St. Xavier's College (Autonomous), Kolkata
DEPARTMENT OF BIOTECHNOLOGY

EDITION XI

CHIASMA 2021

A CROSSOVER OF MINDS

RESILIENCE AND COGITATION

St. Xavier's College (Autonomous), Kolkata

DEPARTMENT OF BIOTECHNOLOGY

CHIASMA 2021

A CROSSOVER OF MINDS

ABOUT THE THEME

It has been a difficult time. For this issue of Chiasma, we pay respect to the indomitable spirit of all those engaged in the effort to fight the COVID-19 Pandemic. At the start of the pandemic, there was complete chaos which has been represented by the yellow flames in the cover picture. Uncertainty, paucity of knowledge took human lives and complicated medical healthcare. Through months of struggle and resilience, the global community not only shed light on the pathogen and pathogenesis of COVID-19, but also established vaccination protocols. This is represented by the blue flames, overpowering the orange shades of chaos. These times have not been kind to anyone, least of all to those at the forefront of the war. Closed eyes symbolise the effort, and why we must remember to protect ourselves to protect these immortal warriors. Lastly, the syringe and the vial represent our strongest weapon in this fight, a miracle of science.

The contents of the e-version of this magazine are available online at chiasmabmbt.in

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CONTENTS

MESSAGES

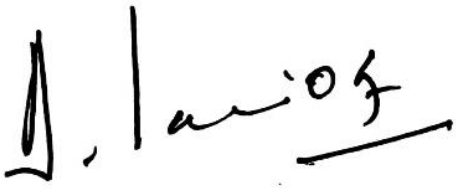
MESSAGE FROM THE PRINCIPAL

I am pleased to find that the Department of Biotechnology of St. Xavier's College (Autonomous), Kolkata, is sustained in its commitment to publish the eleventh volume of their annual magazine "Chiasma" 2021. This effort is indeed an efficient way of exchanging scientific thoughts and ideas among young minds.

The Department has been instrumental right from its inception in imparting quality teaching, reflected by the students' performance, both nationally and internationally. The faculty members are involved in intense research and have published their works in peer-reviewed journals. Such scientific research parallel to teaching motivates the students to pursue research after their post-graduation from the department.

I understand and appreciate the relentless effort undertaken by the magazine committee members in editing articles and giving a final form to the magazine. I acknowledge their dedication and hard work.

Finally, I congratulate all the faculty members, support staff and students of the department and wish them success in their concerted efforts. God bless you all. Nihil Ultra!



Rev. Dr. Dominic Savio, S.J.
Principal
St. Xavier's College (Autonomous), Kolkata.

MESSAGE FROM THE VICE-PRINCIPAL (ARTS AND SCIENCE DEPARTMENT)

The fact that Chiasma, the annual magazine published by the Department of Biotechnology, is now in its eleventh year of publication is evidence enough of the department's absolute commitment to academics, research and publication.

The magazine provides a space not only for articles related to the discipline but also, I believe, for literary and artistic expression. This is what makes Chiasma a bespoke magazine, designed to shape and develop a holistic development in the students of the department.

I further applaud the decision to augment the publication with an accompanying website which, I am told, may well fulfil the criteria of an e-magazine, something which might increase visibility, reach and impact.

Congratulations to the department on one more notable accomplishment.

Prof Bertram Da'Silva

Vice-Principal (Arts and Science Department)
St. Xavier's College (Autonomous), Kolkata.

MESSAGE FROM THE DEAN OF SCIENCE

Congratulations to the Department of Biotechnology for bringing out the eleventh volume of their annual magazine 'Chiasma'. Biotechnology is an integrated multi-disciplinary subject and is well- reflected in the spectrum of articles published in this magazine. I expressed my heart-felt appreciation to the students and faculty members of the department for their endeavour.

Dr. Tapati Datta

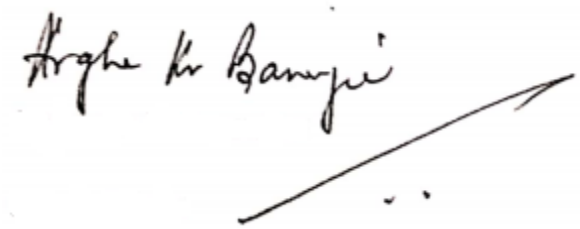
Dean of Science
St. Xavier's College (Autonomous), Kolkata.

MESSAGE FROM THE DEAN OF ARTS

Being a member of the Humanities department, I feel extremely privileged to be requested by a science department to pen a message for their journal. 'Chiasma' is an earnest endeavour of the Department of Biotechnology, St Xavier's College (Autonomous), Kolkata, which show-cases the scholarly research conducted by its faculty members and students.

It is my deep conviction that this annual invigorating experience of putting together a journal would encourage more students and faculty members to tread the path of research in the coming years. I hope, like yesteryears, this year's issue too will explore new fields of research and make a substantial contribution to the relevant domain.

My sincere best wishes are both with the faculty members and students of the Biotechnology department. I once again thank them for their gracious thinking in involving me to be a part of their glorious journey towards excellence.



Dr. Argha Kr Banerjee

Dean of Arts
St. Xavier's College (Autonomous), Kolkata.

MESSAGE FROM THE HEAD OF THE DEPARTMENT

Pandemic, Lockdown, Online classes and more: A teacher's view

We have witnessed a journey from Pathshala to smart classrooms, no-phone to iPhones, the first version of the desktop to the most sophisticated version of the laptops. We were enjoying the changes until the COVID pandemic busted like a disaster on us. Another obvious partner of the pandemic was the lockdown. We were suddenly shocked to experience illness and demise in family and friends. We felt the pain of migrant laborers, jobless people, and orphan children worldwide. We heard about the phrase 'The show must go on'. After accommodating the sudden blow of lockdown, we decided to start our journey of chalk and duster in an altered 'online' mode, because the education sector has to remain vibrant to keep the nation vibrant. Teaching apparently invisible students in 'online' mode was a great challenge to us. From July 2020, this journey is on.

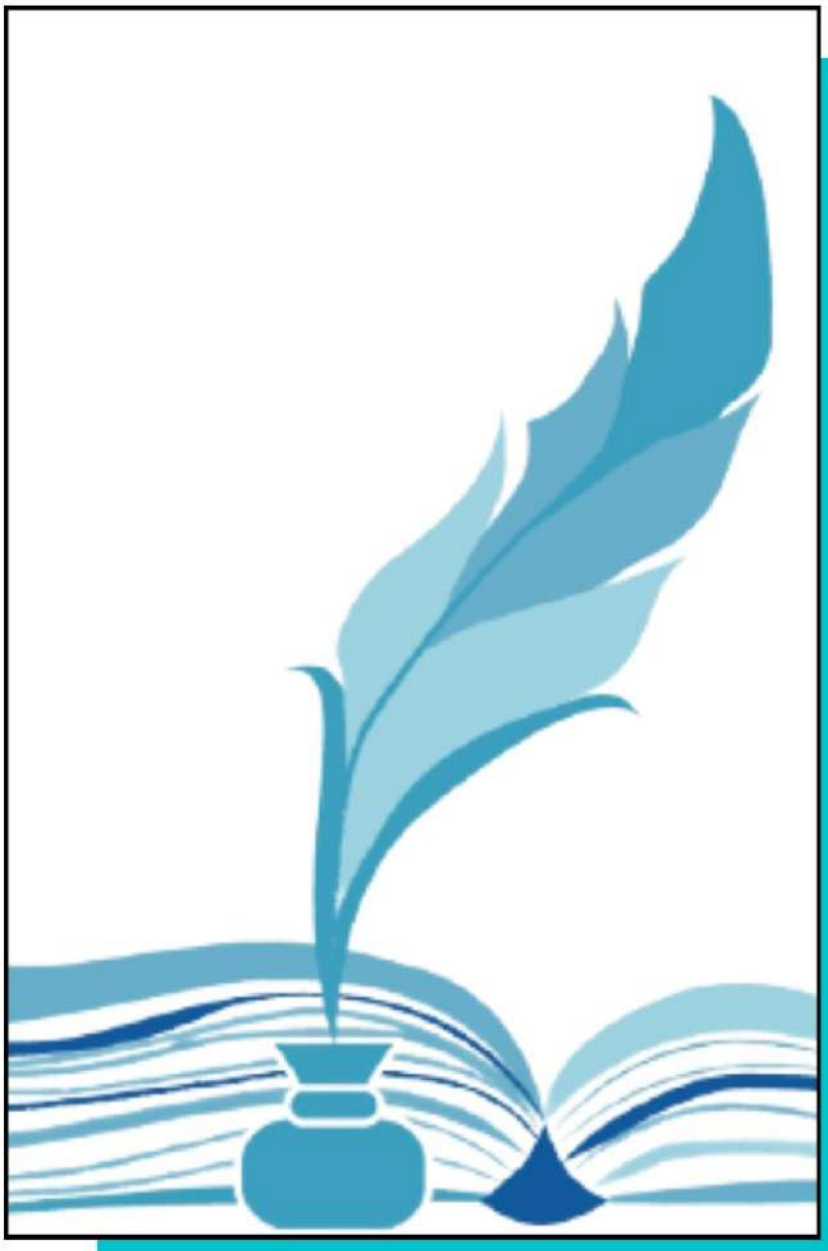
However, there was another side of this catastrophic period. We have learned how to be more and more accommodative. We were shattered to hear about the illness of our beloved students and their family members. At the same time, we were astonished to witness their strength and maturity even after losing their family members, especially during the notorious second blow of the pandemic. We also observed their fearless perseverance and dedication to their curriculum and research. During our illness, we witnessed the gleam of colleagues as beloved cousins, superiors as comrades, students as a shield of their teachers.

Hope, very soon, we shall be in our institution premises with all our learnings and experiences (academic and personal) to prepare honest, humble, and efficient citizens through crossing over of enthusiastic minds. I extend all my cordial support to the 'Chiasma' team and wish them unlimited success.

Dr. Jhimli Dasgupta,

Head of the Department,
Department of Biotechnology,
St. Xavier's College (Autonomous), Kolkata

Editor's Desk



From Editors' Desk

Life has its own design and rhythm. The situation that we are all currently in, as history tells us, happens only once in a lifetime. We should thus treat this as an opportunity to re-evolve, rebuilt and enhance our skills amidst this adversity. Following the concept embedded in the famous 'Gaia hypothesis', it seems that our mother earth wants us to have this second chance to regrow our potential possibilities.

We are striving hard to adapt to this new normal by attempting to circumvent and dissuade our individual losses. The academic world has faced the conundrum of online classes over virtual platforms. Several discussions, views and deliberations have taken place over the media and numerous webinar platforms, which have discussed and iterated the various aspects of the pandemic. We believe that we have had enough of these vibes. Have we contemplated over what happens next? How we might migrate from the 'new normal' to the 'next normal' when this uncertainty subsides? Are we ready to take on the 'New World' since 'change is inevitable'? Are students ready to confront the possible challenges to adapt to the new career requirements? All these seem to be important questions at this juncture.

In the midst of all these ruminations and myriad challenges, the Department is ready with the 11th edition of the ***"Chiasma - A Crossing over of minds",*** the annual magazine; which has carved out a niche for itself since its inception in 2010. The veracity and versatility of the contents have diversified over the years, with exciting scientific and literary articles waiting to stimulate the agog reader and to inculcate fresh and innovative thought processes. This year 'Chiasma' has an accompanying website; which truly makes the magazine digital.

The entire Magazine Committee worked tirelessly, without whose hard toil, the publication of the present volume would have been next to impossible. Inspite of having a packed online class schedule, the members worked in unison, participating in virtual meetings, editing articles, designing the layouts and online contents.

We sincerely thank our respected Father Principal Rev. Fr. (Dr.) Dominic Savio, SJ, from the core of our heart for being the source of constant motivation and encouragement. We would also like to extend our heartfelt gratitude to Prof. Bertram Da Silva, our Vice Principal, Dr. Tapati Dutta, the Dean of Science and Dr. Arghya Banerjee, the Dean of Arts for rendering their valuable advice. We also thank our Head of the Department, Dr. Jhimli Dasgupta, our departmental colleagues, research scholars, students and laboratory staff members, who all have been a constant source of support in this endeavour.

The pandemic edition of 'Chiasma', not only is a confluence of minds, but is an attempt to synergise the conglomerative resilience that every member of the Department and Institution has displayed over this span of one and half years. We need to ponder on all possible means to embark upon our 'Resilience Account' which shall enable us to tide over this phase. We need to cogitate. Together, we shall overcome all odds.

Dr. Priyanka De

Assistant Professor
Department of Biotechnology
St. Xavier's College (Autonomous), Kolkata

Dr. Sayak Ganguli

Assistant Professor
Department of Biotechnology
St. Xavier's College (Autonomous), Kolkata

Departmental Diaries

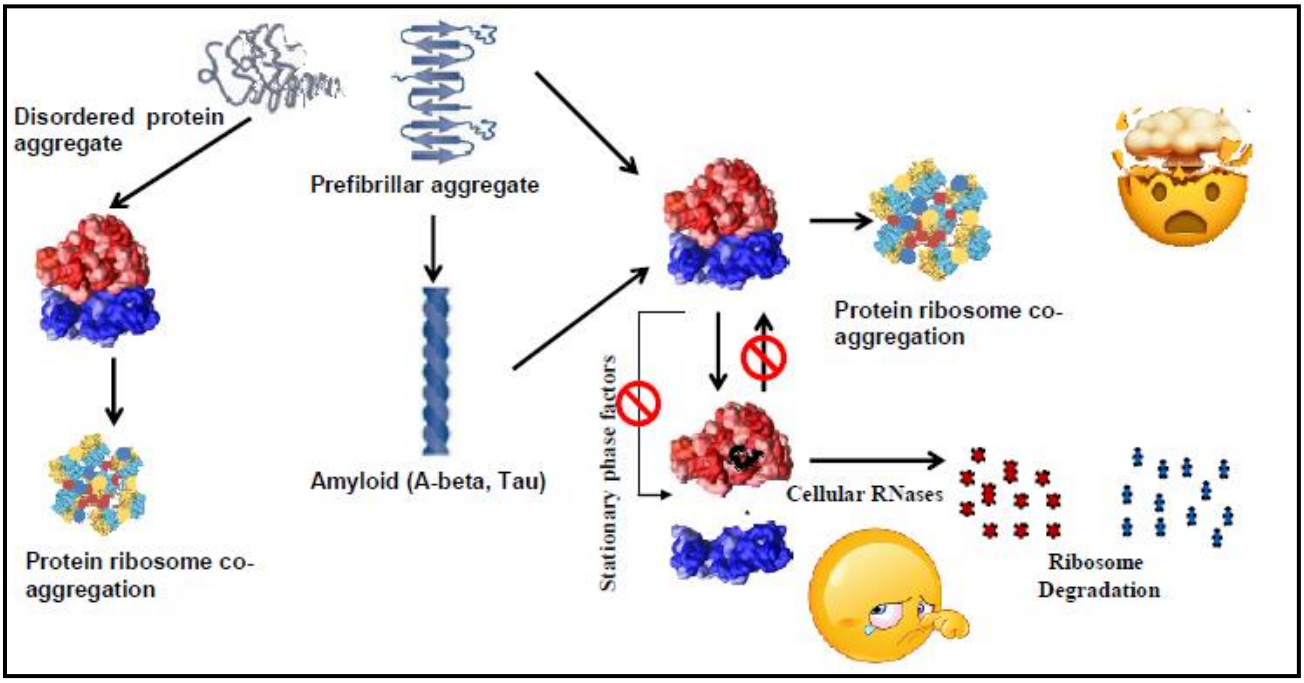
FACULTY PROFILE

Dr. Chandana Barat

Research Interest:

Study of interaction of ribosome with unfolded protein and protein aggregates

The ribosome is the translational machinery of the cell. However, it has multiple other important functions like: acting as a chaperone, acting as a platform for other cellular chaperones and stress factors, co-translational protein folding etc. The protein folding ability of the ribosome is unique because it functions as an ATP independent chaperone. In unfolded protein mediated dissociation of the 70S ribosome its subunits, the unfolded protein acts as an anti-association factor to the 50S subunit. This results in creation of a sustained pool of dissociated subunits which are prone to degradation by cellular nucleases. During stress conditions, along with the increase in the concentration of unfolded proteins, there is an increase in the expression of stress factors also. Some of these factors include stationary phase factors like HPF, RMF and YfiA. These might act by inhibiting the unfolded protein mediated 70S dissociation and subsequent degradation. Recent studies in the laboratory have shown that aggregating proteins are capable of sequestering ribosomes leading to ribosome-protein co-aggregate formation. Both amorphous and disease associated amyloid aggregates are capable of sequestering ribosomal RNA as well as proteins. The ribosomal RNA can also assist the aggregation process both for amorphous and amyloid aggregation systems.



Selected publications:

1. Pathak BK, Mondal S, Banerjee S, Ghosh AN, Barat C. (2017) Sequestration of Ribosome during Protein Aggregate Formation: Contribution of ribosomal RNA. *Sci Rep*. 7:42017.

2. Pathak BK, Banerjee S, Mondal S, Chakraborty B, Sengupta J, Barat C. (2017) Unfolded protein exhibits antiassociation activity toward the 50S subunit facilitating 70S ribosome dissociation. *FEBS J.* 2017 Nov;284(22):3915-3930.

3. Banerjee, S., Ferdosh, S., Ghosh, A. N., & Barat, C. (2020). Tau protein-induced sequestration of the eukaryotic ribosome: Implications in neurodegenerative disease. *Scientific reports*,*10*(1), 1-15.

