xavier's, apart

from excellent academic training, students are groomed to outshine in their careers and serve as a valuable asset to society. Letting us organize the Department festival 'Palindrome' for the year 2016 was one of the enriching experiences I had at this prestigious Department. Other such memorable experiences include organizing scientific elocution competitions hosted by 'Lupin', participating in 'Reach to Teach' social cause event, an industrial visit to Goa, forming a business proposal for a product and many more. Engaging assignments and interesting group activities helped me to learn things more creatively and develop my soft skills. Extensive scientific writing training also made me understand that one must not limit his or her research to the lab but should learn how to communicate it to the audience or readers effectively. These experiences and values helped me to grow academically and professionally, shaping me into a personality I am today.

Currently, I am pursuing my Ph.D. at the Department of Chemical En-

gineering in IIT Bombay, and would proudly say that the knowledge, experiences, and skills learned at St. Xavier's college has helped me fit flawlessly in my current career position. I will be forever grateful to St. Xavier's and especially to the faculties of the Department of Biotechnology who taught and mentored me during my Masters. Also, I would like to quote few lines from St. Xavier's anthem to express my gratitude towards this incredible institute- **'Xavier's, you gave me roots and wings, opened my eyes to things and somewhere along the way you taught me how to fly and stay, in the world outside so differently you helped me become more me!'**

I would like to advise the students and freshers to sit back and enjoy the roller coaster of your Master's journey at the Department of Biotechnology, St. Xavier's.

ALL THE VERY BEST FOR YOUR FUTURE ENDEAVORS!

**-By, Ketaki Bachal
PhD Scholar, Indian Institute of
Technology, Bombay
Alumnus Batch 2016-2017**



Retrieved from: https://www.freepik.com/premium-photo/arrow-symbol-start-jogging-track-selective-focus-arrow-symbol-road-park_1650446.htm



DEPARTMENT PROJECTS

Scientific approach provides impetus to the social growth and is the best way to resolve the existing issues. Having recognized this, our department encourages the young minds to develop a scientific temper by providing the opportunity and facilities to work on projects.

ENVIRONMENT

BIOSORBENTS FOR SEQUESTRATION OF SYNTHETIC DYES AND METALS- AN ECOFRIENDLY APPROACH

Akhila Nair, Lizelle Fernandes, Berness Falcao, Sarah Barretto, Pragnesh Parmar, Shavin Fernandes, Clarice Bhattacharya, Stinita D'souza (Project guide: Ms. Norine Dsouza)

Synthetic dyes and metals form one group of pollutants which are not generally eliminated by conventional methods as they are highly stable, making them toxic and carcinogenic in nature. Substantial use of the wastes produced in the form of pomace and sugarcane bagasse can be instrumental in using them as a resource. In the present study, value added products like pectin and cellulose were extracted and utilised to determine their dye uptake ability when subjected to dyes like Methylene Blue and Commassie Brilliant Blue. In a similar manner, cadmium and mercury chelation ability of the two products was also checked. Thus, these products can act as promising low cost sorbents with exceptional dye binding and metal binding capacity to purify wastewater. Another aspect of this study was synthesis of bucky paper functionalized with pectin which will be further checked for its dye uptake and metal binding properties.

VALORIZATION OF VEGETABLE WASTE TO DEVELOP AN ALTERNATIVE BACTERIOLOGICAL MEDIA

Shalini Chowdhury, Ruqayya Manasawala, Ashika Singh, Shiza Sarguroh, Bhumika Waghela, Mayuri Goriwale, Supriya Garale (Project Guide: Dr. Ira Vashisht)

Food processing industries and households generate a substantial amount of organic waste every day. Easily available & minimally processed waste such as cauliflower stalks, pea pods, coriander stems and cucumber peels were utilized in the formulation of alternative microbial growth media. Commonly used microorganisms such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Staphylococcus aureus* were cultured for studying the nutrient potential of the formulated alternative media. Biochemical and morphological characterization along with growth kinetics analysis depicted maximum potential of coriander stems' waste in supporting bacterial growth. Utilization of minimally processed vegetable waste could act as a cost-effective alternative to nutrient media for microbial culture, in turn helping relieve the environmental burden.

UTILIZATION OF OIL-BASED WASTE FOR BIOSURFACTANT PRODUCTION

Conceetha Sequeira, Sharline Johnson, Tejas Suryawanshi, Gunjan Dutt, Berin Babu, Pency Martina, Rutuja Yelmar, Tarana Anand (Project Guide: Dr. Shiney Peter)

Biosurfactants are surfaceactive agents produced by microorganisms that have higher efficiency and stability, lower toxicity and higher biocompatibility and biodegradability than chemical surfactants. The objective of this study was to optimize biosurfactant production using oil based substrates like coconut oil cake, rice husk and used cooking oil using Lab-strains, *P. aeruginosa* and *B. subtilis*. The product was characterized using physiochemical methods. Antimicrobial activity of biosurfactants was checked and found to be effective against *S. aureus*. It was found that coconut oil cake is one of the potential commercially viable substrates giving high yield of biosurfactants.

EFFECT OF NUTRITIONAL STRESS ON PRODUCTION OF POLYHYDROXYBUTYRATE

Mystica Jacob, Subhasini Singh, Vishakha Sakhareriya, Haifa Parkar, Rutuja Chalke, Vedanshi Dharnidharkha, Aswini Anbazhagan (Project guide: Ms. Norine Dsouza)

Effects caused to the environment due to the persistence of conventional plastics have raised the need to replace them with eco-friendly alternatives namely Bioplastics for e.g. Polyhydroxybutyrate (PHB). The present study focusses on the production of PHB using soil organisms like *Cupriavidus necator*, *Bacillus megaterium*, *Bacillus subtilis* and S3 in Nutrient broth, Nitrogen deficient medium and GM2 medium, followed by extraction using Chloroform method, in order to determine the medium that enables the organisms to yield maximum amount of PHB. FTIR spectroscopy analysis of the PHB films extracted in the presence of chemical inducers indicated resemblance to the data obtained through analysis of standard PHB. Co-culturing of *Bacillus megaterium* and *Bacillus subtilis* with *E.coli*, and that of *Bacillus megaterium* with *Bacillus subtilis* was also performed. Also, degradation studies were carried out in order to check for the degradation rate of commercially available biodegradable plastic bags and spoons, by determining the mass percentage loss.



DEPARTMENT PROJECTS

IN VITRO TESTING USING CELL LINE MODELS

CYTOTOXICITY STUDY OF *Annona muricata*: AN IN VITRO COMBINATORIAL APPROACH

Akhila Nair, Lizelle Fernandes, Berness Falcao, Sarah Barretto, Pragnesh Parmar, Shavin Fernandes, Clarice Bhattacharya, Stinita D'souza

(Project Guide: Dr. Shiney Peter)

The anti-proliferative potential of combination therapy using ethanolic *Annona muricata* extract with chemotherapeutic drugs like Adriamycin, Vincristine and Methotrexate on A549 and HEK293 cell lines was evaluated using SRB assay. The combination therapy exhibited pronounced cytotoxicity in comparison to the extract alone with higher growth inhibitory effect observed in case of HEK293 cells. The IC_{50} values of *A. muricata* extract in combination with Adriamycin, Vincristine and Methotrexate were found to be 32 $\mu\text{g/ml}$, 94 $\mu\text{g/ml}$ and 90 $\mu\text{g/ml}$ respectively against HEK293 cells. Thus, anti-proliferative activity of *A. muricata* extract as a single agent maybe improved by using it in combination with Adriamycin, Vincristine and Methotrexate. However, these interactions remain uncertain and need to be further evaluated to be considered for potential cancer therapy.

CYTOTOXICITY ASSESSMENT OF SYNTHETIC FABRIC LEACHATES – AN IN VITRO STUDY

Shalini Chowdhury, Ruqayya Manasawala, Ashika Singh, Shiza Sarguroh, Bhumika Waghela, Mayuri Goriwale, Supriya

Garale (Project Guide: Dr. Shiney Peter)

The surge in the use of synthetic fabrics has resulted in an increased release of processing chemicals and microfibers in the environment. The environmental hazards and dangers of these fabric leachates on the marine system are well documented. However, there is limited knowledge on the direct effect of these leachates on human cells. The present study aimed at assessing the toxicity of synthetic cloth leachates on human and murine cell lines using SRB assay. The cloth fabric was suspended in sterile DMEM medium for varied time intervals to obtain leachates. Morphological changes and toxicity due to direct contact of fabric material with the cells was evaluated. A statistically significant decrease in percentage viability of cells was observed.