4. Ferdosh, S., Banerjee, S., Pathak, B. K., Sengupta, J., & Barat, C. (2020). Hibernating ribosomes exhibit chaperoning activity but can resist unfolded protein-mediated subunit dissociation. *The FEBS Journal*.

FACULTY PROFILE

Dr. Uma Siddhanta

Hello Readers,

This is Uma Siddhanta, a member of the Biotechnology Team at St. Xavier's College, since its inception. I had varied research interests starting from Enzymology to Structure-Function Relationship in Proteins to Cell Signaling but, my passion for Teaching always over-ruled my love for research. I was absolutely elated when I was offered a Lecturer position in the Department of Biotechnology, St. Xavier's College. This is the sixteenth year running and I have never felt bored with teaching even for a single day. I did try to initiate research a few times by applying and receiving minor and major research grants but for some reason or the other my endeavors were not very successful. So finally, I have decided 'no more research'!

Now my aim is to expose the beauty of a cell, the functional and structural basis of life, with all its wonderful machineries, to my students. I want to instill the spirit of research into my dear students. Their success stories, starting from receiving competitive fellowships within India or abroad, to publishing papers in scientific journals, to finding academic or R&D jobs make me feel proud. My students' success stories are my publications!

Before I conclude, I would like to confess that if my 'research-career clock' could be rewound I would have clearly opted for research in the fields of Immunology and/or Virology not only because I find these fields very intriguing but also a lot is still to be unraveled and regarding relevance … standing at the periphery of the 'COVID Pandemic – 2019-2020' I am sure all of you will agree that we immediately need more research institutions dedicated to research in these two areas.

Finally, a thought question for all of you – in the recent past the human community is threatened repeatedly by lethal infectious diseases, like SARS, Dengue, Zika, Ebola, etc. whose causative agents are RNA Viruses. Have you ever tried to reason this, 'Why RNA viruses?'

Dr. Sudipa Saha

Research Interest:

Structure function studies of proteins.

List of Publications:

- Ashis Biswas, **Sudipa Saha** and K. P. Das. "Structural Features of Molecular Chaperones: A Possible Micellar Connection". J. Surface Sci. Technol., Vol. 18, (2002), 1-24.
- **Sudipa Saha** and K. P. Das. "Relationship between Chaperone Activity and Oligomeric Size of Recombinant Human αA- and αB-Crystallin: A Tryptic Digestion Study". Proteins, Vol. 57, (2004), 610-617.
- C. Bhattacharjee, **Sudipa Saha**, A. Biswas, M. Kundu, L. Ghosh and K. P. Das. "Structural Changes of β- Lactoglobulin During Thermal Unfolding and Refolding- An FT-IR and Circular Dichroism Study". The Protein Journal, Vol. 24, (2005), 27-35.
- **Sudipa Saha** and K. P. Das. "Unfolding and refolding of Bovine α-Crystallin in Urea and Its Chaperone Activity". The Protein Journal, Vol. 26, (2007), 315-326.
- Ashis Biswas, Srabani Karmakar, Victor Banerjee, **Sudipa Saha**, Madhuchhanda Kundu, Jaya Bhattacharyya, Dipak Chandra Konar and K. P. Das. "Biophysical studies on the molecular chaperone function, structure and interaction of eye lens protein α-crystallin – A Review". J. Indian Chem. Soc., Vol. 88, (2011), 1827-1855.
- **Sudipa Saha** and K. P. Das. "Structure and interactions in α-crystallin probed through thiol group reactivity". Advances in Biological Chemistry, Vol. 3, (2013), 427-439.
- **Sudipa Saha** and K. P. Das. "Effect of thermal treatment on the oligomeric size and chaperone activity of α-crystallin". J. Indian Chem. Soc., Vol. 92, (2015), 1531-1536.

- **Sudipa Saha**. "Oligomeric structure and molecular chaperone function of eye lens protein α-crystallin – A Review". J. Indian Chem. Soc., Vol. 93, (2016), 1233-1242.
- **Sudipa Saha** and K. P. Das. "Hydrophobicity of α-crystallin and its relationship with chaperone activity- bis-ANS binding study". J. Indian Chem. Soc., Vol. 94, (2017), 959-970.
- **Sudipa Saha**. "Eye lens protein α-crystallin and cataract – A Review". J. Indian Chem. Soc., Vol. 96, (2019), 239-253.

Research Projects:

1. Project Title: Preparation and properties of molecular chaperone α-Crystallin from easily available sources
Granting Agency: University Grants Commission (UGC)
Period of Sanction: 09.01.2009-08.07.2010.

2. Project Title: Comparative studies of molecular and functional properties of eye lens proteins from some Indian fishes
Granting Agency: University Grants Commission (UGC)
Period of Sanction: 27.02.2013-26.02.2015.

3. Project Title: Comparative studies on biochemical and physicochemical characteristics of lens α-crystallin from habitat-specific fish
Granting Agency: West Bengal Department of Higher Education, Science & Technology and Biotechnology
Period of Sanction: 2018-2021.

Invited talks/ Papers presented at Conferences/ Seminars:

- Presented paper entitled "Studies on the Oligomeric Structure of α-Crystallin- Effect on Chaperone Function" in "38th Annual Convention of Chemists, 2001" held at Jai Narain Vyas University, Jodhpur, Rajasthan during December 26-29, 2001 organized by Indian Chemical Society.
- Presented paper entitled "Relationship between Chaperone Activity and Oligomeric Size α-Crystallin- A Tryptic Digestion Study" in "40th Annual Convention of Chemists, 2003" held at Bundelkhand University, Jhansi, Uttar Pradesh during December 23-27, 2003 organized by Indian Chemical Society.

- Delivered invited lecture on the topic "Structure and interactions in α-crystallin probed through thiol group reactivity" in "50th Annual Convention of Chemists 2013" held at the Department of Chemistry and Centre for Advanced Studies in Chemistry, Punjab University, Chandigarh during December 04-07, 2013 organized by Indian Chemical Society.
- Presented poster on the topic "Relationship between Chaperone Activity and Oligomeric Size of α-Crystallin by Unfolding and Refolding study" in 33rd Annual National Conference of Indian Council of Chemists held at the Department of Applied Chemistry, Indian School of Mines, Dhanbad during December 15-17, 2014 organized by Indian Council of Chemists.
- Presented poster on the topic "Study of chaperone activity and hydrophobicity of α-crystallin in presence and absence of urea" in "52nd Annual Convention of Chemists and International Conference on Recent Advances in Chemical Sciences" held at JECRC University, Jaipur, Rajasthan during December 28-30, 2015 organized by Indian Chemical Society.
- Presented poster on the topic "Study of oligomeric structure of α-crystallin by using denaturant" in "National Seminar on Current Trends in Chemistry-VII (NSCTC-VII)" held at University of Kalyani on 24th February, 2016 organized by Department of Chemistry, University of Kalyani.
- Presented poster on the topic "Hydrophobicity- the important determinant of chaperone activity of α-crystallin" in "23rd West Bengal State Science and Technology Congress, 2016" held at Presidency University, Kolkata during 28-29 February, 2016 organized by Presidency University.
- Presented poster on the topic "Recognition of substrate binding site in α-crystallin" in "National Symposium on Recent Advances in Chemistry & Industry 2016" held at University of Calcutta during 02-03 August, 2016 organized by Indian Chemical Society.
- Presented poster on the topic "Study of oligomeric structure and chaperone activity of α-crystallin under heat stress condition" in 35th Annual National Conference of Indian Council of Chemists held at Haribhai V. Desai College, Pune in association with College of Engineering, Pune during December 22-24, 2016 organized by Indian Council of Chemists.
- Delivered talk on the topic "Determination of molecular chaperone function of α-crystallin using tryptic digestion study" in "International Seminar on Recent Advances on Chemical Sciences and Allied Areas (RACS2A-2018) and 55th Annual Convention of Chemists 2018" held at Department of Chemistry, G. B. College, Naugachia (T. M. Bhagalpur University), Bhagalpur, Bihar during December 28-30, 2018 organized by Indian Chemical Society.

Seminars/ Conferences Attended:

- Attended "Fourth CRSI (Kolkata Chapter) Symposium-2006 in Chemistry" held on 4th August 2006 organized by the Department of Chemistry, University of Kalyani.
- Attended "The Retraining of College Teachers under UGC sponsored training course – Research Project Proposals & Funding Agencies" held during 23-24 March 2007 organized by University with Potential for Excellence Scheme, Jadavpur University.
- Attended "National Seminar on Current Trends in Chemistry-II" held on 4th March 2008 organized by the Department of Chemistry, University of Kalyani.
- Attended "Recent Concerns in Environmental Issues" held on 19th February, 2011 organized by St. Xavier's College, Kolkata
- Attended "National Seminar on Chemistry for a Better World (sponsored by the UGC, New Delhi)" held on 29th March 2011 organized by the Department of Chemistry, University of Kalyani.
- Attended "National Symposium on Recent Advances in Chemistry and Industry (2015)" during July 31 and August 01, 2015, organized by Indian Chemical Society.

FACULTY PROFILE

Dr. Aniruddha Banerji

Areas of Research and Academic Interest

Primary area of research interest: Cancer biology

- Study of cell surface receptors (integrins, EGFR) and their roles in tumour biology.
- Study of cellular signalling pathways which are dysregulated in cancer to promote invasion and metastasis.
- Study of matrix metalloproteinases (MMPs) and the crucial roles they play in tumour invasion and metastasis.
- Study of the anti-tumorigenic and anti-invasive effects of natural compounds and the molecular mechanisms by which such effects are exerted.

Additional areas of research and academic interest include:

- Wildlife biology: Study of biodiversity and conservation.
- Evolutionary biology: Study of human, mammalian and vertebrate evolution.
- Animal behaviour and ecology
- Genetics and genetic analysis
- Comparative anatomy
- Environmental biology

Publications (2020-21)

Journals

1) **A. Banerji**. Tigers and Conservation in India: Literary Attempts at Creating Awareness. *Magis – Xaverian Journal of Education* (2020) vol. IX pp. 53-60.

2) **A. Banerji**. Habitat Conservation – The Necessity of Awareness. *Magis – Xaverian Journal of Education* (2021) vol. X pp. 18-23.

3) I. Chakraborty, A. Roy, **A. Banerji**. Therapeutic Potential of Phosphatidylinositol 3' Kinase (PI3K) Inhibitors in Cervical Cancer. *Science and Culture* (2021) vol. 87(1-2) pp. 57-61.

Book Chapters

1) **A. Banerji**. Endocrine Disrupting Compounds (EDCs): The Risks for Aquatic Fauna. *Current Strategies in Biotechnology and Bioresource Technology Vol. 2*, pub: Book Publisher International (2020) pp.149-155; Print ISBN: 978-93-89816-88-4, eBook ISBN: 978-93-89816-89-1.

2) **A. Banerji**, K.K. Ganguly, A. Chatterjee. All-trans Retinoic Acid (ATRA), a Potential Inhibitor of Matrix Metalloproteinase-2 (MMP-2) and Tumour Invasion in Melanomas. *Current Strategies in Biotechnology and Bioresource Technology Vol. 2*, pub: Book Publisher International (2020) pp.156-168; Print ISBN: 978-93-89816-88-4, eBook ISBN: 978-93-89816-89-1.

3) **A. Banerji**, P. Ghoshal. Agricultural Production and Climate Change: The Scope for Innovation in the Post-COVID 19 Scenario. *Current Strategies in Biotechnology and Bioresource Technology Vol. 2*, pub: Book Publisher International (2020) pp.169-176; Print ISBN: 978-93-89816-88-4, eBook ISBN: 978-93-89816-89-1.

4) A. Majumder, S. Ray, **A. Banerji.** Phosphatidylinositol 3′ Kinase (PI3K), A Crucial Regulator of Epidermal Growth Factor Receptor (EGFR) Modulated MMP-2, MMP-9 and MT1-MMP Expression in Breast Cancer Cells. *Recent Progress in Microbiology and Biotechnology Vol. 2*, pub: Book Publisher International (2020) pp. 165-174; Print ISBN: 978-93-90206-62-9, eBook ISBN: 978-93-90206-59-9.

5) P. Ghoshal, **A. Banerji**. Studies on Some Issues Specific to Demography during COVID-19 Pandemic. Issues and Development in Health Research Vol. 3, pub: Book Publisher International (2021) pp. 1-9; Print ISBN: 978-93-91595-14-2, eBook ISBN: 978-93-91595-16-6.

6) A. Roy, I. Chakraborty, **A. Banerji**. Determination of Phytochemicals as Potential Inhibitors of Matrix Metalloproteinases (MMPs) with Special Reference to Breast Cancer. Issues and Development in Health Research Vol. 5, pub: Book Publisher International (2021) pp.72-81; Print ISBN: 978-93-91882-30-3, eBook ISBN: 978-93-91882-32-7.

Honours and Awards

1) Elected as Member of the Sectional Committee of the Section of New Biology, Indian Science Congress, 2019-2020 and 2020-21.

Invited talks at Conferences/ Seminars (2020-21)

1) Delivered invited lecture "Epidermal Growth Factor Receptor (EGFR): A Potent Regulator of Matrix Metalloproteinases (MMPs) and Tumour Invasion in Breast Cancer" at *107th Indian Science Congress (Section: New Biology)* organized by The Indian Science Congress Association at Bengaluru, Karnataka, Jan 3rd–7th, 2020.

2) Delivered invited lecture "Improving Cancer Therapeutics: The Potential of Curcumin and ATRA" at *International Conference on Chemistry for Human Development (ICCHD-2020)* organized by Professor Asima Chatterjee Foundation, Kolkata, University of Calcutta and Heritage Institute of Technology at Kolkata, Jan 9th-11th, 2020.

FACULTY PROFILE

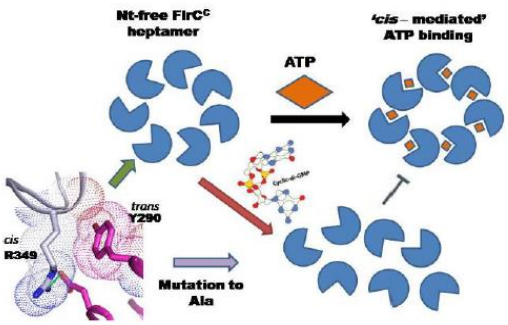
Dr. Jhimli Dasgupta

Research Interests:

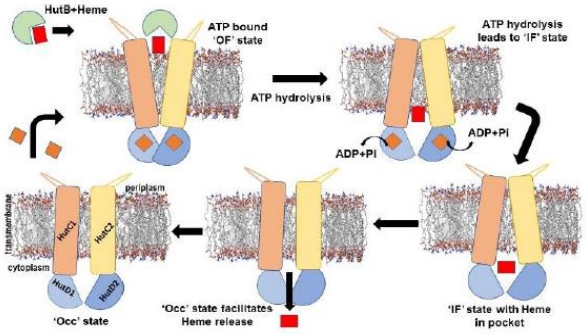
(1) Structural and functional insights of bacterial enhancer binding proteins and GTPases involved in flagellar gene transcription of pathogenic bacteria;

(2) Structure and reaction mechanism of Sensor Histidine kinase involved in flagellar gene transcription of pathogenic motile bacteria;

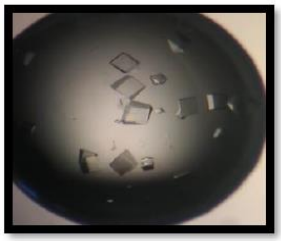
(3) Mechanism of nutrient uptake by ABC importers of pathogenic bacteria.

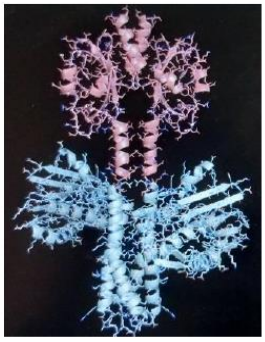


Modulation of bEBP, FlrC by ATP and c-di-GMP



Proposed mechanism of Heme transportation through ABC importer HutCD





Crystals and Proposed structure of Sensor Histidine kinase, FlrB

FACULTY PROFILE

Dr. Aryadeep Roy Choudhury

Research interests:

Plant Physiology & Biochemistry, Molecular Biology and Biotechnology

- Understanding the molecular regulation of multiple abiotic stress (fluoride, arsenic, heavy metal toxicity, salinity and drought) in *indica* rice varieties
- Deciphering the biochemical basis and molecular regulation of aroma production in aromatic rice varieties

Details of publications available at the Google scholar profile:

https://scholar.google.com/citations?user=2z52kIAAAAAJ&hl=en

Current research projects:

- Principal Investigator of the project entitled "Deciphering the biochemical and molecular mechanism of melatonin action during arsenic-mediated stress in *indica* rice varieties" [sponsored by Department of Science & Technology and Biotechnology, Govt. of West Bengal]
- Principal Investigator of the project entitled "Deciphering the biochemical and molecular response of *indica* rice varieties to fluoride-mediated environmental stress and cloning of putative fluoride exporter (FEX) from rice for characterization" [sponsored by Science and Engineering Research Board, Govt. of India]

FACULTY PROFILE

Dr. Ronita Nag Chaudhuri

RESEARCH INTEREST

- Epigenetic regulation of DNA damage response and Gene expression
- Investigating abiotic stress response and related aspects of plant development genetic and epigenetic regulatory mechanisms

RECENT PUBLICATIONS

- DNA methylation and regulation of gene expression: Guardian of our health.
  Invited Review as a part of Special Thematic Issue
  Gaurab Aditya Dhar, Shagnik Saha, Parama Mitra and Ronita Nag Chaudhuri.
  The Nucleus (2021), DOI: 10.1007/s13237-021-00367-y
- Deacetylation of H4 lysine16 affects acetylation of lysine residues in histone H3 and H4 and promotes transcription of constitutive genes.
  Anagh Ray, Preeti Khan and **Ronita Nag Chaudhuri.**
  Epigenetics (2020), DOI: 10.1080/15592294.2020.1809896

- ABI3 plays a role in *de-novo* root regeneration from *Arabidopsis thaliana* callus cells.
  Sourabh Sengupta and **Ronita Nag Chaudhuri.**
  Plant Signaling & Behavior (2020), 1794147. DOI: 10.1080/15592324.2020.1794147

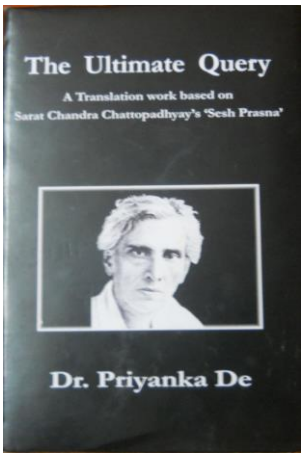
- ABI3 mediated repression of RAV1 gene expression promotes efficient dehydration stress response in *Arabidopsis thaliana*.
  Sourabh Sengupta, Anagh Ray, Dristhi Mandal and **Ronita Nag Chaudhuri.**
  BBA Gene Regulatory Mechanism (2020), 1863(9):194582
  DOI: 10.1016/j.bbagrm.2020.194582

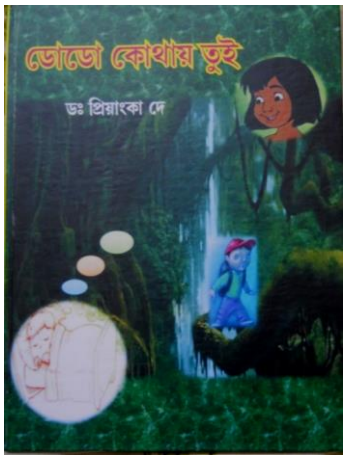
FACULTY PROFILE

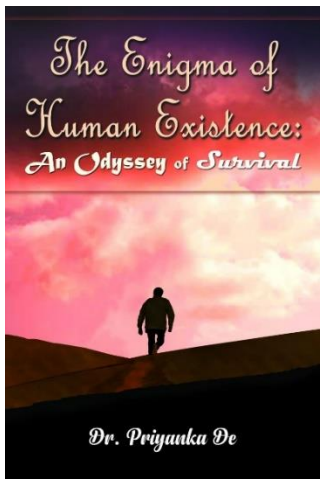
Dr. Priyanka De

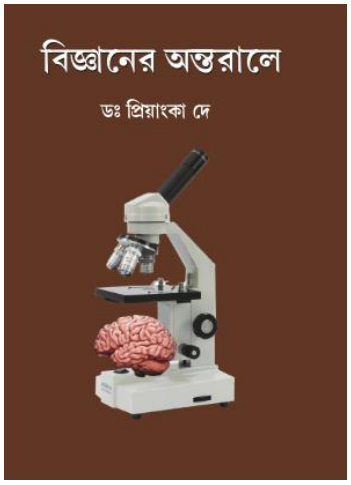
Book Publication:

- Book entitled '*The Ultimate Query*', a translation work based on Sarat Chandra Chattopaddhya's Sesh Prasna (ISBN: 978-93-83548-89-7). 2016.
- Book entitled '*Dodo Kothai Tui*', a bengali story book for children (ISBN: 978-93-84184-41-4). 2016.
- Motivational book entitled '*The Enigma of Human Existence: An Odyssey of Survival*' (ISBN: 978-81-940456-4-9). 2019.
- Book entitled '*Bigyaaner Antoraale*', a collection of scientific articles (ISBN: 978-93-84184-87-2). 2021.









Latest Book chapters:

- Book Chapter entitled "*Diverse Facets of Physiological Ailments in the Light of Health Geography*" as part of Book "Geography in the 21st Century: Emerging Issues and the Way Forward" [ISBN: 978-81-947715-9-3], published by Namya Press, India. 396-417; 2020.
- Book Chapter entitled "*Enigma of Indian Tradition of Healing: A Phytomedicinal Perspective*" as part of Book "Handbook of Agriculture & Plant Sciences" [ISBN: 978-93-91002-25-1], published by ABS Books Publisher, India. 334-351; 2021.
- Book Chapter entitled "*Post-Pandemic Health Communication: Significance and Emerging Prospects*" as part of Book "Opportunities in Media Industry" Post-COVID-19 (Vol 2) [ISBN: 978-93-91537-90-6], published by Clever Fox Publishing, India. 189-207; 2021.
- Poetry Book Chapter: Poem entitled '*Protikhhya*' as part of Book "Karonakaler Kobita" [ISBN: 9789354453618]. 57; March 2021.

As Resource Person and Performer:

- Invited talk on '*Bornomoy Vidyasagar*' at Brihottoro Behala Boimela, Kolkata. 2020.
- Invited Lecture on '*Lock down stress relievers - a focus on emotional health*' as part of International Webinar Series - Genesis, Revelation in a Post-apocalyptic world, 2020, hosted by Postgraduate Dept of Zoology, Asutosh College, Kolkata. 2020.
- Invited Lecture on '*Enigma of Pain: A Neurocognitive Perspective*' as part of Alumni Scientific Interactives, hosted by Postgraduate Dept of Zoology, Vivekananda College, Kolkata. 2020.
- Invited Lecture on '*Insidious Depression: A Neurocognitive Perspective*' hosted by Postgraduate Dept of Zoology, T.H.K. Jain College, Kolkata. 2020.
- Invited Performer in the International Program entitled '*Kothay o Kobitay Rabindranath Tagore*' as part of International Festival-2021, organised by International Culture Centre (ICC). 8 August, 2021.
- Invited Performer in '*Thailand: Bangladesh Bharat International Sanskritik Jot*'. 15 August, 2021.
- Invited Performer in International cultural program entitled '*Tumi acho Chirodin*' organised by The Global TV (UK). 25 August, 2021.
- Invited Performer in '*Murshidabad Bharat Bangladesh International Sanskritik Jot*'. 12 September, 2021.
- Invited Performer in '*Dhaka Mahanagar Dakshin: Dhaka Kolkata International Sanskritik Jot*'. 15 September, 2021.
- Invited Performer in International cultural program entitled '*Banglar Kristi*' organised by Early Star TV (Italy). 18 September, 2021.
- Honorary Position as Associate Producer in the Television Channel from UK, 'The Global TV'. (16 Oct 2021 onwards).

FACULTY PROFILE

Dr. Souvik Roy

Ph.D. (Microbiology), M.Phil. (Microbiology), M.Sc. (Microbiology, 1st Class 1st, GOLD-MEDALIST), B.Sc. (Microbiology, 1st Class 1st, GOLD-MEDALIST), 75th All-Bengal Rank in Madhyamik Examination

HONOURS/ACHIEVEMENTS [2020-2021]

- Awarded with the **SECOND PRIZE (National Award, Govt. of India)** in the International Level Critical Essay Writing Competition on the Theme "How Science Should Be Taught?" at the India International Science Festival (IISF), 2020, organized by Ministry of Science and Technology, Ministry of Earth Sciences, and Ministry of Health and Family Welfare, Govt. of India, in collaboration with Vijnana Bharati (VIBHA) by Council of Scientific & Industrial Research (CSIR).
- Received the **BEST PAPER AWARD [Oral presentation] in RESEARCH** for the Original Research Paper "Pre-Treatment With Scopolamine Naturally Suppresses Japanese Encephalitis Viral Load In Embryonated Chick Through Modulation Of TLR & Type-I IFN Signaling Pathways" at Biospectrum 2020, an International Conference on Biotechnology and Biological Sciences, organized by the Department of Biotechnology, University of Engineering & Management (UEM), Kolkata in collaboration with SMART Society, USA, **Indian Ecological Society and Microbiologists' Society India**.
- **Delivered a Talk** on the Topic "TB Awareness & Prevention" at Rotary Club of Calcutta, Kasba [Rotary International District (RID) 3291] in 2020.
- **Vice Deputy President**, Entrepreneurship Development Cell (EDC), St. Xavier's College (Autonomous), Kolkata.

- **Vice Deputy President**, Enactus, St. Xavier's College (Autonomous), Kolkata.
- **Member** of the College Magazine Committee (CMC), St. Xavier's College (Autonomous), Kolkata.

RESEARCH PROFILE

- **Research experience:** 2006-till date.

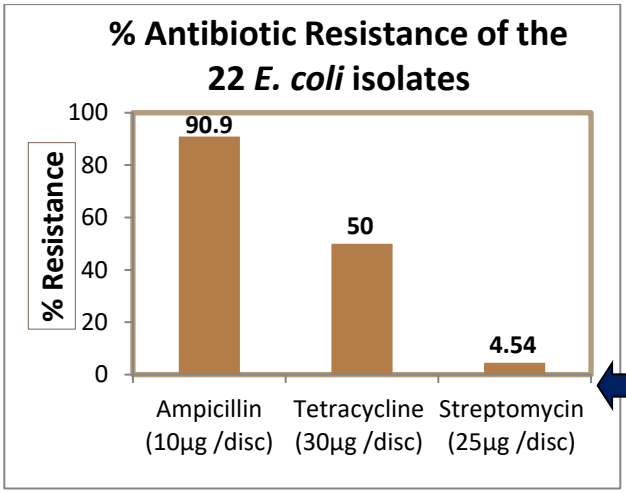
- **Present Research Interests:**

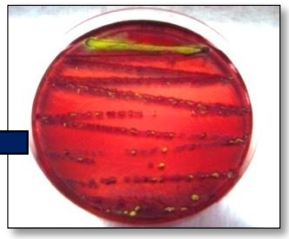
  - **Phytochemicals as anti-tubercular agents:** As cases of MDR-TB are on a speedy rise now, not only globally, but India also reporting a whooping number, with co-morbidities and poor immunity worsening the situation, herbal medicines ('Green Pharmacy'), including garlic, offer a potential alternative for the cure of MDR-TB. Promising results regarding the same have already been obtained by bright-field, fluorescence and phase-contrast microscopy; microbiological, biochemical and immunological assays; and studies in animal cell-culture, awaiting further confirmation through clinical trials.
  - **Evaluation of the microbiological quality of various street-vended and shop-sold food and aromatic beverages:** As different food items and aromatic beverages, like made-tea, sold from different shop and itinerant road-side vendors are very prone to huge microbial contaminations, including notorious pathogens, a periodic assessment of their sanitary qualities, and tracing down ways to maintain their hygiene status as far as practicable, should always be in the top priority list of Food and Industrial Microbiologists for an overall societal benefit.
  - **Different aspects of Clinical Microbiology:** Urinary tract infections (UTIs) are a very common disease in people of all age groups, particularly women and young girls. This bacterial disease is contracted principally from unhygienic public washrooms visited by them. Although commercially-available toilet-seat sanitizers claim to be effective in killing the responsible uropathogens, their efficacies need to be checked periodically and compared, particularly keeping in mind the rapid emergence of MDR- and new uropathogens.

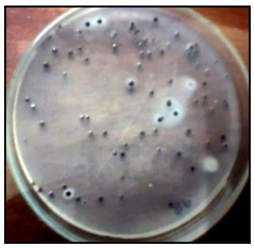
Some Representative Pictures from Research Works Undertaken

A) Shop-vended Khoa (base of most Indian Sweets)

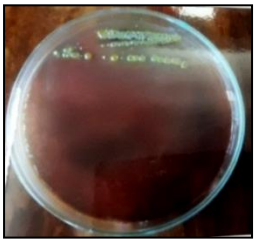
Pathogens isolated and confirmed

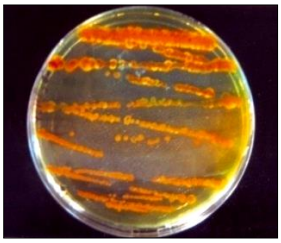






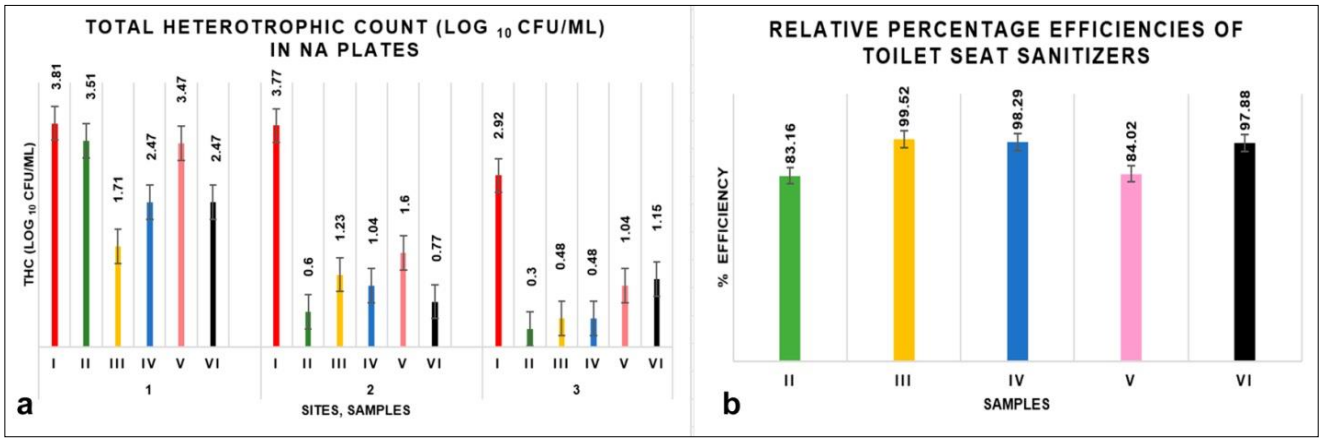
E. coli* (fecal coliform)** ***Staphylococcus aureus



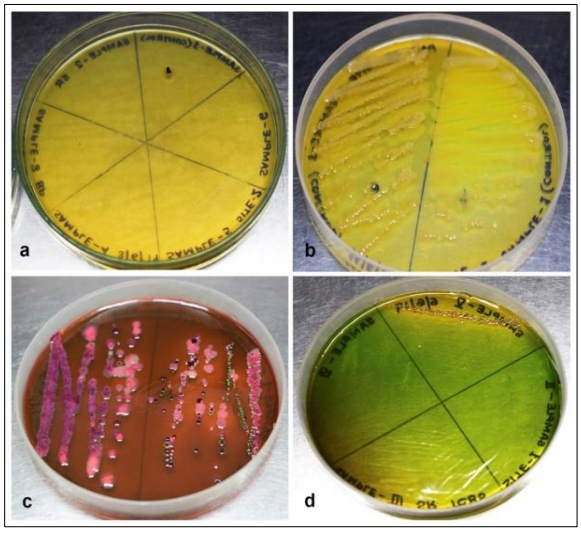


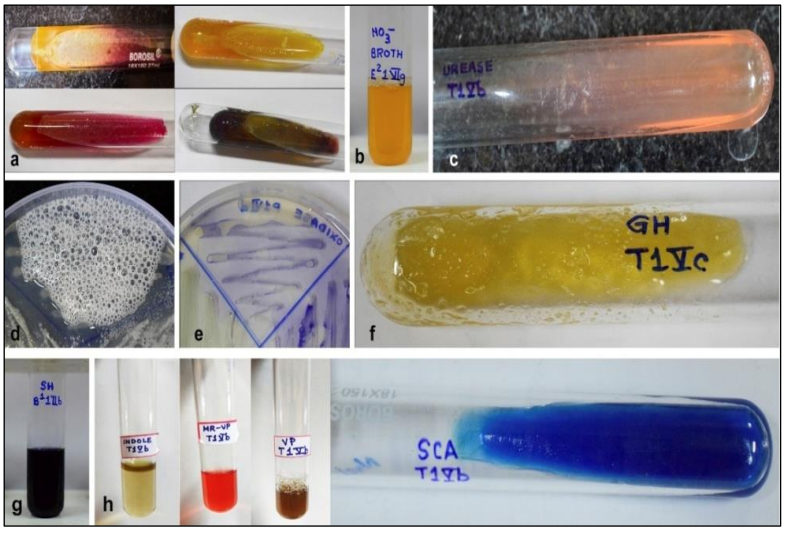
Salmonella* spp.** ***Shigella* spp.** ***Vibrio cholerae

B) Toilet seat wash samples [collected after the application of each of five different commercially-available toilet seat sanitizers]