IN VITRO CYTOTOXIC EFFECT OF *Calotropis* SPECIES EXTRACTS ON HUMAN A549 AND HEK 293 CELL LINES

Conceetha Sequiera, Sharline Johnson, Tejas Suryawanshi, Gunjan Dutt, Berin Babu, Pency Martina, Rutuja Yelmar, Tarana Anand

(Project Guide: Dr. Shiney Peter)

Calotropis is a medicinal plant which has been shown to have potent anti-proliferative activity. This study focuses on cytotoxic effects of the hot and cold methanolic extracts of *Calotropis procera* and *Calotropis gigantea* against A549 and HEK 293 cell lines using sulforhodamine B assay. Significant effect of these extracts was observed on A549 cell line with morphological changes which indicated potential anti-proliferative activity and can be used further for cancer treatment.

PROTECTIVE POTENTIAL OF *Tamarindus indica* SEEDS AND *Butea monosperma* LEAVES ON CELL LINES

Mystica Jacob, Subhasini Singh, Vishakha Sakhareriya, Haifa Parkar, Rutuja Chalke, Vedanshi Dharnidharkha, Aswini Anbazhagan

(Project Guide: Dr. Shiney Peter)

In this study, we tested the protective effect of alcoholic extracts of *Tamarindus indica* seeds and *Butea monosperma* leaves on HEK293 and 3T3 cell lines for their use in cosmetics. In-vitro cytotoxicity testing was performed to detect changes in cell viability using varying concentrations of the extracts. *T. indica* seed extract showed IC_{50} values of 92 $\mu\text{g/ml}$ and greater than 100 $\mu\text{g/ml}$ on HEK293 and 3T3 cell lines, respectively. *B. monosperma* leaf extract showed an IC_{50} value of 80 $\mu\text{g/ml}$ and greater than 100 $\mu\text{g/ml}$ on 3T3 and HEK293 cell lines, respectively. These extracts can be used at a concentration lower than their IC_{50} values, so as to ensure their protective effect in cosmetic formulations.

“Research is to see what everybody else has seen, and to think what nobody else has thought” - Albert Szent-Gyorgi



CLONING AND CHARACTERIZATION OF INTERACTING PROTEINS OF THE PROTEASOMAL CHAPERONE, PSMD9 **Clarice Bhattacharya (PI: Dr. Prasanna Venkatraman, ACTREC)**

Proteasomes regulate the cellular protein level by maintaining a balance between synthesis and Chaperone proteins such as PSMD5, PSMD9, PSMD10 and PAAF1 are responsible for proteasome assembly, PSMD9 is a hub protein that plays a critical role in the progression of diseases such as Breast Cancer, Prostate Cancer and Glioblastoma. Recent studies have identified hnRNPA1 as one of the novel interacting partners of PSMD9 amongst various others that can be used as a drug target in cancer cells which require consistent NF- κ B activity for survival. In this thesis, an effort has been made to assess the specificity of EXKK motif in the binding of PSMD9 with its interacting proteins. A linear correlation was observed as the concentration of peptide increased, number of PSMD9 molecules bound to the peptide. In order to assess a direct interaction in the native form of a protein rather than a peptide, two EXKK-containing proteins namely, Rab1a and hnRNPA2B1 were chosen. Among the two, only hnRNPA2B1 showed positive binding to PSMD9. Hence PSMD9 and its interacting partners pave way for a structural understanding of PSMD9 to be further researched as a potential therapeutic target for various cancers.

IDENTIFICATION OF MECHANISMS REQUIRED FOR MIGRATION AND INVASION UPON LCN2 OVEREXPRESSION **Tejas Yuvaraj Suryawanshi (PI: Dr. Sorab N. Dalal, TMC-ACTREC)**

Epithelial cancers contribute about 90% of total cancers. The epithelial cells are in contact with each other through cell junctions like desmosomes which plays important role in cell adhesion and signaling. Loss of desmosomal protein Plakophilin 3 (PKP3) results in decreased cell-cell adhesion and causes increase in expression of Lipocalin 2 protein. Lipocalin 2 (LCN2) is a glycoprotein which plays important role in cell proliferation, apoptosis and also shows bacteriostatic activity against many bacterial species. LCN2 plays important role in invasion and migration by altering the actin dynamics. The levels of different proteins involved in actin dynamics in epithelial cancers and role of iron in invasion were studied in HCT116 derived PKP3 knockdown, PKP3 and LCN2 double knock down and LCN2 overexpressing clones. Altered levels of different proteins involved in actin nucleation, depolymerization and cellular protrusion formation were observed in clones. BFP-actin clone was prepared to study filamentous actin. The role of iron in invasion was studied in Deferoxamine treated PKP3 knockdown and LCN2 overexpressing clones by Boyden chamber invasion assay. The results showed that LCN2 does play role in invasion and migration by altering the level of different proteins and by interacting with iron which will help to elucidate the mechanism.

EVALUATION OF ANTI-TB PROPERTIES OF A PLANT TRITERPENOID "BA-19" IN MURIN MACROPHAGE CELL LINE (RAW264.7) **Gunjan Ravi Dutt (PI: Dr. Pramod K. Gupta, RMC, BARC)**

Tuberculosis infection caused by *Mycobacterium tuberculosis* is a global cause of mortality. The rise in incidences of MDR-TB and XDR-TB has made its treatment challenging. Drug resistance has developed gradually over the years and thus, novel treatment method and drugs are necessary. Host directed therapeutics using drugs obtained from plant extracts is an emerging alternate treatment concept. Triterpenoids are one such plant extracted compound that show several medicinal properties. In the present study, anti-tuberculosis properties of the triterpenoid BA-19 was investigated. The expression of surface molecules like MHC II and CD 86, Nitric oxide formation, MAPK activation, reduction of intracellular survival of MTB and the effect of phagosome lysosome fusion in the macrophage cell line (RAW264.7) were studied. In MAPK activation, two different concentrations of BA 19 induced the activation of MAPK. BA 19 also caused an increase in cell surface expression of CD86 and MHC II markers by flow cytometry analysis. Through confocal microscopy the effect of BA 19 on phagosome lysosome fusion in cell line was seen. These two dosages enhanced the fusion,



STUDIES ON THE EFFECT OF COX-2 INHIBITOR NS-398 ON LYMPHOCYTES AND LYMPHOMA CELLS

Pragnesh Dilip Parmar (PI: Dr. Bhavani Shankar, Homi Bhabha National Institute Bhabha Atomic Research Centre)

Cancer can be described as an uncontrolled autonomous cell growth due to the collapse of boundaries that regulate cellular checkpoints such as differentiation, proliferation and death. Immunotherapy aims to stimulate the immune system and thereby increase the host resistance to fight against the tumor cells. Earlier studies in the lab had revealed that tumor-derived PGE2 downregulates the Zbtb46 transcription factor which is important for differentiation of classical dendritic cells (cDC). Inhibition of COX-2 by the specific inhibitor molecule NS-398 (N-[2-(Cyclohexyloxy)-4-nitrophenyl]methanesulfonamide) decreased PGE2 secretion and thereby enhanced the dendritic cell (DC) differentiation. This increased DC immunogenicity also led to reduced tumor burden in pre-clinical mouse models. The work presented in this thesis describes the toxicity of NS-398 along with radiation on tumor cells as well as normal lymphocytes.

ISOLATION OF EXTRACELLULAR VESICLES FROM *Fusarium* AND CHARACTERIZATION OF FUSARIC ACID RESISTANCE PROTEIN FROM *Chlamydomonas reinhardtii*

Lizelle Fernandes (PI: Dr. Siddhesh B. Ghag, UM-DAE Center for Excellence in Basic Sciences)

Fusarium wilt of banana, popularly known as Panama disease, is caused by *Fusarium oxysporum f. sp. cubense* (Foc), a hemibiotrophic filamentous fungus. Recent research has revealed the involvement of SIX gene, Sge gene, effector molecules and other long coding RNAs in pathogenesis. However, the precise mechanism of pathogenesis with respect to the transfer of virulent factors and the fungus-plant crosstalk remains unclear. In this study, the extracellular vesicles secreted by *Fusarium*, suspected to be involved in trafficking of virulent agents, were isolated using different methods and their components were analysed using SDS PAGE and Nile Red staining. Results obtained revealed the presence of vesicular structures post Nile red staining. The fusaric acid resistance protein from *Chlamydomonas reinhardtii* was studied in silico. Fusaric acid bioassay was performed using *Bacillus subtilis*, the wild type *Chlamydomonas* RNA was extracted and converted to cDNA. To confirm the presence of the cDNA an actin PCR was done. Amplification of FUSC protein was done using Q5 DNA polymerase.