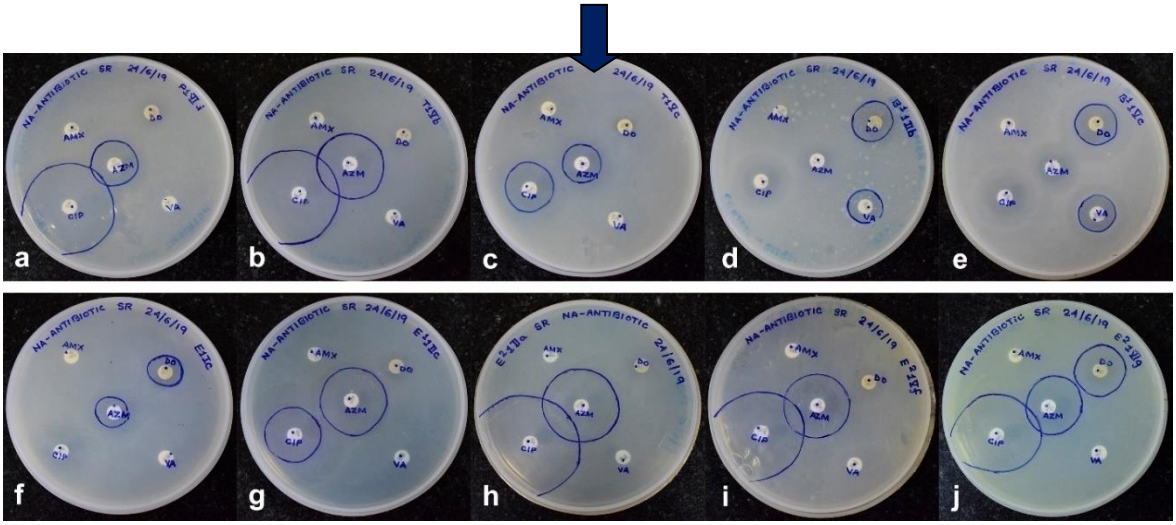


Uropathogens isolated and confirmed

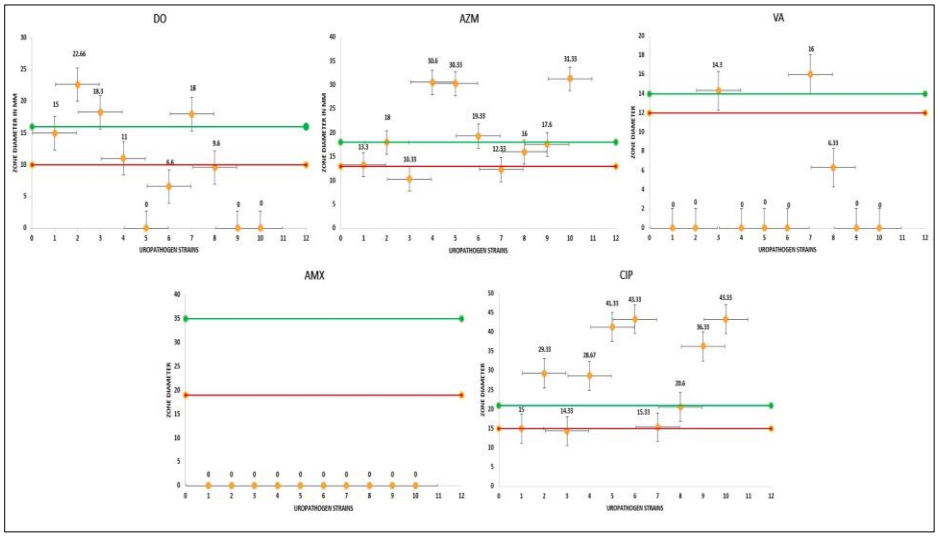




Different Uropathogens: a: *Staphylococcus* spp. b: *Pseudomonas* spp. c: fecal coliforms d: *Vibrio* spp.; and their representative biochemical test results



Antibiotic susceptibility test (Kirby–Bauer Disc Diffusion Assay) of the ten isolated uropathogens for five antibiotic discs (amoxicillin, AMX, 30µg/disc; doxycycline, DO, 30µg/disc; azithromycin, AZM, 15µg/disc; vancomycin, VA, 30µg/disc; and ciprofloxacin, CIP, 5µg/disc)



Scatter plot showing the diameters of the zones of growth inhibition (mm) and the cut-off lines for susceptibility (above the green line), intermediate susceptibility (between the green and red lines) and resistance (below the red line) of the ten isolated uropathogens towards the five antibiotics used (along X axis: 1 – 10: different uropathogen strains)

RESEARCH GUIDANCE

- Guide of **Summer Research Project** of four students (Semester 6) of the 5-Year Integrated Course in Biotechnology, St. Xavier's College (Autonomous), Kolkata, on Medical Microbiology.
- Guide of **Summer Research Project** of one student (Semester 8) of the 5-Year Integrated Course in Biotechnology, St. Xavier's College (Autonomous), Kolkata, on Molecular Microbiology & Microbial Biochemistry.
- Co-guide of **Summer Research Project** of two Post-graduate students of the Department of Microbiology, Lady Brabourne College, Kolkata, on "Effect of aqueous extract of garlic on multi drug resistant (MDR) *Mycobacterium smegmatis*" with Prof. (Dr.) Aditi Nag Chaudhuri, Head, Department of Microbiology, Lady Brabourne College, Kolkata.
- Co-guide of **Summer Research Project** of one Post-graduate student of the Department of Microbiology, Lady Brabourne College, Kolkata, on "Effect of Garlic Extract on NOS expression in *Mycobacterium smegmatis* by using Western Blotting" with Prof. (Dr.) Aditi Nag Chaudhuri, Head, Department of Microbiology, Lady Brabourne College, Kolkata.
- Co-guide of **Summer Research Project** of one Post-graduate student of the Department of Microbiology, Lady Brabourne College, Kolkata, on "Effect of Garlic Extract on Micro RNA synthesis by *Mycobacterium smegmatis*" with Prof. (Dr.) Aditi Nag Chaudhuri, Head, Department of Microbiology, Lady Brabourne College, Kolkata.

PUBLICATIONS [2020-2021]

- **Roy, S.** and Roy, L. (2021) The symbiotic relationship between fungi and plants [3rd Volume (Sustainable Utilization of Fungi in Agriculture and Industry) of the Series - Mycology: Current and future developments]. **Bentham Science Publishers** (*In Press*).
- **Roy, S.,** Choudhury, L., and **S**arangi, N. (2021) COVID-19, Long COVID and its Neurological Effects. **International Journal of Biology, Pharmacy and Allied Sciences (UGC approved)** [ISSN (Online): 2277-4998; Impact Factor = 1.318] *(In Press)*.
- Roy, L., **Roy, S.**, Siddhanta, U., Siddhanta, A. (2021) Prevalence of antibiotic-resistant pathogenic bacteria from canal bank soils in and around Kolkata, India. **International Journal of Environmental Studies (Taylor & Francis) (UGC approved)**. https://doi.org/10.1080/00207233.2021.1966249. [ISSN (Print): 1735-1472; ISSN (Online): 1735-2630; Impact Factor = 2.86].

- **Roy, S.,** Ghorai, S., Choudhury, L., Das, A., Banik Ghosh, R. and Banik, S.P. (2021) Advances in cellulosic enzyme technologies for enhanced stability and catalysis. **Journal of Advanced Scientific Research (UGC approved). 12**(2) Suppl 1:49-65 [ISSN (Online): 0976-9595].
- **Roy, S.**, Bhattacharjee, A., Chaudhuri, R, Dash, J.J., Saha, M., Choudhury, L. (2021) Pre-treatment with Scopolamine naturally suppresses Japanese Encephalitis Viral Load in Embryonated Chick through regulation of multiple signaling pathways. **Applied Biochemistry and Biotechnology (Springer) (UGC approved).** doi: 10.1007/s12010-021-03526-8. [ISSN (Print): 0273-2289; ISSN (Online): 1559-0291; Impact Factor = 2.277].
- **Roy, S.**, Datta, A., Ghosh, A., Mandal, G., Banerjee, S. and Roy, L. (2020) Studies on the susceptibility of Common Uropathogens to Toilet Seat Sanitizers and their Antibiogram. **International Journal of Biology, Pharmacy and Allied Sciences (UGC approved). 9**(9): 2212-2230. https://doi.org/10.31032/IJBPAS/2020/9.9.5178. [ISSN (Online): 2277-4998; Impact Factor = 1.318].
- Choudhury, L., **Roy, S.** and Chakrabarti, K. (2020) Microorganisms in Khoa, the base of Indian Sweets, and their Impact on Public Health. **International Journal of Biology, Pharmacy and Allied Sciences (UGC approved). 9**(9):2132-2149. https://doi.org/10.31032/IJBPAS/2020/9.9.5171. [ISSN (Online): 2277-4998; Impact Factor = 1.318].
- **Roy, S.,** Bhattacharjee A., Roy, L. and Das, S. (2020) Recent Advances Towards The Development and Applications of Novel Therapeutics against Chikungunya Virus Infections. **International Journal of Pharmaceutical Sciences and Research (UGC approved). 11**(12): 6503-6513 [ISSN (Print): 2320-5148; ISSN (Online): 0975-8232].

FACULTY PROFILE

Dr. Sayak Ganguli

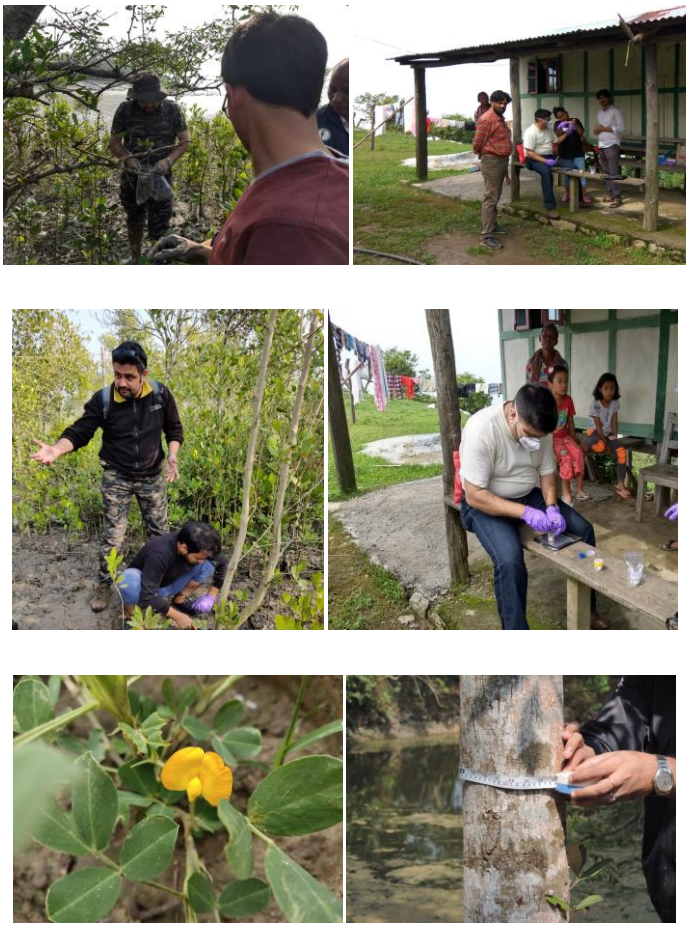
About:

Biologist, with background in Plant Biology, specialization in Plant Tissue Culture and Micropropagation; Bioinformatics, Computational Biology, Genomics and Machine Learning

Current Work Area(s):

Using Genomic techniques (transcriptome and metagenome) to explore:

1. Plant environment interactions in the Indian Sunderbans; a UNESCO World Heritage Site to formulate proper conservation and habitat restoration strategies for reducing the impact of climate change
2. Gut Microbial interactions with traditional diet practices of tribal members of Savar, Bhutia, Mech, Lodha, Toto etc. For predicting new measures for assessment of malnutrition among children and adults.
3. Waste water microbiome to establish a source sink relationship for transmission of antimicrobial resistance and devising a strategy for rapid public health monitoring.



Images: Glimpses from Field trips and Data Collection for the projects on Metagenome and Transcriptome Analysis

Additional Areas of Interest:

1. Annotation and structure elucidation of Hypothetical Proteins from major pathogen genome for identifying novel drug targets
2. Design of therapeutic antisense oligonucleotides and noncoding RNAs
3. Soil Microbiome Analysis

Funding:

Collaborative Projects funded by DST – Government of West Bengal; DST – SERB; with University of Calcutta (Anthropology and Biotechnology, PG Department of Microbiology, SXC Kolkata; PG Department of Botany, Lady Brabourne College, Kolkata; PG Department of Zoology, Rammohan College, Kolkata)

Hobbies:

Collecting Folk Songs; Playing/Watching Cricket and Football, NGO activities

CHIASMA 2021
RESEARCH SCHOLARS

AHELI MAJUMDER

PI: Dr. Aniruddha Banerji

INDIRA CHAKRABORTY

PI: Dr. Aniruddha Banerii

ANIRBAN ROY

PI: Dr. Aniruddha Banerji

PREETI KHAN

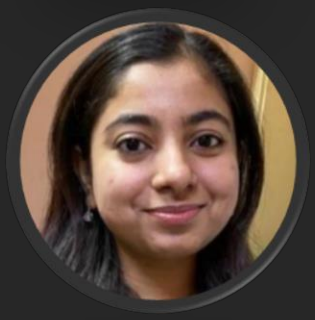
PI: Dr. Ronita Nag Chaudhuri

SAPTARSHI DATTA

PI: Dr. Ronita Nag Chaudhuri

DRISHTI MANDAL

PI: Dr. Ronita Nag Chaudhuri



SHRESHTHA CHAKRABORTY

PI: Dr. Jhimli Dasgupta

PEEALI MUKHERJEE

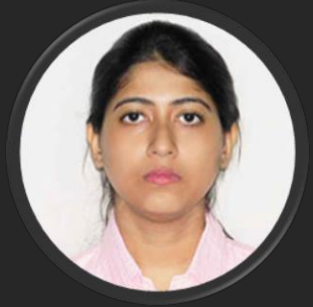
PI: Dr. Jhimli Dasgupta

INDRILA SAHA

PI: Dr. Jhimli Dasgupta

RUCHIRA DAS

PI: Dr. Jhimli Dasgupta



Department of Biotechnology

CHIASMA 2021
RESEARCH SCHOLARS

SUPARNA DATTA

PI: Dr. Jhimli Dasgupta

SEHNAZ FERDOSH

PI: Dr. Chandana Barat

ADITYA BANERJEE

PI: Dr. Aryadeep Roy Choudhury

PUJA GHOSH

PI: Dr. Aryadeep Roy Choudhury

SANTANU SAMANTA

PI: Dr. Aryadeep Roy Choudhury

ANKUR SINGH

PI: Dr. Aryadeep Roy Choudhury

APARAJITA CHAKRABORTY

PI: Dr. Sudipa Saha,

Dr. Priyanka De

SUSHMITA NANDY

PI: Dr. Sudipa Saha,

Dr. Priyanka De

SOURABH SENGUPTA

PI: Dr. Ronita Nag Chaudhuri
Awaiting Ph. D degree.

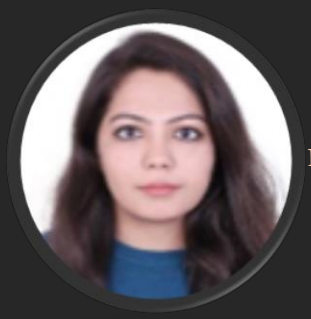
SENJUTI BANERJEE

PI: Dr. Chandana Barat
Provisional Ph. D degree awarded

Department of Biotechnology

CHIASMA 2021

ALUMNI RESEARCH SCHOLARS



Dr. SONIA BEDI

PI: Dr. Ronita Nag Chaudhuri
Ph. D degree awarded.
Genome Solution Specialist,
Molsys Ltd. Bangalore.

Dr. ANAGH RAY

PI: Dr. Ronita Nag Chaudhuri
Ph. D degree awarded.
Post-Doctoral Fellow, National Cancer Institute, NIH, Bethesda, MD, USA

Dr. MAITREE BISWAS

PI: Dr. Jhimli Dasgupta
Ph. D awarded: 2016
Postdoctoral fellow,
University of British Columbia, Canada

Dr. SANJAY DEY

PI: Dr. Jhimli Dasgupta
Ph. D awarded: 2016
Postdoctoral fellow, IGBMC, Alsace, France;
Former Postdoctoral fellow,
Penn State University, USA

Dr. SHUBHANGI AGARWAL

PI: Dr. Jhimli Dasgupta
Ph. D Awarded: 2018
Postdoctoral fellow, Cornell University, USA
Former Postdoctoral fellow,
University of Stuttgart-Hohenheim, Germany

Dr. SAIKAT PAUL

PI: Dr. Aryadeep Roy Choudhury
Ph. D degree awarded.
Postdoctoral Research Associate at
National Institute of Plant Genome Research (NIPGR), India

Dr. BANI KUMAR PATHAK

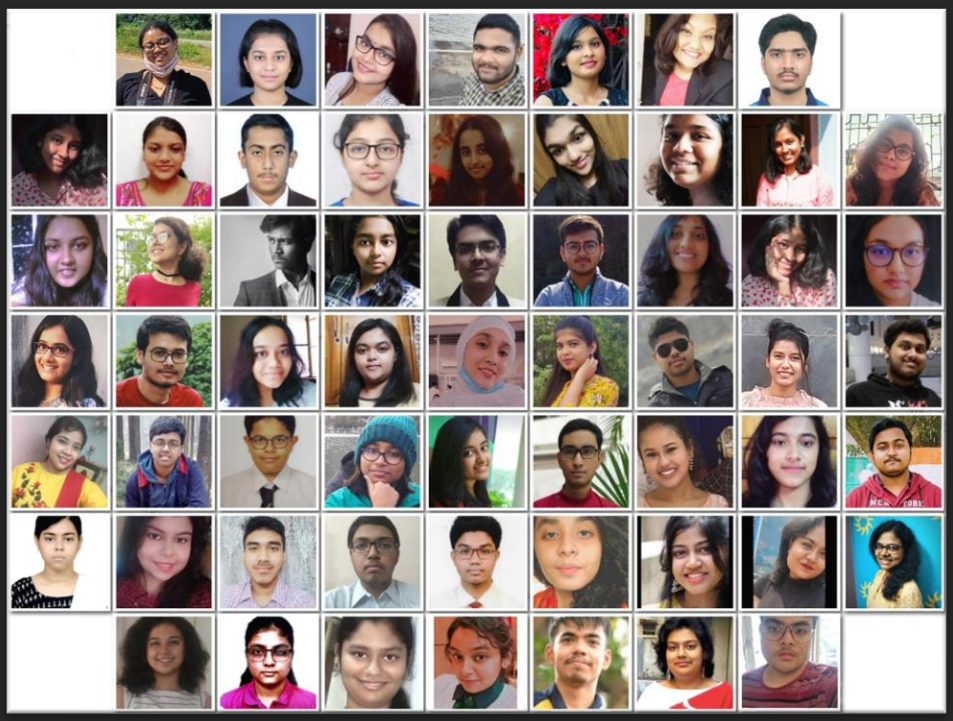
PI: Dr. Chandana Barat
Ph. D degree awarded.
Assistant Professor, Department of Biotechnology
MAKAUT WB

Dr. SUROJIT MONDAL

PI: Dr. Chandana Barat
Ph. D degree awarded.
Senior Officer,
Genetic Toxicology.
JDM Research Pvt Ltd
Vadodara, Gujarat

CHIASMA 2021
BATCH PHOTOGRAPHS

FIRST YEAR



SECOND YEAR

Department of Biotechnology

CHIASMA 2021
BATCH PHOTOGRAPHS

THIRD YEAR

FOURTH YEAR

Department of Biotechnology

CHIASMA 2021
BATCH PHOTOGRAPHS

FIFTH YEAR

SUPPORT STAFF

Department of Biotechnology

DEPARTMENTAL ACHIEVEMENTS

-An Ode to those who have made us proud

Avirup Chakraborty

Semester 7

It has been over a year amid the helplessness and despair of the COVID-19 pandemic, with clouds of the darkest shade of grey cast all over the sky of our lives. Everybody everywhere has been fighting for a firm grip on life, which has been increasingly uncertain since the beginning of the pandemic. But, as it is rightly said,

"When the going gets tough, the tough get going!".

However, at the Department of Biotechnology, giving up is never an option, and the students moved forward despite the trying circumstances. Against all adversities, defying all the odds, the students of the Department of Biotechnology, shone brighter than ever before, with their various academic and extra-curricular achievements. The following is a compiled list of all the students who have made us immensely proud, with their achievements, in the academic session 2020-21.

BATCH OF 2016-21

Sl. No.	Name	Accolade
1.	Debarati Sanyal	CSIR UGC NET JRF June 2020, Rank 5
2.	Ankita Bhattacharyya	(i)CSIR UGC NET JRF June 2020, Rank 9 (ii)DBT BET 2021 Category I Qualified
3.	Attrayee Chakraborty	(i)GATE 2021 Life sciences AIR 51 (ii)GATE 2021 Biotechnology AIR 90
4.	Shagnik Saha	CSIR NET 2020 November. Rank 53

5.	Vaidehi Roy Choudhury	GATE 2021 Life Sciences AIR 25
6.	Spriha Ghosh	(i)Qualified for CSIR NET JRF November 2020, AIR 81 (ii)December 2019 CSIR NET JRF qualification, AIR 58
7.	Ritaja Chattopadhyay	DBT BET 2021 Category I Qualified
8.	Gaurab Aditya Dhar	DBT BET 2021 Category I Qualified
9.	Atreyi Dutta	DBT BET 2021 Category II Qualified
10.	Sampurna Pal	DBT BET 2021 Category I Qualified

SEM IX:

Sl.No.	Name(s)	Accolade
1.	Sayani Shyamal	Qualified GATE-BT 2021 exam with AIR 184
2.	Arunima Bhattacharya	(i) Special Mention Award at iGEM India BioSummit 2020, organised by iGEM BITS Goa, BITSMUN, The Dais and Manipal Biomachines, as a part of All India iGEM Meet 2020, being a part of the Medical Data Privacy Committee that aimed to arrive at tangible solutions for fulfilling Sustainable Development Goals 3 and 9, laid by the United Nations, for 2030.

		(ii) First prize in Sciency Gazette, online blog article writing competition organised by St. Xavier's College Science Association, as a part of their annual event, Sigma 2020.
3.	Sombuddha Roy Bhowmick	(i) Presented poster at 4th Regional West Bengal Science and Technology Congress (Western Region), Burdwan, 2019, organized by the Department of Science and Technology and Biotechnology, Government of West Bengal. (ii) Special Mention Award at Paper presentation in, SBI2 High Content 2020, held virtually, organized by the Society of Biomolecular Imaging and Informatics (SBI2), USA. (iii) Presented poster at International Symposium on Environment and Climate Change, Kolkata ,2019, organized by St. Xavier's College (Autonomous), Kolkata. (iv) Presented Poster at BioEpitome,2021, held virtually, organized by the Society for Biological Engineering (SBE), UIET, Panjab University Student Chapter. (v) Authored original research paper- Biodiversity assessment of bird species as bioindicators and the impact of air pollution on the ecological community, International Journal of Pure and Applied Zoology, Vol. 9, Issue 2, pp 18-25
4.	Jigyasha Laha	Won 3rd prize in St. Xavier's College Sports 2020, Category - 400 m race.
5.	Nilasha Chakrabarty	i) Co-authored original research paper titled & quote; Spectroscopic Studies on the Biomolecular Recognition of Toluidine Blue: Key Information Towards Development of a Non-Contact, Non-Invasive Device for Oral Cancer Detection & quot; published on 27th Oct,2020 in the Frontiers in Oncology (Head and Neck Cancer) based on the 2018 project under the guidance of Dr. Samir Kumar Pal et al, Department of Department of Chemical, Biological and Macromolecular Sciences, S. N. Bose National Centre for Basic Sciences, Kolkata. Publication link: https://doi.org/10.3389/fonc.2020.529132

		ii) Placed first in Scientific Doodling contest "Scribble It", at Sigma 2020, seminar and science fest organized by St. Xavier's College Science Association. iii) Placed third in Scientific Doodling contest at Élan 2019, seminar and environment fest organized by St. Xavier's College Department of Multimedia and Animation iv) Co-authored Review paper under corresponding author Dr. Bharat Kwatra, Invenzion Labs Inc, New Delhi titled "Clinical Applications and Immunology of Calcium Citrate Maleate"; published in the International Journal for Pharmaceutical Sciences Review and Research. [Volume 69, Issue 1, July - August 2021. Article 09.] Publication Links: http://dx.doi.org/10.47583/ijpsrr.2021.v69i01.009 {DOI not activated yet} https://globalresearchonline.net/journalcontents/v69-1/09.pdf
6.	Rajarshee Tagore	Selected to pursue IASc-INSA-NASI Summer Research Fellowship 2021 in University of Delhi
7.	Rajarshee Tagore and Dharitri Chaudhuri	First place at Brainaholic (Quiz) at Frontiers in Biotechnology, 2019.
8	Arunima Bhattacharya, Arkopriyo Banerjee and Debava Chaudhuri	Presented an oral presentation titled "Evolving Efficiently: Fathoming the Enigma of Engineered Proteins" at the International Webinar "Modern Trends in Microbiology" organised by Department of Microbiology, St. Xavier's College (Autonomous), Kolkata and secured 1st position.

SEM VII:

Sl.No.	Name(s)	Accolade
1.	Souptik Ghosh	(i)1st Position in the Sports Quiz of Xavier's Premier League, playing for "Team Anti Hero" with the Best Player Award; organised by Department of Sports and Student Council, St. Xavier's College (Autonomous), Kolkata. (ii)1st Position in Sports Quiz Organized by Department of Sports, St. Xavier's College (Autonomous), Kolkata. (iii) 1st Position in "Quiz on Satyajit Ray" for "Centenary Birth Celebration of Satyajit Ray Organised by Milan Samity in association with St. Paul's Old Boys-1980 (iv)2nd Position in Quiz Organised on occasion of International Mother Language Day, Organised by All Bengal Little Magazine Fair and Literature Festival (v)2nd Position in Quiz at 40th Annual Cultural Competition-2021, Organised by Barasat Bibake Sangha
2.	Zainab Khatun	1st Position in oral presentation on "Corona virus: Prevention and Possible Remedial Measures" organised by Indian Chemical Society, Kolkata
3.	Navaneel Sarangi	(i)Finished term as Astrobiology Changemaker in the Department of Astrobiology, Spaceonova Published paper on "NEUROLOGICAL IMPACT OF COVID-19 AND ITS EFFECT ON PEDIATRIC POPULATION: A COMPREHENSIVE REVIEW" in Aviskaar Magazine - A Xaverian Journal of ResearchPaper on "COVID, LONG COVID AND ITS NEUROLOGICAL EFFECTS" accepted for

		publication in International Journal of Biology, Pharmacy and Allied Sciences (ii)Presented in 3 min slam thesis of " CHESS 2020 - Biology Under Extreme Conditions:2030 and Beyond " organised by Cornell High Energy Synchrotron Source on the topic " Radioprotection in Human Cells using Tardigrade Protein"
4.	Rajeshwari Podder, Ruchira Pal and Nabarun Roy	Presented an oral presentation titled "From The Nuclear Reactor Core To Our Next Jab: A Novel Approach To Vaccine Development" at the International Webinar "Modern Trends in Microbiology" organised by Department of Microbiology, St. Xavier's College (Autonomous), Kolkata and secured 2nd position.

SEM V:

Sl. No.	Name	Accolade
1.	Nilratan Pal	Participated in GREEN REVOLUTION GLOBAL CERTIFICATE PROGRAM. By- UN Framework Convention on Climate Change and Successfully Passed and Scored 60%.
2.	Arunima Basu	Essay writing competition for UG students on COVID-19: A PANDEMIC DISEASE; Organised by- Dept of Physiology, Berhampur Girls College; Position secured - 4th Rank.
3.	Ayan Kumar Jana	Worked as V-Force volunteer (UN volunteers India) for International Youth Day 2021 on the theme "Transforming Food Systems: Youth Innovation for Human and Planetary Health".

SEM III:

Sl. No.	Name(s)	Accolade
1.	Swayambhik Mukherjee	(i)Qualified for Science related project topic: International Research Paper on ERK and Tumour Biology at Civilian Welfare Foundation. (ii)Qualified for Science related project topic: Cell Regeneration: Factors and possible Accelerators (Natural and Synthetic) at Jozbiz Technologies private limited. (iii) Published an article titled "Reviewing Rare Syndromes" in the International Journal of Medical and Biomedical Studies, Volume 5, Issue 5. Doi: https://doi.org/10.32553/ijmbs.v5i5.1919
2.	Aditi Sarkar, Hriddhi Maitra and Reeddhi Banerjee	Received Bigyani Kanya Medha Britti Scholarship 2020 West Bengal
3.	Rohita Sarkar	Participated in Quiz related to Space Science and Technology of ISRO Cyberspace Competitions, 2020 and secured an All India Rank of 477.
4.	Anushree Sadhu	Participated in the Heritage Parliamentary Debate and Chanakya National Law University Parliamentary Debate as Adjudicator and got promoted to Chair in the in-rounds in both the debates

REMINISCENCES

Ankur Rao

Batch of 2019

Current Position:

Ph.D. student, ICMR-JRF, ICMR-NICED, Kolkata, India

REVERIES OF A FIVE-YEAR JOURNEY IN BIOTECHNOLOGY

Having got the chance to write about my departmental memories while sitting in my lab, it now feels like five years have passed in the blink of an eye! These five years in the Department of Biotechnology have been eventful - whether academic or extracurricular. To study biotechnology was my passion; little did I know that I would fall in love with the subject - the prelude being how CB Ma'am taught us to remember all the twenty amino-acid structures in one class without going through the pain to memorize it! It is still worth remembering how she made us fall in love with the various steps of the Central Dogma - effortlessly and passionately explaining as if we are listening to a story. I can still visualize how she would exclaim "Isn't it fascinating?" for every landmark experiment she would teach us. And this is how my love story with Biotechnology began and is still continuing.

Even though the syllabus had been gigantic, our professors - US Ma'am, CB Ma'am, SS Ma'am, AB Sir, JD Ma'am, DC Sir, ARC Sir, RNC Ma'am, SR Sir and PD Ma'am, helped us gain an understanding of the different disciplines -- US Ma'am for making us love RDT, Virology and Immunology and SR Sir for making us love Microbiology and awing us with his meticulous attention to detail - the latter having realized when I joined a lab which focuses on bacteriological work. At the same time, I cannot forget AB Sir's "enlightening" classes on the stipulated topics as well as those outside our formal syllabus which, despite being huge, had been very helpful in qualifying for our competitive exams (particularly - ICMR-JRF NET for medical-oriented research).

Apart from academics, other fond remembrances are the Sports Days - where we had once enchanted the audience by "cloning" ourselves, the different chapters of Frontiers in Biotechnology and being in the editorial committee for Chiasma. One of the best moments was the inception and development of the Science blog "InquiScitive" by Nilanjan (Das) – a departmental sapling in 2017 which has now bloomed into a full-grown tree with members from different departments and institutes.

I can't possibly forget our excursions to the Indian Museum, Alipore Zoo and West Sikkim! The first two were a local delight, while the last one let us enjoy the unadulterated, pristine, and natural beauty and helped teach us about self-discovery and connecting with nature.

It has been two years since I last rushed along the heritage-rich Park Street and raced up the steep steps to the fourth floor to reach room no. 47, 48 and 49. Be it juggling with academics, other activities, or interacting with friends, professors, lab assistants and others, these five years have been an enriching phase in my life, which cannot be replicated physically, but can be replayed as memories preciously etched in my grey cells.

Aditi Saha

Batch of 2020

Current Position:

Ph.D. Student, Transposon Lab, Department of Biological Engineering

Indian Institute of Technology, Gandhinagar, India

When I look back on the days of the last half-decade spent in the department, it gives me immense pleasure to recall the happy times spent in the rooms of 47, 48, 49…. Starting the day by running for metros to attend the first class (for which I was always late.. hehe!!!), to taking short 5 min naps between the two classes, complaining about why we have such strictness with attendance… to taking pride in how the college has molded us to handle tough situations in life. I always believed people take pride when they are about to join or leave Xavier's because they have had exposure to one of the well-facilitated teaching services available for the UG and PG level studies, and teachers who indeed knew everyone by face and name, and not merely by roll numbers… professors who believed in us and also who believed this common knowledge that everyone cannot be good in everything. But the time one has spent here, he/she made sure that they enjoy the journey and not make it mundane.

I simply cannot pinpoint the memorable days of my tenure since there are so many. Be it being one of the convenors of 'Frontiers in Biotechnology' for two consecutive years (2018 and 2019)

and working with an amazing bunch of seniors, friends and juniors, or be it being the last batch for the excursion to Daringbadi, or leading the departmental contingent in the Sports day, or be it holding departmental picnic… I truly miss them. I miss the time spent in Lab 1 and 2, writing long practical copies, cursing the education system and blah blah blah!!! Little did we know that we were writing memories with a bunch of lunatics named *Friends*.

I have my heartfelt condolence for my juniors who are missing the fun-filled moments of college life due to the pandemic, but I earnestly believe that the sun will shine upon us again and you all will also experience some of the greatest and the craziest days of your life. For my juniors, I would like to say, “May all your dreams come true”. Do not go onto the rat race- everyone has their own pace on the road to success. Keep your spirits high no matter what, otherwise Xavier’s and Biotechnology department will add no colors to your life. You have got one of the best privileges in the education sector one can ever ask for.

Attrayee Chakraborty

Batch of 2021

Current Position:

Ph.D. Scholar, Department of Molecular Reproduction, Development and Genetics (MRDG)

Indian Institute of Science (IISc), Bangalore

MEMORIES IN 1825 DAYS

The last time I visited the Department of Biotechnology at St. Xavier's College as a student, I was running late for a practical class that morning at 10 a.m. I still remember sitting in the lab and writing in the file pages when we heard the announcement that all institutions would be shut down for a few days to stem the pandemic. Little did I know that it would be the last time we would all meet as a batch.

The pandemic has allowed me to be thankful for something I took for granted—my days at college and the Department. What I love most about the Department is how it always made me question things. It made me realise that solving a few questions in Lehninger or Kuby or playing with a protein on PyMol would help me appreciate how amazing science is.
Choosing just a few memories out of my 1825 days of being associated with the college is very difficult! However, my fondest academic memory at the Department has been perhaps the first time I was asked to give a presentation in class. I feel almost all of us have done it at least once.

My topic was to discuss calculating the isoelectric point in proteins and associated mathematical problems. In retrospect, I believe that my interest in everything related to proteins began then. Another fond memory is how we all started the blog called 'InquiScitive' at the end of our first year. Our 3rd-year seniors and a number of us contributed to the blog. I think I speak for everyone when I say how it helped us connect with students and professors of our department academically.

My fondest non-academic memory of the Department was when we used to take the bus home from our Departmental picnics. Perhaps my fondest memories with my classmates will remain there.

I am extremely thankful to all my professors for continuing to guide me through my journey in science, and my classmates, whose insightful questions have always kept me interested in science, no matter how many extracurriculars I found myself in. I realise how fundamental my classes in the Department have been in shaping my concepts and thought-process, since after joining another institute, I find myself so calm in otherwise challenging situations. I would ascribe my success to every experience in the Department, both pleasant and difficult, that has helped me push myself and affirmed my belief in myself. I cherish every motivating talk, advice, and guidance behind the doors of the Department staff room and Room 47.

I hope to visit the Department soon, once this pandemic is over!

Ankita Bhattacharyya

Batch of 2021

Current Position:

Intern at Shodhaka Life Sciences Pvt. Ltd. at Bangalore

A BAG FULL OF MEMORIES

Thinking about the day I first walked through the doors of SXC, with fear and excitement about the journey I was about to begin, I got overwhelmed by the uncountable memories made these past five years. Fresh out of high school, five years seemed like a huge commitment to make and yet somehow it feels like only yesterday we were given the brand-new ID cards that we donned around our necks every morning, climbing the never-ending stairs to room 47.