EVALUATION OF ANTIOXIDANT AND ANTI-AGING PROPERTIES OF SULFATED POLYSACCHARIDES EXTRACTED FROM *Chlamydomonas reinhardtii* UNDER SALT STRESS

Berness Peter Falcao (PI: Dr. V. L. Sirisha, UM-DAE Center for Excellence in Basic Sciences)

Skin aging, a natural phenomenon witnessed by humans, is governed by various intrinsic and extrinsic factors. Antioxidants known to fight oxidative stress can be used to combat early skin aging. In the present study, the antioxidant and anti-aging properties of sulphated polysaccharides (SPs) from freshwater microalgae *Chlamydomonas reinhardtii* (Cr) grown under conditions of salt stress are evaluated. The semi-purified KCl stressed Cr-SP extracts showed enhanced carbohydrate and uronic acid content indicating enhanced SP production by Cr under salt stress. An increase in the total antioxidant activity and reducing the power of KCl stressed Cr-SPs extracts was observed along with an increase in ferrous iron-chelating activity. The anti-aging properties of KCl induced Cr-SPs extracts were assessed on the basis of their anti-elastase activity. A staggering increase in enzyme inhibition activity was observed in KCl stressed Cr-SPs extracts in addition to an increase in anti-collagenase and anti-hyaluronidase activity. These promising antioxidant and anti-aging properties of KCl induced Cr-SPs unlocks their potential use as a cost-effective ingredient in anti-aging formulations.

MOLECULAR TOOL BUILDING FOR STUDYING THE INTERACTION BETWEEN A MYC-BINDING PROTEIN-1 AND MYC-BINDING PROTEIN-1 ASSOCIATED PROTEIN FROM *Chlamydomonas* FLAGELLA

Shalini Roy Chowdhury (PI: Prof. Jacinta S. D'Souza, UM-DAE Center for Excellence in Basic Sciences)

The cilia central pair apparatus (CPA) of *Chlamydomonas* houses a scaffolding protein viz. A Kinase Anchoring Protein (AKAP240) involved in signaling pathways. FAP174 is a MYC-binding Protein and has an RII-like binding domain that interacts with AKAP240. FAP147, being one of the interactors of FAP174, is a MYC-binding Protein Associated Protein but its exact function is yet to be elucidated. The current study adopts a one-gene, one-protein approach viz. screening of mutants and generation of antibodies against FAP147 recombinant protein, to study its role in the *Chlamydomonas* flagella. Using a bioinformatics approach, it was found that FAP147 is a 103 kDa protein majorly consisting of beta-sheets. Screening of the mutants revealed that phenotypically they were clumped and non-motile whereas, genotypically they were positive for the control locus and paromomycin cassette. Based on the designed primers, the expected size was observed in 4 clones indicating disruption of the target gene. The antigenic region of the *fap147* gene was cloned and transformed into *E. coli* BL21(DE3) using pET28a and protein expression studies were done. These findings would pave the way for a better understanding of the interaction of FAP147 with FAP174 as well as its function in *Chlamydomonas* flagella.

IDENTIFICATION OF DIRECT INTERACTORS OF FAP174 IN THE FLAGELLA OF *Chlamydomonas reinhardtii*

Shiza Imtiaz Sarguroh (PI: Prof. Jacinta S. D'Souza, UM-DAE Center for Excellence in Basic Sciences)

Cilia/flagella contain microtubules surrounded by proteinaceous projections that interact with the radial spokes and the dynein arms. The central pair apparatus (CPA), however, remains elusive. FAP174 is one such protein located within the C2 microtubule of *C. reinhardtii* flagella. The *fap174* mutant exhibits stunted flagella and impaired motility. The present study is aimed at identifying the probable interacting partners of FAP174 in the CPA. Flagella were isolated from wild-type and *fap174* mutant cells and de-membranated to obtain the axonemal fraction. This was subjected to treatment with high salt chaotropic reagents such as NaCl/KCl and KI to enrich the central pair proteins. Protein content of the central pair fractions was estimated and the proteins were resolved by electrophoresis. The resolved gels were visualized and blotted to carry out far-western and anti-FAP174 probing. The highest protein and intense expression of FAP174 was seen in the KCl+KI fraction. The number of spots observed on the 2DE gel were relatively higher in the KCl+KI fraction in comparison to that of NaCl+KI. The results obtained indicate the presence of several probable interacting partners of FAP174 in the C2 enriched microtubule. Characterization of the whole complex using FAP174 as the bait protein could give further insights into its function in this dynamic organelle.

EFFECT OF SMALL MOLECULES ON ACTIN POLYMERIZATION DYNAMICS

Haifa Parkar (PI: Dr Avinash Kale, Reader, School of Chemical sciences, Center for Excellence in Basic Sciences)

Actin, ubiquitous cytoskeleton protein, whose continuous assembly/disassembly is essential for many cellular processes. Any dysregulation leads to diseases such as cancer metastasis, neurodegenerative disorders. Protruding structures formed by the metastatic cells namely invadopodia, filopodia are made up of actin filaments which are responsible for the mobility of these cells while rapid turnover in the actin dynamics help the cells metastasizing in the body. In neurodegenerative disorder such as Alzheimer's disease there is formation of Hirano bodies, paracrystalline structures rich in actin filaments. The aim of this study is to check inhibitory action of small molecules on actin polymerization dynamics. The protein was purified from acetone powder extracted from pig thigh muscles. Three drugs were screened to check its effect on depolymerizing the actin filaments using biophysical techniques such as synchronous fluorescence spectroscopy, light scattering, and kinetics. Circular dichroism was performed to examine the changes in secondary structure of protein in presence of drugs. Size exclusion chromatography confirmed the conversion of polymeric/aggregate actin into lower oligomeric state by drugs. Out of the three drugs, results showed that Drug C has potential actin depolymerization activity. Hence drug C with the help of targeted drug delivery system can prove to be a promising candidate to treat actin related diseases in future.



BINDING POCKET MUTANTS OF PDZ DOMAIN OF PSMD9, A PROTEASOMAL CHAPERON

Rutuja Subhash Yelmar (PI: Dr. Prasanna Venkatraman, ACTREC)

The common motifs responsible for protein-protein interactions involves 'Short Linear Interacting Motifs' and PDZ domains are protein interaction domains which recognize SLiMs on their interacting partner surface. PSMD9 is a proteasome assembly chaperone harboring an atypical PDZ domain. The interaction of PDZ domain of PSMD9 with hnRNPA1, an RNA binding protein, leads to proteasomal degradation of I κ B α , thereby leading to activation of NF- κ B. Since NF- κ B is often overexpressed in many cancers, understanding the detailed mode of PSMD9-hnRNPA1 interaction would help in rational design of inhibitors to block PSMD9-hnRNPA1. Based on computational studies and previous reports, four residues were chosen for our study; namely, Cys216, Ile218, Phe162, and Gln181. Out of these, Cys 216 and Ile218 are a part of the beta5 sheet that forms the floor of the binding pocket and reported to involved in peptide binding from Nas2 PDZ domain. Using site-directed mutagenesis PCR approach, the above residues were mutated to glycine and were confirmed by Sanger sequencing. The secondary structure of C216G mutant was assessed by CD spectroscopy did not show loss of secondary structure as compared to wild type PDZ. Further, the thermal stability of C216G mutant was checked using nanoDSF, which showed reduced T_m (54oC) as compared to wild type PDZ domain (66oC). The binding of C216G mutant was checked by ELISA and it had the same affinity as the wild type PDZ domain. This indicated that the cysteine in PDZ domain is not involved in formation of disulfide bond with the peptides and this mutant does not alter the secondary structure of the protein but leads to minor destabilization since cysteine 216 is a part of the secondary structure of PDZ domain.

COMPUTATIONAL PREDICTION OF MIRNAS AND THEIR POTENTIAL TARGET GENES IN INDIAN CATFISH, *Clarias magur*

Stinita D'souza (PI: Gireesh Babu, ICAR-Central Institute of Fisheries Education)

Micro RNA (miRNA) are small, non-coding molecules that recognise the cognate sequences and induce silencing of genes by interfering in the transcription, translation and epigenetic processes. Investigating the role of miRNA in fish can help in the conservation of fishes and can be of biological and economic importance. In the present study, mining of the conserved miRNA from commercially important freshwater fish *Clarias magur* was achieved using homology-based bioinformatics approach. The miRNA mature sequences retrieved from the miRBase database of two similar species and transcriptome data of *C. magur* obtained by the Illumina sequencing platform were searched for sequence similarity using BLAST Plus. 15,612 sequences were flanked with 100 nucleotides upstream and downstream to aid in filtering the coding and non-coding sequences. The current study reports 50 potential targets for 29 miRNAs. The RNA sequence data from the brain and gonad tissues of *C. magur* strongly suggest that miRNA is involved in the post-transcriptional regulation of reproductive and neuronal proteins which was confirmed by target prediction. Few other target proteins are also reported that function in response to stress, control cell cycle and signalling pathways.

DEVELOPING DNA BARCODES FOR IDENTIFICATION OF FRESH WATER FISH SPECIES

Supriya Garale (PI: Annam Pavan Kumar, ICAR-Central Institute of Fisheries Education)

India has a rich aquatic biodiversity spreading across different aquatic ecosystem. Recently DNA barcoding technique has been used to know the percentage similarity between intraspecies and inter species. The present study was carried out to develop DNA barcodes for selected fresh water species. Species contain both mitochondrial as well as genomic DNA. Mitochondrial DNA has COI gene which was taken as target gene in order to find out the similarities between family, genus and species. DNA was subjected to PCR amplification in order to amplify the target gene. Elution for amplified gene were carried and sequences of the genes were retrieved. Later the sequences were subjected to bioinformatics tool Mega7, the sequences were aligned, pair wise distance as calculated using bootstrap method. The neighbour joining method was used to create phylogenetic tree. The bootstrap values were more than 75 therefore the relation observed is statistically significantly.



EFFECT OF THREE DIFFERENT BIOFLOC SYSTEMS ON THE HEALTH STATUS OF GIFT TILAPIA Conceetha Sequeira (PI: Dr. Gayatri Tripathi, ICAR-Central Institute of Fisheries Education)

The expansion of aquaculture due to rising population has caused various environmental problems to the environment. The growth performance of GIFT tilapia, histological alterations in liver, gill and intestine was studied along with expression levels of immune genes in the kidney, liver and intestine tissues. Biofloc was prepared using three different carbon sources such as tapioca flour (T1), jaggery (T2) and wheat flour (T3) and a control tank was maintained. By the end of the experiment, the highest growth of GIFT tilapia was observed in T1 and least in T2. However, the growth of the fishes in the treatment tanks was not significantly different from control tanks. The water parameters assessed for biofloc systems and control tanks throughout the experiment were within the acceptable limits. Meanwhile, histopathological alterations were observed in the liver, gill and intestine of fishes from T2 and T3 when compared to T1 and control. In liver tissue, congested sinusoids and focal necrosis was observed. The gills displayed swollen tips and lamellar fusion, while the intestine showed complete necrosis of the intestinal villi. Immune gene expression of IL-8, HSP-70 and IFN γ was not observed in both treatments as well as in the control tanks. These results suggest that biofloc prepared with the carbon source of tapioca flour improves water quality, growth performance and the overall health status of the animal.

IN SILICO IDENTIFICATION AND CHARACTERIZATION OF NOVEL SNPS IN DISEASE-RELATED GENES OF *Clarias magur*

Pency Martina (PI: Dr Aparna Chaudhari, ICAR-Central Institute of Fisheries Education)

Clarias magur is a popular catfish species which is now enlisted under the 'endangered' category due to the vulnerability towards disease outbreaks. Genetic improvement for disease resistance variety can improve its aquaculture prospects. To discover novel polymorphisms in candidate genes that could be associated with the disease, tissue samples were collected. The total RNA was isolated for cDNA library preparation and was sequenced with Illumina MiSeq platform, a transcriptome data with 78.96 million high-quality reads were obtained. A de novo transcriptome assembly resulted in 52,237 contigs and using Blast2GO software the sequence was annotated among which 36642 contigs were the known sequence databases. From the total known sequence databases, 24 genes related to immune regulation and immune defense mechanism against disease were screened. About 121 SNPs were identified from which 64 SNPs were located in the CDS region of the gene. Among 67 transitions, 54 transversions were detected among polymorphic SNPs. Total 39 non-synonymous SNPs resulted in substitution by an amino acid of a different class. The greatest number of SNPs was found in HSP-70, LMP and C3 gene fragments. Therefore, the primers are designed to amplify the specific region. The selected SNPs have to be validated and can be used in marker assisted selection for selective breeding.

ANTIBACTERIAL AND ANTIBIOFILM ACTIVITY OF SULFATED POLYSACCHARIDES EXTRACTED FROM *Chlamydomonas reinhardtii* CC-124 AGAINST *Klebsiella pneumonia* AND *Proteus mirabilis*

Bhumika P. Waghela (PI: Dr. V. L. Sirisha, UM-DAE Center for Excellence in Basic Sciences)

Bacteria within the extracellular matrix are more resistance to antibiotics. Studies on *K. pneumonia* and *P. mirabilis* is of importance because they form biofilm and are difficult to eradicate via antimicrobial drugs. Algae are well-known to produce bioactive sulfated polysaccharides (SPs) that exhibit antibiofilm activity. *C. reinhardtii* is known to secrete SPs in stationary phase or when exposed to abiotic stress. In the current study, SPs are extracted from *C. reinhardtii* in order to develop them as a natural antibiofilm agents. Cr-SPs showed efficient antibacterial activity against *K. pneumonia* and *P. mirabilis* as indicated by clear zones of bacterial growth inhibition around the wells. Concentration-dependent reduction in the number of colonies formed by *K. pneumonia* and *P. mirabilis* suggested their potential to inhibit the clonal expansion of the bacterial cells. The minimum inhibition concentration (MIC) of Cr-SPs was found to be as low as 850 $\mu\text{g/ml}$ for *K. pneumonia* and 1.6 mg/ml for *P. mirabilis*. Dose dependent reduction in extracellular DNA in the extra polymeric substance (EPS) revealed that Cr-SPs interacts with EPS and destroy the biofilms. With further screening and validation, they can be developed treatment of nosocomial infections.



A STUDY EVALUATING THE ROLE OF SUBSTRATE STIFFNESS IN CELL PROLIFERATION VIA CELLULAR CONTRACTILITY

Sarah Stanley Barretto (PI: Dr. Abhijit Majumder, Indian Institute of Technology Bombay)

Human Mesenchymal Stem Cells (hMSCs), a promising candidate in the field of regenerative medicine, have self-renewing and differentiating properties. While the role of biochemical cues and factors controlling hMSC proliferation has been investigated extensively, the involvement of mechanical factors and mechano-transducers is relatively unexplored. The present study is aimed at identifying the role of contractile proteins in hMSCs proliferation in response to changing ECM stiffness. The results obtained demonstrate that the cells become quiescent on treatment with an increasing concentration of Y27632 (contractility inhibitor) as shown using BrdU assay, fold change assay, and Traction force microscopy (TFM) analysis. An increase in cellular traction is observed on LPA (contractility enhancer) treated hMSCs grown on 5 kPa substrate stiffness; while the same was not observed for hMSCs grown on 2 kPa substrate under same conditions. It can be concluded that an interplay of mechanical forces and biochemical signals is required to determine cell fate. An understanding of the involvement of contractile proteins in cell cycle progression will provide valuable insights on controlling cellular behaviour of hMSCs *in vitro*.

DESIGN AND DEVELOPMENT OF POINT-OF-CARE DEVICE FOR DETECTION OF VITAMIN B12

Ashika Singh (PI: Prof. Rohit Srivastava, Indian Institute of Technology Bombay)

Deficiency of vitamin B12 causes complications in pregnancy leading to poor maternal and child health. Detection of vitamin B12 involves laboratory testing or retrospective analysis which are unreliable, expensive, and time-consuming. In this work, a point-of-care device for the detection of vitamin B12 based on the principle of competitive-type lateral flow immunoassay (LFIA) was developed. The assay quantifies vitamin B12 in physiological range of pmol/L. It requires hapten bound to a carrier protein at the carboxylic group of vitamin B12. It served as the target for the competing binding reaction and was characterised by UV-Visible Spectrophotometry and Circular Dichroism. Synthesis of gold nanoparticles by citrate-reduction method was done and was conjugated with the vitamin B12 antibodies to serve as potent tags. The bioconjugates were characterised by UV-Visible Spectrophotometry, TEM, and Dynamic Light Scattering. Extensive investigation was done to check the stability and reactivity of these conjugates. The capillary action of the LFIA strips was demonstrated. The test results suggested the need to optimize the LFIA by overcoming the limitations of the test line to achieve better maternal health.