There have been a lot of people who've been astounded by my love and reverence for biology, at times considering that I was making it up! But I know that anyone and everyone who has been a part of BMBT felt that magic at some point or another. The magic our professors created as they took us on the journey of unearthing Nature's secrets and left us wide-eyed, marvelling at the foresight of legendary Scientists that created the foundation of all that we know today. That right there affirmed my love for where I was. I watched with awe how a folded paper became a beta-barrel, how the wire of a mouse became a nucleosome, how my classmate's ID card became super-coiled DNA – uncountable such moments have merged to shape me into who I am today - an

aspiring researcher with a thirst to know more, and to mind, that must never stop asking questions. For all of this and so much more, who do I thank if not my *gurus*, my professors?

But was that all? Only academic discussions to guide us into the world of research? Not even close. We sat down in dimly-lit classrooms and understood the difficulties of the career most of us would be choosing, and accepting them wholeheartedly. Understanding with our Professors that while the more ostentatious lifestyles may be reserved for others, we would lead a life that would be fulfilling and rewarding in a whole other way! Sitting on the floor of lab 2 late in the evening, desperately trying to get accurate results and sharing life experiences with everyone around, being terrified of the centrifuge exploding when left alone in the lab, the first experience of casting a gel and following it up with perfect sample loading – oh if only those walls could talk!

We have had innumerable firsts in those rooms, in our protected Department in that secluded corner of the fourth floor, dealing with the unbearable heat as our Projectors and ACs refused to cooperate, as we spent hours making props for our Sports Day parade, prepped for the Departmental picnic months in advance, set up committees for Chiasma, managed finances and events for FIB and shared our first wins – smiling as we all grew up together.

It has been an incredible, unbelievably beautiful journey in my department, with its shares of highs and lows, small victories and oh-so-many failures, friendships and some nasty fights, with a batch that stayed united in times of need and Professors that stood by our side every step of the way.

So now, when I look at old pictures of the department, our batch photos, think about our excursion that didn't happen, about the night we looked at stars from the observatory, about every annual viva terror, about the last moment practical submissions, the freezing temperatures of R K Hall as we shivered during our 4 hour long papers, the chaos of autoclaving v/s media preparation during practical and the laughter that filled the corridors of the fourth floor at 12.45 pm every day - I am filled with nothing but gratitude. Gratitude towards all my professors, my friends, my juniors, ever-present Rajkumar Da, Bidesh Da and Abhijit Da, our senior scholars who spent hours prepping for our practical and of course, my entire batch.

The pandemic might have taken away a significant, rather important chunk of our college lives, knocked us all a little off-balance, but I will always have my bag full of memories. Saying goodbye to my department while I sit at home in front of my laptop was never the way I imagined this would end, but then, life goes on. All I wish is for my juniors to be able to go back to college soon, and experience all of this and so much more.

Thank you for raising us. Thank you for loving us. Thank you. For everything.

বৈদেহী রায় চৌধুরী

২০২১-এ উত্তীর্ণ

বর্তমানে কেমব্রিজ বিশ্ববিদ্যালয়ের রসায়নবিদ্যা বিভাগে পি.এইচ.ডি পাঠরত

কৃতজ্ঞতা জ্ঞাপন

দিনটা ছিল ২০১৬ সালের জুলাই মাসের এক বৃষ্টিস্নাত শুক্রবার। দ্বাদশ শ্রেণির কঠোর পরিশ্রম ও ইঞ্জিনিয়ারিং বনাম ডাক্তারির দ্বন্দ্বে বিচলিত মন নিয়ে বিদ্যালয়ের গণ্ডি পেরিয়ে প্রথমবার সেন্ট জেভিয়ার্স কলেজের জৈবপ্রযুক্তি বিভাগে প্রবেশ করি। সামনে তখন অনিশ্চিত ভবিষ্যৎ – কী করব? আগামী পাঁচ বছর এই বিভাগেই কাটিয়ে দেব? নাকি সাদা কোট ও স্টেথোস্কোপের দায়িত্ব কাঁধে তুলে নিতে আরেকবার যুগ্ম প্রবেশিকা পরীক্ষায় বসব? নাকি সংখ্যার জটিল মারপ্যাঁচের সমাধানের খোঁজে গণিতে মনোনিবেশ করব?

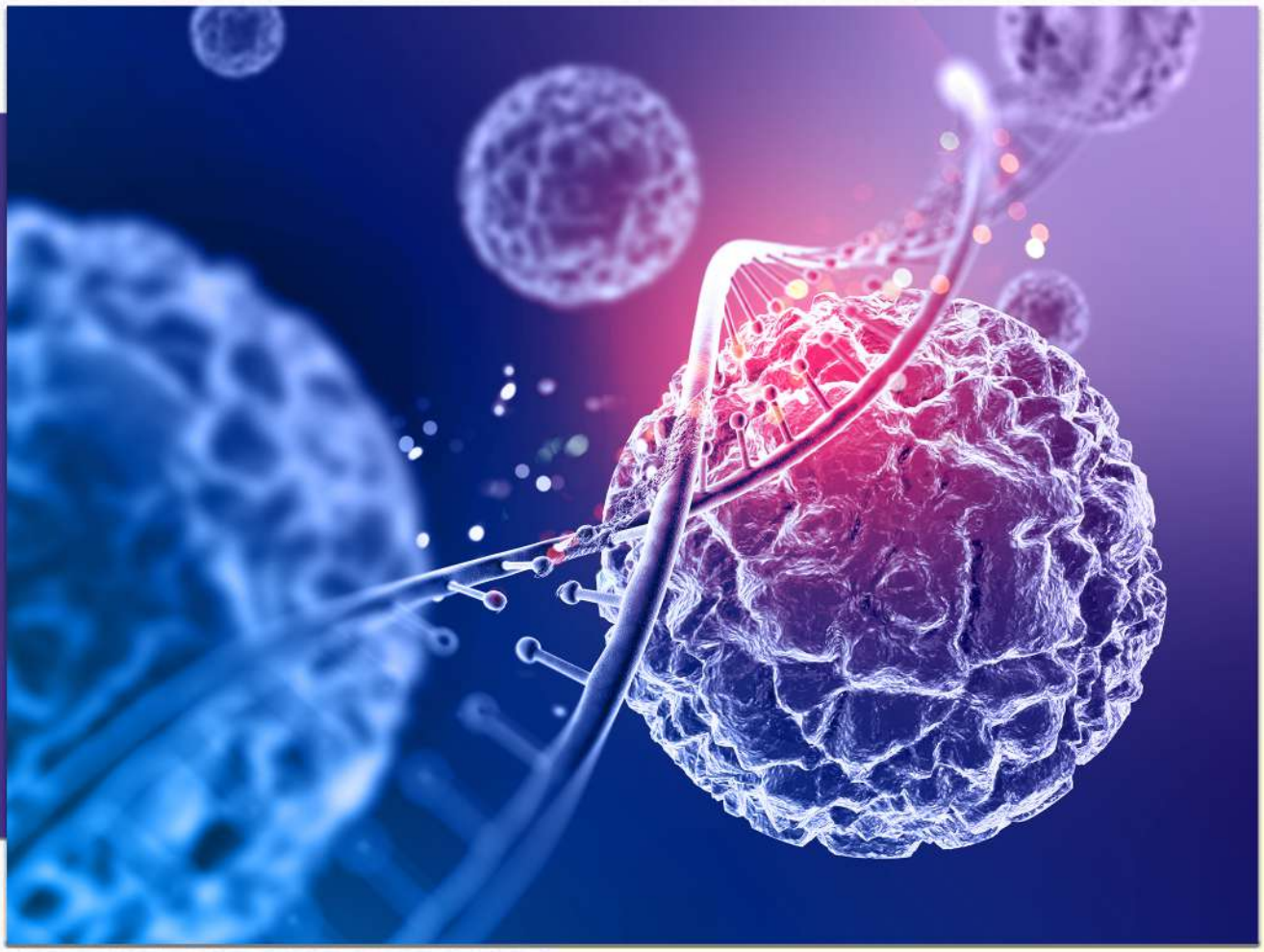
এহেন মানসিক দোলাচলের মধ্যে দিয়েই একটা বছর কেটে গেল; নিজের অজান্তেই কখন যে ডিএনএ ও প্রোটিনের রসায়ন আমার প্রিয় বিষয় হয়ে উঠল, টেরই পেলাম না। এরই মাঝে নতুন মানুষদের সাথে আলাপ হলো – অধ্যাপক ও বন্ধুদের সান্নিধ্যে আমার বিজ্ঞানমনস্কতা ও চিন্তাশক্তি বৃদ্ধি পেতে লাগল। সঙ্গে ছিল দিনের শেষে জুবিলি বিল্ডিং-এর ছাদে অন্যান্য বিভাগের ছাত্রছাত্রীদের সাথে সঙ্গীতচর্চা এবং সপ্তাহান্তে একটি গির্জায় কচিকাচাদের পড়াতে যাওয়া –

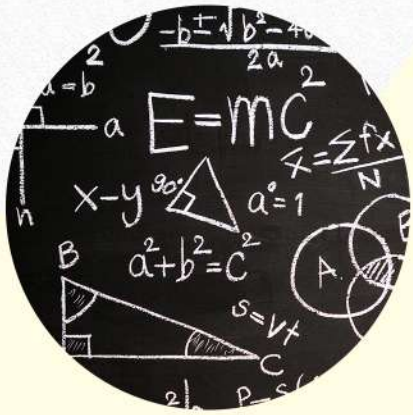
বাধ্যতামূলক নিয়মাবলীর ছলে আমাদের মনকে সজীব ও সুহৃদ করে তোলার যে ফন্দি মহাবিদ্যালয় এঁটেছিল, তা মন্দ নয়।

সময়ের সাথে সাথে পড়াশোনার বোঝা বাড়তে থাকে, কিন্তু তা কখনই আমাদের সৃজনশীলতা ও সংস্কৃতিচর্চার ক্ষেত্রে বাধা হয়ে দাঁড়ায়নি। প্রতি বছর এই সময় বিভাগের সকলে একত্রিত হতাম আমাদের মনন, সৃজন ও ভাবনার Chiasma রচনা করতে, যা রূপ পেত আমাদের বিভাগীয় পত্রিকা ও আলোচনাসভার মাধ্যমে। সেই সভাকে আরও আকর্ষনীয় করে তুলতে আমরা মেতে উঠতাম নৃত্য-গীত-কাব্য পরিবেশনে ও অঙ্কন, বিতর্ক জাতীয় নানান প্রতিযোগিতায় – সঙ্গে থাকত অধ্যাপকদের উৎসাহ ও অনুপ্রেরণা।

আমাদের মনের ঐকতান কখনও বেসুরো হয়নি। নানান সংকটে, এমনকি অতিমারীর করালগ্রাসেও এর জয়ধ্বনি শোনা গেছে। আর তারই মাঝে আমি খুঁজে পেয়েছি আমার নিজের সত্ত্বাকে, আবিষ্কার করেছি আমার সুপ্ত প্রতিভা, ভালোলাগার বিষয়গুলিকে।

আত্মোপলব্ধির এই যাত্রার প্রতিটি মুহূর্তে আমার পাশে পেয়েছি আমাদের এই জৈবপ্রযুক্তি বিভাগকে। এখানে বিজ্ঞান-শিক্ষার দর্পণে দেখেছি জীবনদর্শনের প্রতিচ্ছবি। তাই আজ পাঁচ বছর পর এই প্রতিবেদনের মাধ্যমে আমাদের "BMBT" নামক পরিবারকে আন্তরিক ধন্যবাদ জানাই। ভবিষ্যৎ জীবন এখনও অনিশ্চিত, কিন্তু তাকে দেখার দৃষ্টিভঙ্গি এখন অনেকটা স্থির, স্বচ্ছ এবং দৃঢ়।





Scientific Articles

COVER ARTICLE

Pandemic: A Dark Portal and The New Normal!

Pallavi Chakraborty
Semester IX

Ushri Patra
Semester IX

We had all read about what a pandemic is in some textbook but never in our worst nightmare had imagined that we would have to survive through one. The word “pandemic” has become all too frequent in discussions over the last 1.5 years. This devastating pandemic has affected the whole world and left drastic impacts from which countries are yet to recover fully. It has changed the way of life for all mankind, changed the definition of “normalcy”, and has brought upon an uncertainty in the lives of all. How do we define this powerful word? A pandemic is defined as ‘an epidemic of an infectious disease that has spread over a large region, for instance multiple continents or worldwide, affecting a substantial number of people.

The current COVID-19 pandemic originated in the Wuhan province of China, where pneumonia-like cases were observed during the end of December 2019. The increasing number of cases alarmed the Chinese government. Scientists from the Wuhan Institute of Virology and the Chinese Academy of Sciences could isolate the virus from the Vero E6 cell lines and the Huh cells. The virus was identified early in January 2020, and a few days later its genetic sequence was shared publicly. The virus shared almost 94% sequence similarity with SARS-CoV-1, and on 11th February 2020 ICTV announced the name as “severe acute respiratory syndrome coronavirus 2” or SARS-CoV-2.

The virus quickly spread within different parts of China, and within a short period, the neighboring nations got affected too. On January 20th, 2020, Japan, Thailand and South Korea reported their first case, and on January 21st in Washington, USA recorded its first case. Europe found its first case in France on January 24th, 2020, and soon it spread to eight other countries

within Europe. COVID-19 was then declared as a "public health emergency of International concern" by the World Health Organization. Mortality rate due to the novel coronavirus was rapidly increasing, and by February it had crossed 900 in China. In March, the cases had increased exponentially in all of USA, and Italy was the worst hit nation.

Back home in India, Kerala reported the first case, and in March, cases had significantly increased. Hence, India launched its first lockdown on March 25th, 2020. As cases kept on increasing through April, Lockdown 2.0 followed. Over almost 1.5 years, waves of the pandemic kept lashing across different countries and is still continuing to do so. India suffered the most dreadful blow during the peak of the 2nd wave around April 2021. Mortality increased manifolds, the health system crippled and hit rock bottom, scarcity of oxygen and beds in hospitals kept on increasing, and the crisis was nothing short of a nightmare.

During this time, if it was not for the frontline-workers, we would have never seen the clear light of day. The doctors and nurses worked tirelessly in hospitals, wearing the gruesome PPE kit to help COVID patients and provide them with the best treatment. They are the real heroes who dedicated their time solely to serve the ailed and couldn't even visit their own homes for days, in fear of transmitting the virus.

This also led to a paradigm shift in all the other major sectors of the society. Under the light of lockdown and social distancing measures, schools and other educational institutes were closed for an extensive period of time leading to the emergence of Online Teaching/Learning as the only panacea. However, due to absence of digitalization and developed networks in several pockets of the country, a section of students was completely deprived of basic education. Limited movement and impaired interaction with friends and teachers have led to physiological and emotional distress. As the rural children were deprived of the mid-day meals, many showed malnourished development and weaker immunity, adding to the existing crisis.

Barring the IT sector where work-from-home was still prevalent, the economic sector suffered a terrible setback, sparking fears of economic crisis and recession. Workforce at the work places got reduced due to travel restrictions and forced people to go jobless. People suffering from various chronic medical conditions or acute deadly diseases other than COVID-19 added to the collateral damage. Medical professionals were not always present to attend to their needs, and thus the mortality rate kept increasing exponentially.

Surprisingly, the extensive use of internet during lockdown emerged as a boon in disguise when the youth of the country started using this platform to spread awareness, providing key

information about the availability of oxygen cylinders, medicines, hospital beds and quarantine homes. It became one of the faster procedures to get hold of essentials in cases of emergencies. NGOs, local clubs and institutes, all stood together as the a strong pillar to fight against the pandemic.

With one of the largest RNA genomes and 4 major structural proteins [Spike proteins (S), Envelope proteins (E), Membrane proteins (M) and Nucleocapsid proteins (N)], developing a vaccine against the virus was a great challenge. The rate of mutation for the spike protein gene was so high, that when finally potential candidates for vaccines such as Oxford University's adenovirus vaccine, Sinovac's CoronaVac, Novavax and Moderna's mRNA vaccine emerged, it was the first ray of hope against the deadly pandemic. Over time, many other vaccines like Covaxin [developed by Bharat Biotech in collaboration with the Indian Council of Medical Research (ICMR) - National Institute of Virology (NIV), Pune] have been produced, and increasing vaccination rates have changed much of the scenario towards normalcy.

While different facets of the society are starting to adapt to the evolved surroundings, the evolution of the global research culture is worth a mention. Covid-19 has prompted an explosion in preprints, focused on the need of fast and large-scale clinical trials, and the origin of all these can be traced back to a superior, united motive: "To find a cure for the Virus". Procedures such as mandating a way of sharing data among the researcher community with proper expertise has been looked upon with greater importance. In order to expedite the publications of studies for COVID-19, the peer review process of scientific journals have been accelerated. This has helped in drastically quickening up the research process of therapeutics and vaccines related to Covid-19.

Research focus has shifted mostly towards COVID-19, and reputation of the pharmaceutical industry has also increased by multiple folds. People, in general are more aware of how certain research procedures take place. The words of Francis Collins, the director of National Institutes of Health best sum up the role of Science during the pandemic: "We did science in ways that people did not think we could, driven by this sense of urgency, which we all say that every day counts. This is a pandemic that is taking lives and destroying economies, and there's no excuse for anybody arguing for delay."