DEVELOPMENT OF POINT-OF-CARE DEVICE FOR DETECTION OF GRAM POSITIVE BACTERIA

Mayuri Dattaram Goriwale (PI: Prof. Rinti Banerjee, Indian Institute of Technology Bombay)

Gram positive bacteria like *Staphylococcus aureus* are known to be associated with multiple infections in humans as well as animals. This has led rampant use of antibiotics and eventually a bioburden of resistance against most antibiotics. Development of one device has been attempted in the current study to identify presence of Gram positive bacteria like *Staphylococcus*. Three different types of nanoparticles namely- Chromogenic liposomes, Gold nanoparticles and Polyvinyl alcohol-Polystyrene (PVA-PS) nanoparticles bound to specific antibody were prepared. Alternately agglutination reactions with specific PVA-polystyrene nanoparticles coated with human plasma for identification of *S.aureus* were also developed. Primarily the antibody conjugated with both Liposomes and Gold nanoparticles were unable to bind specifically to the test analyte. While PVA-polystyrene nanoparticles could help identify with a peculiar agglutination reaction. The reaction clearly distinguished *S.aureus* making the material highly specific, also the limit of detection was found to be 107 CFU/ml that is detectable range in clinical samples. In conclusion, the study was enriching through different nanomaterials conjugated with various bacteria specific identifying moieties for identification of GPB like *S. aureus*. With further studies like stability of material, clinical validation and device design will make the technology a marketable product.



DEVELOPMENT OF POINT-OF-CARE DEVICE FOR THE DETECTION OF CARBAPENEM RESISTANT BACTERIA

Subhasini Singh (PI: Prof. Rinti Banerjee, Indian Institute of Technology Bombay)

Carbapenem Resistant Enterobacteriaceae has become the utmost, extensively spread menace all over the world due to its high mortality rate. The present study focuses on the development of a rapid diagnostic tool i.e. paper based Point-of-Care Device that will help to detect Carbapenem resistant bacteria based on Iodometric method of detection..The stable starch-iodine coated bio-polymeric nanoparticles synthesised were found to be of size approximately 40-60nm as observed using Scanning electron microscopy. The Transmission electron microscopy and Energy Dispersive X-ray Spectroscopy analysis confirmed the presence of starch-iodine coating around the core of bio-polymeric nanoparticles. Whereas, the shift in zeta potential value of bio-polymeric nanoparticles ranging from -30mV to +30mV indicated the synthesis of highly stable core- shell bio-polymeric nanoparticles with a net positive charge of +47.3 for bio-polymeric nanoparticles (core) and net negative charge of -28.3 for coated bio-polymeric nanoparticles (core-shell). The in vitro evaluation of device with saline suspension and enriched nutrient broth showed the positive reaction.RGB analysis and statistical analysis showed the significant difference between the intensity of discolouration in case of Carbapenem resistant and Carbapenem susceptible strains. However, the results obtained from the study are a preliminary analysis which will be used further for determining the stability and validation of device. Thus, the development of such device would help to combat the lethal effect caused due to anti-microbial resistance for both nosocomial conquered as well as community conquered infections.

DNA BARCODING OF SELECTED FRESHWATER FISH SPECIES

Valiyaveettil Mystica Jacob (Dr.A. Pavan Kumar, Scientist. ICAR-Central Institute of Fisheries Education)

Fishes play a key role in the biotic community as they offer humans with the source of food. Trading of freshwater fishes helps in economic growth and to maintain sustainable development. However, over population, mining, pollution, over-fishing etc; are leading many species to the verge of extinction. So there is an urgent need to conserve such species. Earlier, the species identifications were carried out by taxonomist based on the morphological characteristics as well as meristic characters due to which classification was not accurate.DNA barcoding is considered as an assuring tool for species identification, for safety assessment and authentication carried out for people's security, for better classification of species, also to know more about genetic differences of species that are closely related. It is carried out by using a short mitochondrial gene cytochrome c-oxidase sub unit I. After extracting the DNA, the PCR products are amplified by using primers Fish F1 and Fish R1 and the products are further exposed for sequence analysis by using different bioinformatics tools. Nucleotide composition revealed an average GC content of 46% and also among the three codon the second codon was highly conserved, third codon was highly variable. Distance matrix revealed the genetic differences between species. Phylogenetic tree also showed that species that arise from same background form clusters indicating they are closely related to each other.

TARGETED SURVEILLANCE OF COMMON PATHOGENS AND HEALTH MONITORING OF ZEBRAFISH

Aswini Anbazhagan (PI: Ms. Jeena Kezhedath, ICAR-Central Institute of Fisheries Education)

Zebrafish being the dynamic animal model organism for the study of vertebrate biology, it is extremely vital to maintain a flock of healthy, disease free zebrafish stocks. Information of common pathogens affecting zebrafish breeding and rearing facilities is scarce. To achieve this, a throughput screening programme was constituted in the CZEBRAG facility of ICAR – CIFE based on the manifestation of extensive clinical signs and symptoms. Quarantine tanks set up, were used to analyse the regression and progression of the disease while concurrently keeping the fishes confined to its respective individual tank. Brain, gills, kidney, intestine and the tumour samples were collected from diseased fishes and were subjected to histological studies. Biochemical tests viz oxidase, catalase and iMVIC tests then Gram's staining for the identification of isolated microbes along with molecular characterisation by performing 16s rRNA PCR and targeted surveillance of Mycobacterium sp. Pseudoloma sp. and Aeromonas sp. Further detailed investigations are required to draw conclusions. The study also proposes guidelines for a health monitoring programme of zebrafishes.



FORMULATION DEVELOPMENT AND EVALUATION OF LIPOSOMES-BASED ANTI-FUNGAL GEL **Vishakha Mahesh Sakhareriya (PI: Prof. Rinti Banerjee, Indian Institute of Technology Bombay)**

Cutaneous candidiasis refers to a skin infection caused by *C. albicans*, an opportunistic pathogen primarily affecting chronically moist and warm skin surfaces of intertriginous areas. The purpose of this project was to develop and evaluate a liposomes-based anti-fungal gel as a therapy to cutaneous candidiasis. Characterization of active ingredient was carried out like melting point was noted to be 146.99°C using differential scanning calorimetry (DSC). Fourier-transformed infrared spectrometry and X-ray powder diffraction spectra were found comparable to the standard spectra representing purity of drug. Liposomes formed using solvent injection technique had an average particle size of 127.2 nm with PDI of 0.195 and zeta potential -52.7 mV. Anti-fungal gel loaded with liposomes was observed to be slightly translucent and homogenous with pH of 7.1±0.1. Spreadability of gels was estimated to be 4.03±0.03 g.cm/s, and tube extrudability of 93.24% compared to the marketed formulation. Viscosity was noted to be 12.2 Pa.s and 10.7 Pa.s at 25° and 37°C respectively. Pseudoplastic behaviour of the gel was revealed by rheological analysis. The optimized liposomes-based gel formulation was observed to be more efficient to give extended drug release (64.67% at 8h) following Peppas model for drug release kinetics. Anti-fungal activity of the gel against *Candida albicans* ATCC 12031 was assessed using cup-plate method. The diameter of inhibition zone was found to be 16, 18 and 15 mm for marketed gel, pure clotrimazole and optimized gel respectively. Thus, liposomes-based gel prepared in this study may have a potential as a new-fangled delivery system for treating cutaneous candidiasis and other alike fungal infections.

DYNAMIC STUDIES OF METHYLTRANSFERASE TO UNDERSTAND THE MOLECULAR BASIS OF RECOGNITION AND METHYLATION

Rutuja Dattatray Chalke (PI: Dr. Ruchi Anand, Indian Institute of Technology Bombay)

Antibiotic resistance has emerged as a global threat as pathogenic bacteria are developing immunity towards the newly discovered antibiotics, conventional drugs like macrolides have been rendered ineffective. One of the mechanisms adopted by pathogens to protect themselves from antibiotics is methylation of target residues in ribosomal RNA. It is important to delineate these mechanisms to develop next generation effective antibiotics which can re-sensitize the existing resistant micro-organism. Erm methyltransferase catalyzes the dimethylation of adenine residue located at position 2058, in 23S rRNA and confers resistance toward the Macrolide-Lincosamide-Streptogramin B group of antibiotics. Whereas, its structural homolog KsgA methylase, plays a crucial role in 30S subunit biogenesis by modifying A1518 and A1519 of 16S rRNA. There is a paucity of information with regard to the mode of specific recognition by these enzymes. Here, we have reported preliminary purification of methyltransferase and 30S ribosomal subunit using density gradient. Fluorescence studies are being optimized to decipher the specific molecular mechanism involved in the interaction of methylase with its substrate.

A STUDY ON THE INTERPLAY BETWEEN HISTONE DEACETYLASE INHIBITOR AND SUBSTRATE STIFFNESS ON THE DIFFERENTIATION OF BONE MARROW DERIVED HUMAN MESENCHYMAL STEM CELLS **Vedanshi Dharnidharka (PI: Dr. Abhijit Majumder, Indian Institute of Technology Bombay)**

Histone deacetylase inhibitors (HDACi) are epigenetic modulators capable of regulating human mesenchymal stem cell (hMSC) differentiation. Studies show that stiffer and softer substrates support differentiation of hMSCs into osteoblasts and adipocytes respectively. HDACi such as sodium butyrate support osteogenic differentiation and suppress adipogenic differentiation. We found that increasing concentrations of sodium butyrate caused an increase in the cell area of hMSCs on soft polyacrylamide gels and also increase in nuclear area of hMSCs. The cell area and nuclear area of hMSCs was found to be larger on stiffer gel. Increasing concentrations of sodium butyrate decreased the proliferation of hMSCs on soft gels of 3 kPa and stiff gels of 34 kPa while traction force of hMSCs was also found to increase on 3 kPa gels. Sodium butyrate suppressed adipogenic differentiation of hMSCs cultured on 3 kPa and 34 kPa gels supplemented with adipogenic induction media. These results show the interplay of sodium butyrate and substrate stiffness on cellular behaviour and differentiation of hMSCs. In the future this study will help design better tissue engineering strategies for bone related disorders.

PREDICTION OF FUNCTIONAL CONSEQUENCES OF MUTATION ON HYPERMUTABLE TRANSCRIPTION FACTORS **Shavin Fernandes (PI: Dr. Aswin Sai Narain Seshasavee, NCBS, Bangalore)**

Transcription Factors (TFs) are DNA binding proteins that regulate gene expression which may have phenotypic manifestations. *E. coli* transcriptional regulatory network consists of TFs that show a high amount of mutations in the form of nonsynonymous variation. Of the 270 TFs in *E. coli*, the ones involved in acid stress response are the most susceptible to mutations. The present work was aimed at studying these variations and predict the effects of hypermutable TFs on the population. These variations in gammaproteobacterial TF paralogues were studied using a phylogenetic approach using MUSCLE tool. The nonsynonymous variations were observed using a structure-based approach with a focus on protein stability and the effect it has on the survival of the organism using FoldX tool. The results suggest that there is a positive correlation observed among the hypermutable TFs and the amount of destabilizing mutations.

EXPRESSION KINETICS OF EXPANSIN AND INVERTASE GENE IN ZINGIBER-PYTHIUM PATHOSYSTEM **Berin Babu (PI: Dr. George Thomas, Rajiv Gandhi Centre for Biotechnology, Kerala)**

Ginger is a cash crop of the Zingiberaceae family with medicinal and commercial value as a spice. The soft rot caused by species of *Pythium*, is the major disease which decreases the production yield. Several species of *Pythium*, are broadly distributed in India. Earlier study reveals that cell wall lignification in *Z. zerumbet*, a wild variant of cultivated ginger, renders the crop resistant to soft rot. In this study, the role of cell wall related genes in Zingiber-*Pythium* pathosystem is studied, using gene expression analysis of Expansin and Invertase gene in *Z. officinale* and *Z. zerumbet* post infection. An isolate of *Pythium myriotylum* was used to cause infection. RNA isolated from infected plants at different time intervals were quantified. The primers were synthesized and standardized for both genes. The PCR products were sequenced and analyzed for similarities. About 80% similarity of Invertase and 82% similarity of Expansin were identified with gene of *Musa acuminata*. Target gene expression was normalized using Actin. The results show that the Expansin gene up regulated in *Z. officinale* whereas, less expression was observed in *Z. zerumbet*. In case of Invertase the gene was up regulated in *Z. zerumbet* and the expression was low in *Z. officinale*.

EVALUATION OF THE EFFICACY OF 6-GINGEROL ON PMA INDUCED MAPK ACTIVATION ON COLON CANCER CELL LINE SW-480

Sharline Johnson (PI: Dr. Ruby John Anto, Rajiv Gandhi Centre for Biotechnology, Kerala)

Colon cancer is the third most cause of cancer worldwide. Recently, phyto therapeutic agents i.e. compound obtained from plants can be used in developing drugs. The present study was focused on determining the cytotoxic effect of 6-Gingerol, bioactive compound in ginger on Colon cancer cell line SW-480 and its chemopreventive effect on Phorbol Myristate Acetate (PMA) induced Mitogen-activated protein kinase (MAPK) pathway. Cytotoxic effect of 6-Gingerol was checked using MTT assay. The IC₅₀ value of 6- Gingerol was found to be between 250µM and 300µM. The effect of 6-Gingerol on PMA induced MAPK pathway was checked using immunoblotting where antibody used was against p-p38, a mitogen activated protein kinase. When the cells were pre-treated with 6-Gingerol, it was able to down regulate PMA induced phosphorylation of p38. These results states that inhibition of the expression of p-p38 is one of the mechanism behind chemopreventive and anti-cancer efficacy of 6-Gingerol against colon cancer cell line SW-480.

ROLE OF WNT AND BMP CROSSTALK ON EPITHELIAL PATTERNING OF MEDIAN FINFOLD OF ZEBRAFISH EMBRYO

Ruqayya Manasawala (PI: Dr Mahendra Sonawane, TIFR)

The role of crosstalk amongst the Wnt, BMP, and FGF pathways in limb development is less known. A gradient of canonical Wnt and BMP signaling exists along the proximo-distal (PD) axis of the median finfold in developing zebrafish correlating with epithelial cell shape and number. Dampening BMP disrupts Wnt gradient thereby affects epithelial patterning. Further, dampening of BMP in a gain of Wnt function-apc mutants, re-establishes the lost gradient along the PD axis causing the median finfold cells to regain their morphology. The present work confirms the existence of canonical Wnt and BMP gradient along the PD axis of the zebrafish median finfold and dampening the BMP signaling using the drug Dorsomorphin which disrupts the epithelial patterning. Experiments involving Dorsomorphin treatment of apc mutants are being standardized. This work confirms the previous findings, paving way for better understanding the complex Wnt-BMP crosstalk and its role in appendage development. However, many other molecular pathways and signaling molecules may be involved that needs to be probed to get a complete understanding of epithelial patterning during appendage development.

PROBING THE ROLE OF CANDIDATE ETS-DOMAIN PROTEINS IN REGULATING THE GERM CELL PROLIFERATION AND SYNCHRONY IN *Drosophila* TESTIS

Akhila Manoharan Nair (P.I - Prof. Krishanu Ray, TIFR)

Stem cell progeny divide mitotically for a definite number of times before differentiation in a process known as transit amplification (TA) which plays a vital role in maintaining tissue homeostasis. E26 transformed specific (ETS) domain transcription factors define a family of DNA binding proteins that regulate a series of events downstream of the mitogen-activated protein kinase (MAPK) pathway. Deregulation in the ETS activity can lead to over-proliferation and induce tumorigenesis. The *Drosophila* genome encodes nine ETS-domain proteins that are known to regulate different developmental phenomena under the MAPK-mediated signaling. ETS domain transcription factors are considered to be the direct targets of the MAPK pathway. Here, we report the effect of five ETS domain proteins viz. pointed, Eip78C, ETS-96B, ETS-98B and ETS-97D in regulating the germline proliferation and the synchrony of germline cell cycle. For this, a limited RNAi screen of ETS-domain proteins in the somatic cells was carried out. Out of the five ETS-domain candidates, the somatic knockdown of pointed (ptd) and ETS-97D led to germline overproliferation. However, asynchrony among germ cell divisions within a cyst was observed in the ptd RNAi background only. These results suggest that both the ptd and ETS-97D could act as downstream effectors of the ERK in maintaining the synchrony of germline mitoses within a cyst during the transit amplification division.