Even though this pandemic seems to be one of the darkest periods for mankind, there's always light at the end of the tunnel. People have struggled but survived this pandemic and are acclimatizing themselves to the "New Normal", one day at a time. Masks and sanitizers have become a part of daily life. The bloom of the online platform has opened up avenues which were

never known. Lockdown has gifted us a much purer and greener environment. With the pandemic almost changing into an endemic, it's now our responsibility to keep moving forward and build a better tomorrow.

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The Wonderful Mind

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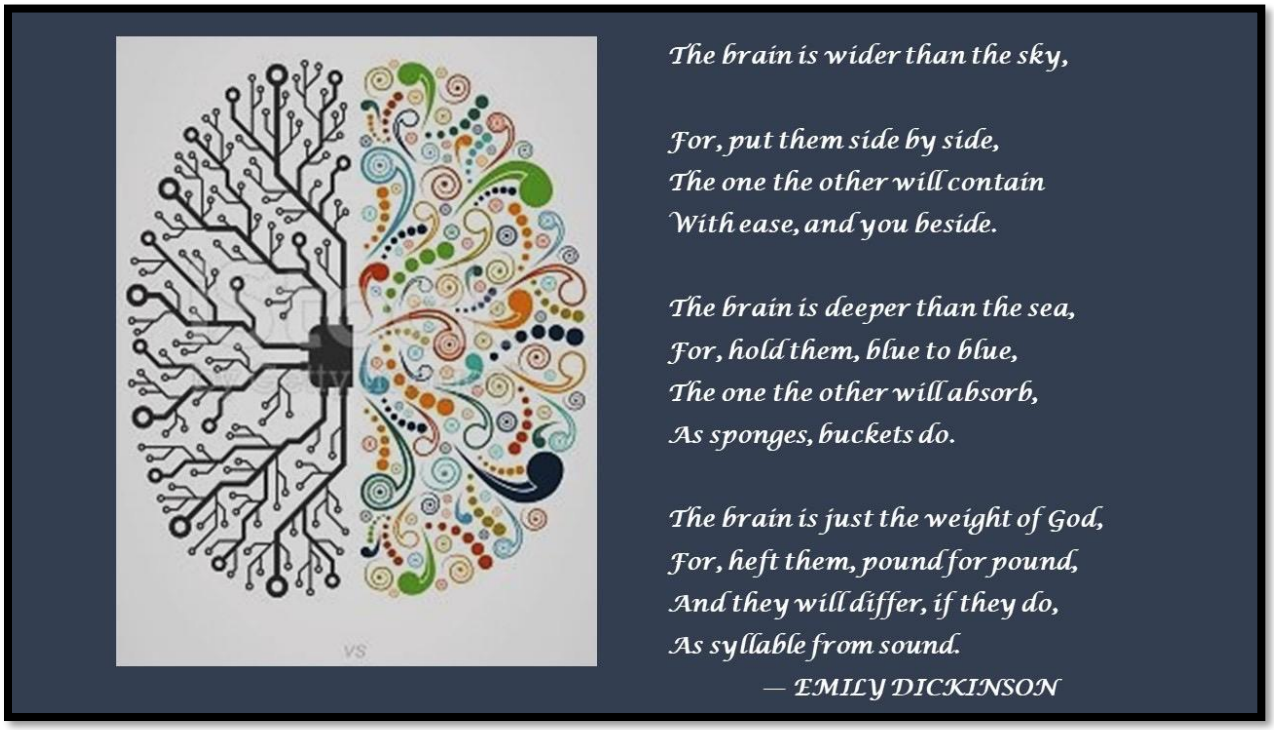


An interview with Anil Seth, Professor of Cognitive and Computational Neuroscience at the University of Sussex was published in the August issue of the newspaper, The Guardian. In this interview he expressed the concern that we risk not understanding the central mystery of life - that is, of not understanding how the brain relates to conscious experience. In his new book, Being You, he proposes an idea of the human mind as a "highly evolved prediction machine", rooted in the functions of the body and "constantly hallucinating the world and the self" to create reality. In 1995, the cognitive scientist David Chalmers had coined the term "the

hard problem" to describe the question of why and how our brains create subjective, conscious experience. Even with advances in neuroscience and brain imaging techniques, large parts of that fundamental relationship between the physical matter of the brain and the conscious mental activity that it creates, remain stubbornly mysterious. Prof. Seth however believes that statistical models and mathematical methods can be developed for characterizing things such as emergence and expresses faith in the straightforward materialist approach of understanding how the brain relates to conscious experience. He is impressed with the pace at which Artificial Intelligence is capable of mimicking and organizing perception along with the advent of natural language processing machines. He is however skeptical about whether it would be possible to build an AI system or a robot that does subjectively experience having a self that is the sense of the "I" and "me". This therefore brings us to the question of whether the metaphoric use of thinking about the brain in terms of a computer is appropriate or not.

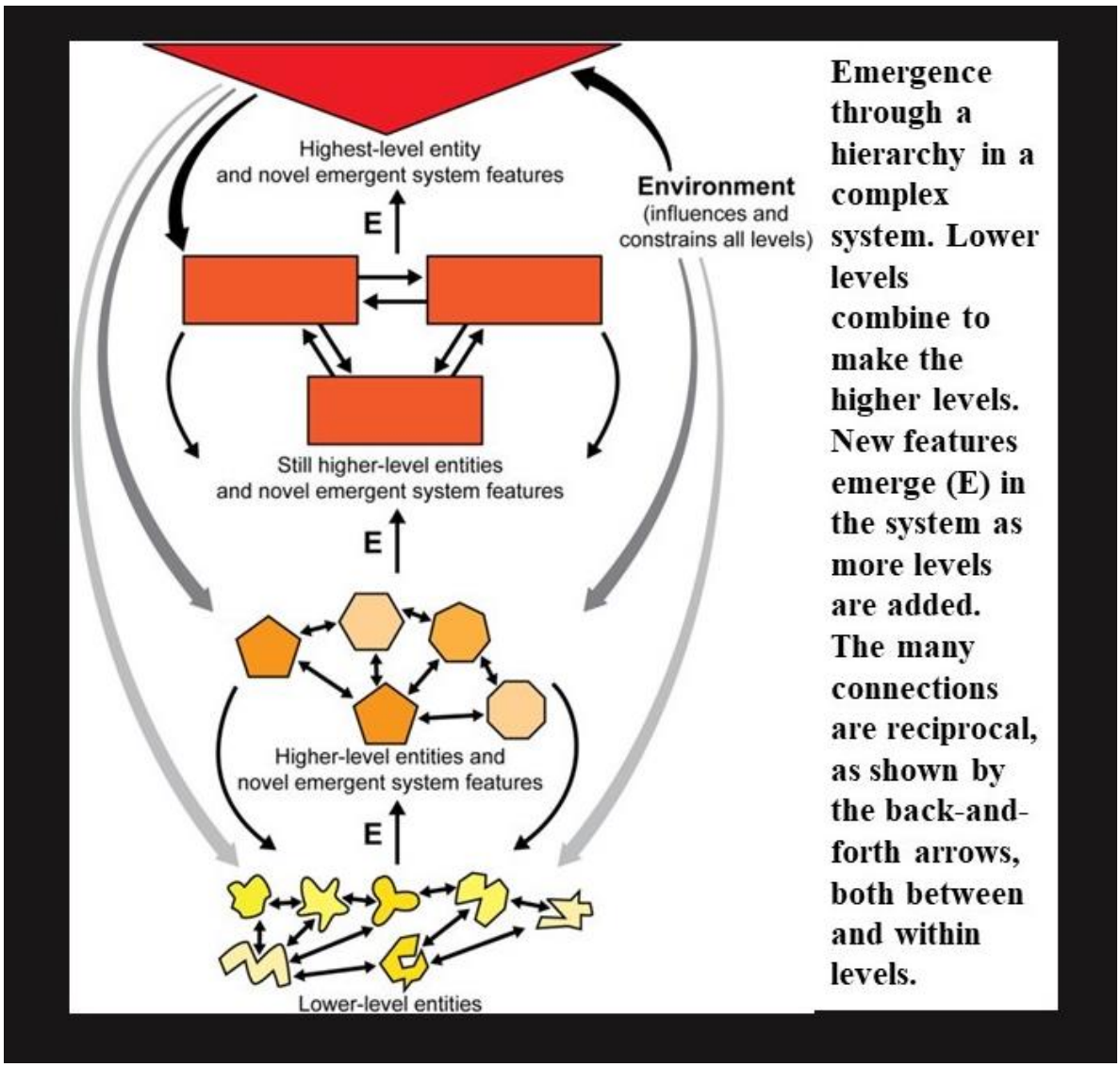
Matthew Cobb, in his book "The Idea of the Brain" brings forth several arguments against the above contention. This dismissal of the metaphor has been taken even further by the French neuroscientist Romain Brette, who has challenged the most fundamental metaphor of brain function: coding. Since its inception in the 1920s, the idea of a neural code has come to dominate neuroscientific thinking. Brette's fundamental criticism was that, in thinking about "code", researchers inadvertently drift from a technical sense, in which there is a link between a stimulus and the activity of the neuron, to a representational sense, according to which neuronal codes represent that stimulus. However, how the "downstream structures" that have access to the optimal way to decode the signals and actually process those signals is unknown and is the problem that remains unaddressed even in simple models of neural network function. According to the Hungarian neuroscientist György Buzsáki, the brain is not simply passively absorbing stimuli and representing them through a neural code, but rather is actively searching through alternative possibilities to test various options. From this he concludes that the brain does not merely represent information, it also constructs it. Further, the metaphors in neuroscience of thinking of brain function in terms of computers, coding, wiring diagrams are partial since the neuron is not like a binary switch that can be turned on or off forming a wiring diagram but instead respond in an analogue way, changing their activity in response to changes in stimulation. The nervous system alters its working by changes in the patterns of activation in the networks of cells that is composed of large numbers of units - it is these networks that channel, shift and shunt activity. In addition, unlike a computer in which the software and hardware are separate, our brains and our minds consist of what can best be described as wetware, in which what is happening and where it is happening are completely intertwined. Unlike any device we

have yet discovered, the nodes of the neuronal networks are not stable points like transistors or valves. Sets of billons of neurons constitute the human brain. How such a system can respond consistently as a network over time and understanding even the simplest of such networks is currently beyond our grasp.

There is also significant debate amongst those who think consciousness is all internal to the body and claim that it involves our bodies and objects we engage with and those who say our experience is external that is one with the things experienced. Neuroscientists are almost all internalists. Christof Koch in his book "Consciousness: Confessions of a Romantic Reductionist" claims that we are our brains and that knowledge of brain "wiring" and activity will eventually allow us to know what a person is thinking by examining brain activity. The renowned scientist Francis Crick, the co-discoverer of the DNA double helix, looked at the problem from an evolutionary perspective and considered the brain to be an integrated, evolved structure with different parts of it appearing at different moments in evolution and adapted to solve different problems. Daniel Dennett, one of the most celebrated contemporary internalist also builds an evolutionary view of consciousness as something organisms developed due to their "intentional" engagement with the world and is a phenomenon made infinitely more powerful in humans, because of the discovery of language.

The application of the idea of emergence to explain phenomenal consciousness has also appeared in recent studies. It is believed that the feature of emergence might be especially important for analyzing the creation of consciousness and fulfil the explanatory gap that lies within a scientific framework. Emergence occurs when novel entities and functions appear in a system through self-organization. Modern formulations of emergence stem from efforts to understand the nature of life in the early part of the twentieth century, when it was realized that both the then-dominant hypotheses were scientifically inadequate: namely, vitalism (a mysterious life force) and reductionism (life can be explained mechanically as the mere sum of its parts). With the concept of emergence, scientists were capable of relinquishing the idea of vital forces and also deny that life properties can be fully reduced to the mechanics of their parts. Instead, they embraced a layered picture of nature consisting of ascending and interacting levels of increasing organizational complexity (Figure below), with each higher level depending in part upon, but inexplicable in terms of, the properties of lower levels alone The major features of emergence are that it is a property of complex systems, with many interacting parts in which there are aggregate system functions that are not present in the parts alone. Novel properties emerge in such a system from the hierarchical arrangement of different levels. Reciprocal connections exist among

structures within and between levels of the neural hierarchy leading to circular causality in which lower levels bring about the higher levels, which then influence the lower levels. The structures within the same level also influence each other via extensive reciprocal connectivity. In such a system the external environment can also constrain the whole and the parts.



The proponents of the theory of strong emergence however claim that no known properties of neurons could ever scientifically reconcile the differences between subjective experience and the brain; that is, that the explanatory gap can never be closed. Antti Revonsuo summarizes this position as follows: "Supporters of strong emergent materialism point to the fundamental differences between the subjective psychological reality and the objective physical (or neural) reality. The former includes qualitative experiences that feel like something and exist only from the first-person point of view; the latter consists of physical entities and causal mechanisms that involve nothing subjective or qualitative about them and exist from the third-person point of view or objectively. Nothing we can think about or imagine could make an objective physical process turn into or "secrete" subjective, qualitative "feels." It is like trying to squeeze wine out of pure water: it is just not there, and there can be no natural mechanism (short of magic) that could ever turn the former into the latter".

Exciting articles are published every day with new discoveries that shed light on how the brain works, along with the promise of new technologies that might enable us to solve the problem. And yet there is also a growing conviction among some neuroscientists that our future path is not clear. The current trend of collecting massive amounts of data in expensive, large-scale projects holds the promise of accumulation of enormous amount of data although such big data might not necessarily mean more knowledge or better understanding. Many scientists are of the opinion that in the absence of organizing principles or a theoretical framework for converting brain data into fundamental knowledge and understanding, despite the vast number of facts being accumulated, our understanding of the brain might be reaching an impasse.

Mankind has been reflecting on consciousness from the moment humans became aware. The phenomenon of experiencing the world and whether the world is as we experience it has been central in the minds of philosophers and more recently of neuroscientists. Whether by focusing on simple neural network principles we will understand higher-level organization or some radical new approach integrating physiology, biochemistry and anatomy will shed decisive light on what is going on, whether new comparative evolutionary studies will show how other animals are conscious and provide further insight into the functioning of our own brains, or whether we will accept that there is no theory to be found because brains have no overall logic, just adequate explanations of each tiny parts still lies in the future. However, the journey in such an exploration is bound to be both challenging and exciting. It is pertinent to conclude with a quote from physicist Michio Kaku "The human brain has 100 billion neurons, each neuron connected

to 10 thousand other neurons. Sitting on your shoulders is the most complicated object in the known universe."

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MEA CULPA

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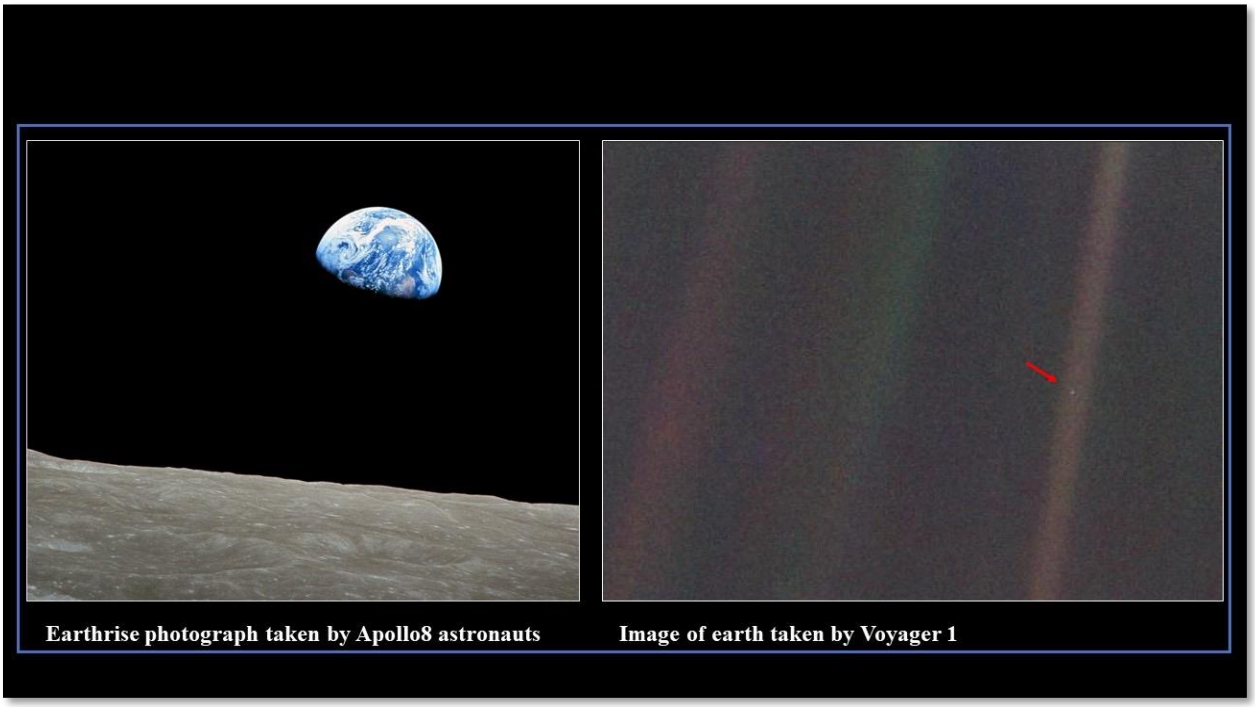
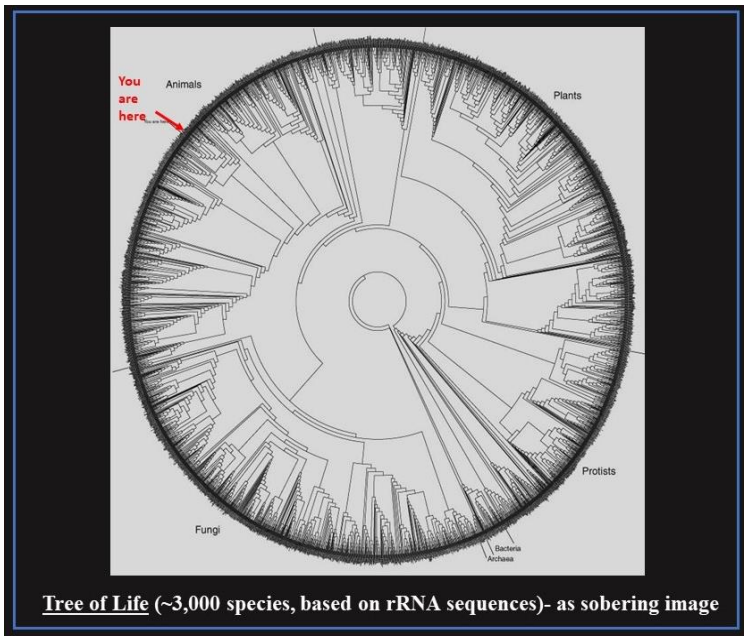
The endeavour of the article is to draw attention to two significant photographs that have been hallmarks of human advancement. Figure 1 shows the famous Earthrise photograph taken by Apollo8 astronauts, 1968 and is the picture of the Earth observed from 240,000 miles away. Jim Lovell, an astronaut who flew on the Apollo 8, has been witness to this spectacle which shows that we live on a tiny rock hopelessly lost in the void, which he describes as a fragile spaceship for 7 billion people and counting.