“No research is ever quite complete. It is the glory of a good bit of work that it opens the way for something still better, and this repeatedly leads to its own eclipse” - Mervin Gordon

Environment Saves, Save Environment

Our environment is the sole factor for the existence of life on Earth. The anthropogenic activities have led to its gradual deterioration since the past few years. Any attempt to provide solution would first require the knowledge about its current scenario. An initiative for the same was taken by the students of M.Sc. part II through an activity to gather information and prepare a documentary about it. Here is the excerpt of the few significant issues that were looked upon.

01 Call of the Mangroves

Holding the land together, holding the sea in place, protecting the fishes providing them space, these are few of the many roles played by 'The Mangroves'.

Mangroves are a major coastal resource. Equipped with external breathing roots known as pneumatophores, they are predominantly found in the intertidal region. Structure of the roots possessed by these mangroves is influenced by their location and function. It ranges from conical to pencil-shaped roots. Depending on their proximity to land and sea, mangroves can be classified into the front, intermediate and back species. Mangroves surrounding the Thane Creek and Greater Mumbai area belong to the species *Rhizophora apiculata*. Mangroves are found all over India, Andaman & Nicobar, predominantly in the Sundarbans- West Bengal. Of all the states in India, Maharashtra has the 6th largest mangrove cover.

To gain insights about the current scenario of mangroves, we visited the Coastal and Marine Biodiversity Centre, Airoli; Thane Creek; Sewri; Vashi, Dharavi; and BKC mangroves. We also interviewed Mr. Stalin from Vanashakti NGO. Known as the coastal kidneys, the peculiarity of mangroves is that they provide oxygen 6 times than that provided by normal trees. This is facilitated by the uptake of carbon dioxide through the roots and release of oxygen in return. These plants

also bear fruits known as mangrove green apples, which are used as lemons by the indigenous communities. Apart from these, mangroves are a habitat for various native and migratory birds such as flamingos.

About 35% of the world's mangrove cover is gone. This has alarmed not only the society but the government as well. Hence in an attempt to safeguard mangroves, stringent policies have been formulated by the government under which an individual found to be responsible for cutting and destruction of mangroves is liable to imprisonment. The Coastal & Marine Biodiversity Centre, Airoli has been set up by the government to ensure awareness and conservation of mangrove species.

Being taken for granted is something every resource has to face. However, developing a sense of responsibility towards the conservation of these valuable resources is imperative and the need of the hour. As it is rightly quoted by Mad-Ha Ranwasii, **"If there are no mangroves, then the sea will have no meaning. It's like a tree with no roots, for the mangroves are the roots of the sea!"**

**-By, Priyanshi V. Suvasia
(M.Sc. Part II)**



Retrieved from: <http://www.asergeev.com/pictures/archives/compress/2015/1607/13.htm>

E-waste and its Management 02

With globalization and industrial advancements, the electronics industry has become one of the fastest-growing industries in the world. Particularly in India, the volume of electronics in society has increased exponentially. In other words, it means that the amount of e-waste generated is constantly on the rise and an issue which has to be addressed at the earliest. Improper disposal of e-waste can contaminate the air, water & soil, and cause a hazard to all living entities. India produces about 2 million tons of e-waste every year. Among the various states, Maharashtra contributes the largest e-waste of about 19.8% but recycles only about 47,810 tons per annum. 80% of waste processing is undertaken by the unorganized sector that collects waste from household and establishments. Children, at large who are under the grip of illiteracy and poverty are targeted to do such work. This increases the unemployment rate and predisposes them to harmful chemicals released during processing of such waste. E-waste management is largely dependent on the attitude of the citizens, collective initiatives by them & the government. The 3 main ways to effectively manage e-waste are- Reuse, Recycle and Refurbish. Practices of reuse of electronics involve continual usage of electronic items that are still functional. Whereas recycle and refurbish mean repurposing or redesigning of the electronic item, that may or may not be functional, into the same type of product or a different product by modifying parts of the same.

To understand the level of awareness amongst people regarding e-waste & its management, a small survey of 222 participants was carried out. Most of the people had an average amount of knowledge about e-waste and what it is made of. Nearly 51% of the participants felt the importance of appropriate e-waste management practices. Surprisingly, 65% of participants did not have any idea about management or collection or recycling centres for e-waste, neither were they aware of government policies or schemes regarding the same. The bright side to it was that almost 54% of people sold off their electronic waste as second-hand goods, and 30% out of the total meticulously submitted their e-waste for recycling at recycling centres. A good 12% of participants still, however, dumped their e-waste directly into the dustbin, thereby unknowingly contributing to the toxicity in the environment.

Kohinoor E-waste Recycling Pvt. Ltd. is an organization based in Mumbai, that focusses solely on electronic recycling and refurbishing. They collect e-waste from corporate offices, housing societies and other organizations, and refurbish the electronics into better products, and most often supply the remodelled products to financially backward schools & institutes that are in need of better electronics. In a way, this organization is not only making money for its own survival but also helping the society and aiding the betterment of the underprivileged people.

Through this project, we tried to gain insights into electronic waste, its generation, management & the threats it poses to the life on earth. The survey was a small step in creating the spark in people's minds about e-waste & the need for its efficient management. The movie, as a whole, was our attempt to learn and help others learn about the essential issues of the world.

**-By, Bushra Khan
(M.Sc. Part II)**



Retrieved from: openpr.com

03 War on Waste: Plastic

In day to day life from morning to night, we consume a huge amount of plastics. From toothpaste tube we squeeze every morning to cling film used to pack sandwiches in, the cup of takeaway coffee we buy in route, the water bottle we buy to quench our thirst and million lots things in between, plastic has become an addiction because it cheap and convenient and it posed an alarming threat to the environment.

Every year we produced 300 million tonne plastic across the globe and around 50% of that is single-use plastics which we use once for second and it stays in nature for hundreds of years and causing harm to everyone. The problem with plastics is they do not easily degrade. They may break down, but only into smaller pieces. The smaller those pieces get the more places they can go to. Many pieces wind up at sea. Tiny bits of plastic float throughout the world's oceans. They wash up on remote islands. They collect in sea ice thousands of kilometres (miles) from the nearest city. They even meld with rock, creating a whole new material. Exactly how much plastic is out there remains a mystery. Scientists are hard at work trying to find out. So far, though, experts haven't found as much plastic floating in the oceans as they expected. All that missing plastic is worrisome, because the smaller a plastic bit becomes, the more likely it will make its way into a living thing, whether tiny plankton or an enormous whale. And that may spell some real trouble.

In India, plastic production is averaging a growth rate of 10 per cent per year. As per Central Pollution Control Board 2016 estimates, 15,000 tonnes of plastic waste is generated every day, of which 9,000 tonnes is collected and processed, while the remaining 6,000 tonnes is usually left to litter the drains, streets or is dumped in landfills. Every year, at least 8 million tonnes of plastic makes its way to the seas, endangering marine life. Much of this hinders waste management too as segregation is still a big problem. Bans don't work without awareness. The segregation of waste needs to take place at the household level. Unfortunately, the dangers of plastic are not known. Where does the bag go once you are done with it? We are just adding more and more plastic to the environment as no one is getting educated at a base level.

After the state-wide plastic ban, the BMC has set up 25 collection centres across the city at strategic locations in and around municipal markets, shopping hotspots and railway stations. Many programs under the Swachha Bharat Abhiyan arranged to increase awareness among the masses and invent new strategies of plastic waste management. An organization like Earth5R implanted programmes like plastic bottle recycling program at Mumbai where many people took initiative.

Still, we don't factor inconvenience for the man in the slum who has limited awareness and knows no better than relying on a plastic bag. We need to break this cycle. We as a society take needs to take initiative for the betterment of life by reducing the use of plastic, recycling and using alternates of plastics like cloth bags, paper wrappers etc.

**-By, Pratiksha Kavade
(M.Sc. Part II)**



Retrieved from: Gettyimages/iStockmouses

CEREBRO SWITCH

INCOGNITO

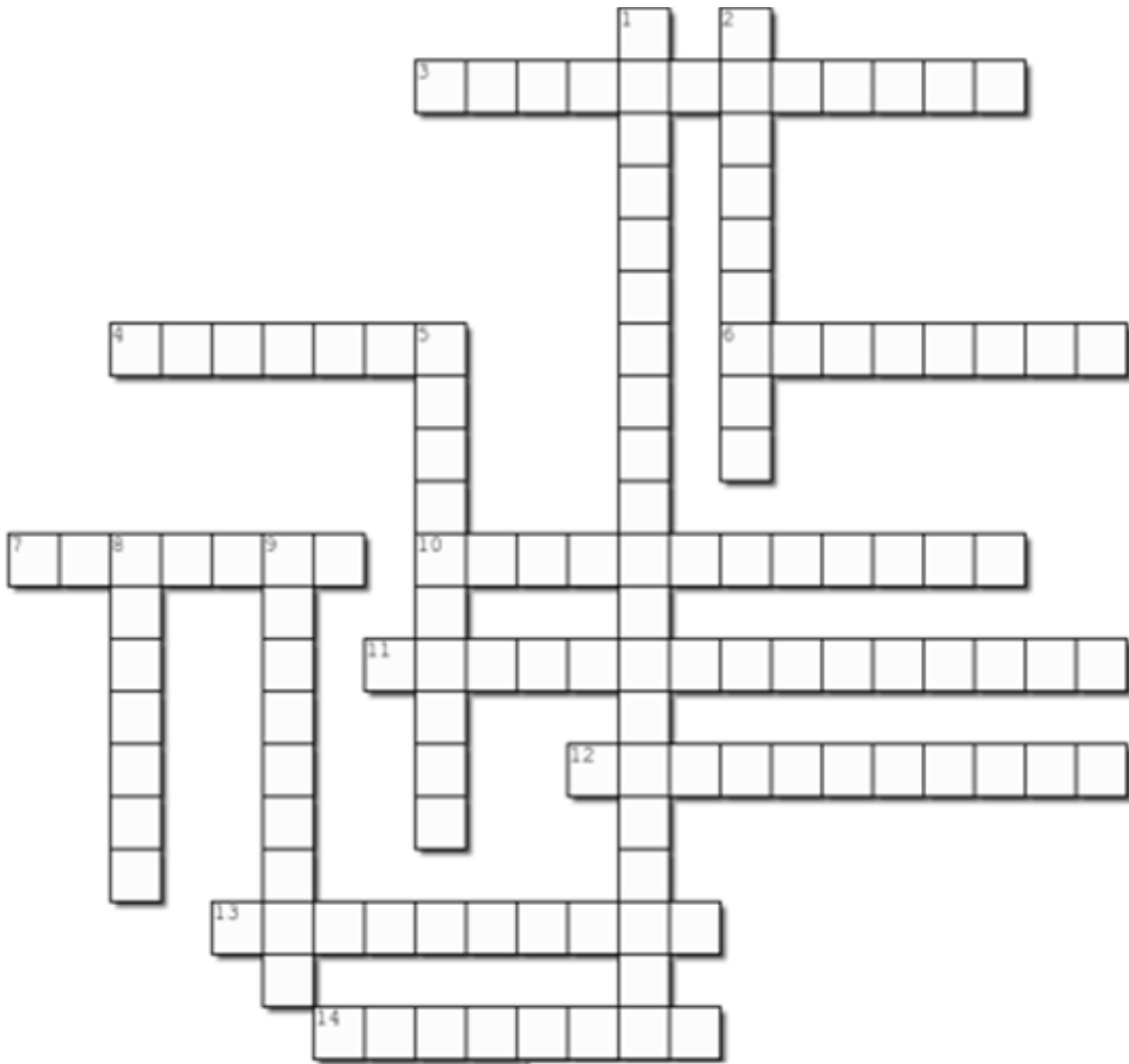
ACE YOUR BIOCATALYST

B I Y G L M P N D E T B H E X	SUPEROXIDE
A B X S E A Y I I F L H H Y E	DISMUTASE
A V B N S N F A A C W F F K S	CATALASE
H D K U A N B L C X J T L O A	DIACYLGLYCEROL
V I W C L A U E Y U D N B Z T	BROMELAIN
O S Y N A N O M L P I Z E I C	OXIDOREDUCTASE
E M M I T A B O G B E P S N U	LACCASE
G U K N A S M R L H S E A G D	PECTINASE
F T K E C E L B Y Q A C D I E	XYLANASE
K A K R K Q H C C N N T I B R	RENIN
L S P A C C H X E M A I M A O	MANNANASE
W E N I A P A P R K L N A I D	PAPAIN
W L A C C A S E O R Y A K N I	AMIDASE
N C A H A P D T L F X S D A X	ZINGIBAIN
R U S U P E R O X I D E K V O	

FACTORIA

Scientist at the J. Craig Venter Institute (JCVI) created a living cell with a synthetic genome made from scratch in 2010, making it the first living cell on Earth to not have a living parent.

NEURO LINK



Across

3. Era of mankind
4. 2019 Noble prize in medicine
6. Cholera vaccine
7. Somatic cell division
10. Replication, Transcription, Translation
11. One of the pathways affected in AES
12. First FDA approved vaccine against prostate cancer
13. Potential treatment against Nipah Virus
14. What is the speciality of Golden Rice

Down

1. Property of pluripotent cells
2. Cell death
5. Most widely used selectable marker
8. Where does India stand in the biotechnological destinations in the world
9. Anti-inflammatory drug

1. Transdifferentiation
2. Apoptosis
3. Anthropocene
4. Hypoxia
5. Ampicillin
6. Shanchol
7. Mitosis
8. Twelfth
9. Ibuprofen
10. Central dogma
11. Glucanogenesis
12. SipuleucelT
13. Remdesivir
14. VitaminA

TRAIL BLAZERS

How well do you know the works of recent Nobel laureates?

Test your skills.

2
0
1
5

DNA is inherently unstable thousands of spontaneous changes happen to cell genome occur on a daily basis. The reason for our genetic material does not disintegrate because of continuous monitoring and repair of DNA. Their work was to map of different repair systems functions at the molecular level.

2
0
1
6

Cell destroys its own contents by enclosing the debris in lysosomes. This mechanism was studied in yeast and showed similar mechanism is used in our cells. His discoveries opened path in our cells. His fundamental importance of this mechanism in many physiological processes such as starvation or infection.

2
0
1
7

Living organisms have a conserved, intrinsic sleep-wake cycle which synchronizes their physiology with the Earth's rotation. Their work elucidated the genes, proteins, other assisting components and the self-monitoring mechanism of the circadian rhythm in fruit flies. This biological clock is associated with metabolism, brain wave activity and hormone production

2
0
1
8

Immune cells have certain molecules on their surface which act as inhibitory checkpoints. Cancer cells, sometimes escape from immune system monitoring by activating these inhibitory checkpoints allowing their multiplication. Their work was focused on the CTLA4 and PD1 immune checkpoints and how inhibition of these checkpoint pathways enables T cells to effectively tackle the cancer cells. This discovery throws light on how inhibition of negative immune regulators, by developing immune checkpoint inhibitors can be used for cancer therapy.

2
0
1
9

Oxygen is vital for conducting several cellular metabolic reactions. Their work explained the propensity of cells to discern and adapt to oxygen availability. The genetic machinery elucidated, modulates gene expression according to levels of oxygen present. This discovery has paved the way for upcoming treatment plans for cancer and anemia.

2019 - William G. Kaelin, Gregg L. Semenza, Peter J. Ratcliffe
2018 - James P. Allison, Tasuku Honjo
2017 - Jeffrey C. Hall, Michael Rosbash, Michael W. Young
2016 - Yoshinori Ohsumi
2015 - Tomas Lindahl, Paul Modrich, Aziz Sancar

Transitioning world

*Integrated in our lives
Are deep roots of science
Breathing the technologies
Sometimes also eating the lies.
The world is emerging
With greater knowledge insights
Bridging the gap between
Human and robotic mind.
Various field have shaken hands
To improve human vitality
Even Biotechnology intervened
To help translate the complexity.
It has been a frontier for future
From kitchen to space juncture
Understanding applications
Of basic research through different ventures.
In agronomics to improve varieties
In medicine to tackle ailments
Adding to the list of endeavors
To built its concrete pavement.
Hustle of our existence
Is supported by these beings
Tweaking nature
To keep pace with changing surroundings.
Still lies a a big void
While applying tech to biology
A difference arising due to
Theoretical results and practicality.
Yet a long way to go
To unravel mysteries that are unheard of
To help humanity
To redeem our biome.*

-By, Neha Kumari (M.Sc. Part II)

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