Earthrise photograph taken by Apollo8 astronauts **Image of earth taken by Voyager 1**

The adjacent is the image taken by Voyager 1 on 14 February 1990, as the spacecraft was departing our planetary neighborhood for the fringes of the solar system and it turned around for one last look at its home planet. Voyager 1 was about 6.4 billion kilometers (4 billion miles) away, and approximately 32^{o} above the ecliptic plane, when it captured this portrait of our world.

Caught in the center of scattered light rays, the Earth appears as a tiny point of light, a crescent only 0.12 pixel in size. Carl Sagan in his book the “Pale Blue Dot” describes it thus – “Look again at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar," every "supreme leader," every saint and sinner in the history of our species lived there --on a mote of dust suspended in a sunbeam. The Earth is a very small stage in a vast cosmic arena. Think of the rivers of blood spilled by all those generals and emperors so that, in glory and triumph, they could become the momentary masters of a fraction of a dot. Think of the endless cruelties visited by the inhabitants of one corner of this pixel on the scarcely distinguishable inhabitants of some other corner, how frequent their misunderstandings, how eager they are to kill one another, how fervent their hatreds. Our posturing, our imagined self-importance, the delusion that we have some privileged position in the Universe, are all challenged by this point of pale light. Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, in all this vastness, there is no hint that help will come from elsewhere to save us from ourselves. The Earth is the only world known so far to harbor life. There is nowhere else, at least in the near future, to which our species could migrate. Visit, yes. Settle, not yet. Like it or not, for the moment the Earth is where we make our stand. It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known”.



Tree of Life (~3,000 species, based on rRNA sequences)- as sobering image

In the Figure 2 we see the phylogenetic tree, created by David Hillis, that depicts the evolutionary relationships throughout the Tree of Life. The tree is from an analysis of small subunit rRNA sequences sampled from 3,000 species that were sampled in proportion to the number of known species in each group. The number of species represented in the diagram is the square-root of the number of species thought to exist on earth (that is 3000 out of an estimated nine million species) or about 0.18% of the 1.7 million species that have been formally identified and named.

This fantastic "circle of life" view of all life retains some characteristics of the tree, but bent around into a circle so that it has no beginning and no end. In the center is the hypothetical organism, ancestor of all living creatures today. All creatures today form the rim of the circle's circumference and in between the rim and the center are the millions of intermediary fossils who once lived on this planet. Your place in the circle is also marked in the Figure. The advantage to this view is that in being represented in the circle, no organism is privileged with being above another. With us humans somewhere in the lineup, the circle of life also better captures the idea that all living organisms today are equally evolved and hence by inference, any organism alive today can boast an unbroken chain of ancestors who have survived the same number of years of 4.5 billion years.

These two illustrations amongst many, are sufficient to jolt us out of the anthropocentric exceptionalism that clouds our judgement. The sense of entitlement that drives the thought that

nature is subservient to the human race needs to be re-evaluated to address the global scale events like climate change that currently face humanity. In this context, one hopes that the article entitled "Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction" that appeared in the June 2020 issue in Proceedings of the National Academy is read not merely as new data but also viewed from a position of accountability. Again, quoting Sagan, "Modern science has been a voyage into the unknown, with a lesson in humility waiting at every stop. Many passengers would rather have stayed home." We hope that we embark in that journey.

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A Tale of City Birds

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Metropolitan cities like Kolkata would appear to be very far from what most people would consider as the ideal abode for birds. When we speak about the habitats of birds, what commonly comes to mind are forests with acres of trees, open expanses of fields, water bodies and the enormous expanse of skies above – all environments relatively unsullied by man and his activities. Kolkata, like most cities, provides a very different environment with skyscrapers of concrete and steel, asphalt-lined roads and air made foul with gases emitted by factories and automobiles. But even within this seemingly inhospitable environment, many birds do manage to make their home.

Birds found in Kolkata do not include only the ubiquitous crow, sparrow, rock pigeon and the common mynah. A multitude of other species is also found in and around human habitations, not just in green havens and water bodies like the Botanical Gardens, Rabindra Sarovar and the East Calcutta wetlands but even in crowded areas in the heart of the metropolis. For instance, the Indian house swift (*Apus affinis*) is perfectly at home in city buildings where it builds its nests; in fact, its preference for nesting in human homes is reflected in its name. This article is dedicated to the birds which I have spotted in and around Kolkata, who successfully cohabit this city of ours with us and do not require only sanctuaries and protected forests for their survival.

Black hooded oriole (*Oriolus xanthornus*)

Barbets with their green bodies, big heads, short tails, and heavy bills, are among the more brightly coloured birds which can be seen. Blue-throated barbets (*Megalaima asiatica*), with their blue throat and red crown, and coppersmith barbets (*Megalaima haemacephala*), with their yellow face, red forehead and breast are frequent visitors to city gardens. All barbets have ringing calls; that of the coppersmith, gives the bird its name. The black hooded oriole (*Oriolus xanthornus*), golden yellow with black head and flight feathers, is another spectacularly coloured bird frequently seen in tree canopies. The Indian golden oriole (*Oriolus kundoo*) is also golden yellow with a black stripe through its eye but lacks the black head of its relative.

The Asian koel (*Eudynamys scolopaceus*) is more frequently heard than seen, with the male pouring its melodious song from dense foliage, often very early in the morning. The Oriental magpie robin (*Copsychus saularis*), the males smart in black and white, has a repertoire of songs and calls and is commonly seen around the city. Rather aggressive, this active little bird does not hesitate to chase away birds much larger than itself. Another aggressive little songbird is the black drongo (*Dicrurus macrocercus*). It is often seen as a dark silhouette perched on wires, fences or poles around meadows, wetlands and fields. Its calls range from chattering and sharp whistles to pleasant flute like songs.

Black drongo *(Dicrurus macrocercus)*

The red-whiskered bulbul (*Pycnonotus jocosus*) with small red ear patches and red undertail coverts and the more solemn looking red-vented bulbul (*Pycnonotus cafer*) with its darker head and red under the tail, can be seen and heard at all hours of the day. The harsh cry of the rufous treepie (*Dendrocitta vagabunda*) has given it its common Bengali name of *hnari-chacha* (pot scraper). Sunbirds- including the purple sunbird (*Cinnyris asiaticus*), the male spectacularly metallic blue and purple, and the purple-rumped sunbird (*Leptocoma zeylonica*) flutter on rapid wings, sipping nectar from flowers. Bee eaters, most commonly the green bee eater (*Merops orientalis*) and the more strikingly coloured chestnut headed bee eater (*Merops leschenaulti*) with its bright reddish brown head, can be seen perched on trees, wires and fences particularly in open areas. Despite the name, these birds feed not only on bees but also consume a variety of insects. Raptors seen in the city include the black kite (*Milvus migrans*), gliding and soaring in the skies while keeping a sharp lookout for possible sources of food on the ground below. Less commonly seen is the shikra (*Accipiter badius*), perched on buildings and tall trees and surveying its surroundings for prey.

Oriental magpie robin (*Copsychus saularis*)

Waterbodies in and around the city have their own wealth of bird life. The little cormorant (*Phalacrocorax niger*) and the Indian cormorant (*Phalacrocorax fuscicollis*), water birds with black plumage, can be seen swimming and periodically disappearing underwater to catch fish.

The little common kingfisher (*Alcedo atthis*), with shiny blue plumage and orange underparts, perches quietly on low branches over water and catches small fish by diving into the water and rising in a shower of silvery droplets. The larger black and white pied kingfisher (*Ceryle rudis*) often hovers over water in search of fish. The white throated kingfisher (*Halcyon smyrnensis*) is brown with a blue back and wings and a prominent white patch extending from its throat to its breast. Less discriminating in its diet than many other kingfishers, it is often found away from water bodies in fields and gardens. The Indian pond heron (*Ardeola grayii*), speckled grey brown with white underparts, frequents water bodies. More uncommon is the black crowned night heron (*Nycticorax nycticorax*), pale grey with a black crown and back.

White throated kingfisher (*Halcyon smyrnensis*)

During the lockdown imposed by the COVID-19 pandemic, I had the opportunity to improve my observation skills, my sighting and hearing. The city was relatively serene and free from pollution which allowed these feathered friends of ours to thrive. For observing and learning about birds, one does not necessarily always need to travel to sanctuaries and national parks. They are right there in the canopy of the trees across the road, in the neighbouring garden, in the park two streets away, around the local water body. All that is required is the wit and the will to see them. We, as a species (*Homo sapiens*), need to play a responsible role towards conserving the other species which cohabit this city of ours. Conservation does not only mean saving large and exotic species in faraway environments; charity can begin right at home even within the

confines of the city. The relationship between humans and birds can and should be symbiotic. All birds need to thrive is a little consideration and a little less interference on our part. The birds themselves have shown their ability, their adaptability to coexist with us. It is upto us to honour this commitment so that our springs, summers, and winters in Kolkata do not fall silent.

[ALL PHOTOGRAPHS TAKEN BY THE AUTHOR]

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"50 Years of Bioinformatics - Looking Beyond"

The pandemic has prevented us from celebrating the golden jubilee year since Paulien Hogeweg and Ben Hesper first coined the term 'bioinformatics'. Since then, bioinformatics has matured into a thriving research field, indispensable in addressing life science research challenges.

The original definition of bioinformatics was not primarily data analysis. Instead, it emphasized the need to study biological systems as information processing phenomena, for example with information accumulation in evolution. Interestingly, with the data accumulation in modern-day life sciences, this information processing perspective is becoming more and more relevant.

Berend Snel (https://tbb.bio.uu.nl/snel/group.html**),** Professor in Bioinformatics, shares his experiences on the subject: *"I was triggered by watching 'Artificial Life' on a Sunday evening in the '90s. I discovered a new way of looking at life. My decision to study biology in Utrecht was greatly influenced by the work and vision of Paulien Hogeweg. During my study sequence analysis was starting to become important, which made the field of bioinformatics even more interesting. The European gold mine of data was available first at European Molecular Biology Laboratory (EMBL) where computational biologists were all pioneering: a.o. Jaap Heringa (Elixir), Martijn Huynen (Radboud University) and also UU honorary doctor Peer Bork (EMBL). It was magic to do my internship there in the nineties. The freedom to play with data and find new knowledge was great! New patterns, new questions, even more new data, new ways*

to look at the same data…The current term 'data recycling'was yet unknown, but there and then bioinformatics became an essential ingredient of Life Sciences."

Adrien Melquiond (https://www.uu.nl/medewerkers/asjmelquiond**),** Coordinator and Assistant Professorin Computational Structural Bioinformatics puts forward his tryst with the subject*"I got annoyed by studying textbooks and I wanted to experience a more data-driven way of learning. Aside my studies I did a long-term internship of three years in a biomedical imaging research group. On the weekends, I went to hospitals to constitute the first database of ~5000 reference cases of foetal malformations, and train a decision support system applied to ultrasonography. Early 2000s, I was developing a machine learning software to help in real time practitioners facing a suspicion of foetal malformation. I really loved it! So, I kept working with data and software development and later got hooked on structural bioinformatics.*"

Berend Snel further opines that : *"The big transformation was the possibility to sequence genomes. Having a genome or not having a genome is key to revolutionary developments such as enabling personalised medicine and targeted breeding, e.g. to realize a new plant race within a few generations. Perhaps even more important on a technological level are all other more recent life science data explosions such as genotyping, transcriptomics, or proteomics were only possible because of the availability of genomes. These new techniques can help us unravel what we cannot see in the cellular system. We thus can assemble new data, and work on even more innovative techniques. The basic principle stays the same, but data are tightly linked to techniques that follow up each other and will rapidly be replaced by new ones. I do sometimes already feel old."*

Another key development which led to the expansion of the field of Bioinformatics was "FAIR data sharing" as observed by Adrien Melquiond:*"More recently, developments in both machine learning and deep learning have been playing an important role in our field. The first bioinformatic breakthrough came from the vision of Margaret Dayhoff, back in the fifties, at a time when data sharing was a hassle. She created the first 'online'database system of protein and nucleic acid sequences, developed tools to interrogate this database and optimized file size with the still used one-letter code for amino-acids. This was the first example of a systematic, smart and well documented way of storing, sharing and querying data! Because sharing data equally'is essential, FAIR data principles have been conceived by pioneering bioinformaticians in a true heritage of Margaret Dayhoff."*

What the future has in store for us:

We have already experienced the power of artificial intelligence in predicting protein structures. In the year 2019; Google's AI firm "DeepMind" reported an algorithm called "AlphaFold (doi: https://doi.org/10.1038/d41586-019-01357-6)," which was established by combining two emerging techniques involving deep neural networks which yielded a set of scores which were then optimised using gradient descent method. The 3D models of proteins that are generated using AlphaFold has been seen to generate, far more accurate structures. The AlphaFold code used at CASP13 is available on Github (https://github.com/deepmind/deepmind-research/tree/master/alphafold_casp13) for anyone interested in learning or replicating the results obtained.

It seems that the next few years in Bioinformatics research would be focused on solving the issues of dark matter (the unknown elements) which is currently a frequently used term in Metagenomic studies. Already efforts are on to produce the complete GAPLESS sequence of the human genome (T2T consortium) and applications of Machine Learning algorithms which are being developed for the processing of images. A good quality image will be processed within minutes to reveal the true identity of the plants; thus, augmenting biodiversity research and real time assessment of data in the field. Digitization and trait extraction followed by comparison with existing holotypes around the world would be achieved within a few moments. The latter will be made possible by the application of Convolutional neural networks (Soltis et al 2020). Plant phenomics and genome comparisons would be augmented by the initiative of Leibniz Institute of Plant Genetics and Crop Plant Research and the German Plant Phenotyping Network who have jointly initiated the Plant Genomics and Phenomics Research Data Repository (PGP) [https://edal-pgp.ipk-gatersleben.de/] as a single infrastructure to comprehensively publish plant research data.

Thus, it seems that the possibilities are endless and the integration of advanced techniques and software applications will allow us to achieve creative solutions using existing data as well as to look beyond the challenges of velocity, veracity, volume and variety that big data analytics poses. Digital Biology and Bioinformatics seems to be the biology of the future.

Forest Fire Disasters: Concerns and Management

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A disaster is normally defined as a severe disruption of functioning of a community or society, causing widespread losses, exceeding the ability of the affected community to carry on beyond the carrying capacity. Any uncontrollable fire responsible for combustion of vegetation is normally treated as forest fire, which may encompass wild fire, brush fire, bush fire and grass fire. Based on the nature of their spread, forest fires may be classified as: (i) ground fire, (ii) surface fire and (iii) crown fire, the last being the most devastating one. Almost 90% of the forest fires are due to anthropogenic causes, either due to agricultural practices or due to early flushing of grass for grazing livestock. In addition, heat waves, drought and cyclic climatic changes such as El Nino can also increase forest fire incidences, affecting the entire ecosystem and livelihood. If we look back to trace the history of forest fire occurrences since the last century, we find that in April 1910, a devastating forest fire swept over the Blackfeet National Forest in northwestern Montana, continuing till August, when fire flames rose hundreds of feet with high velocity of violent tornadic winds, more popularly designated as "Big Blowup", changing history forever. More than three million acres of land and 7.5 billion board feet of timber were totally burnt, with small towns being completely destroyed, thereby appearing as an unparalleled disaster. This was followed by Flathead National Forest fire in 1919, affecting approximately 150,000 acres, followed by Lost Johnny fire on the Coram District in 1926 and Half Moon fire in 1929, north of Colorado, which burnt almost 100,000 acres of National Forest. More recently, the unprecedented wildfire was witnessed in the historic Amazon rain forest in 2019, which was further worsened in 2020, destroying thousands of square miles of the rain forest, imposing a serious threat to the global biodiversity and habitats, and leading to carbon release along with other socio-economic and environmental consequences. A team of researchers from Purdue University used remote sensing strategies like the Visible and Infrared Imaging Radiometer Suite, a satellite-based sensor, to infer that the fire occurrence in 2019 was particularly observed in areas which were substantially deforested a year ago. Such deforestation prominently lowered the moisture content and humidity, while increasing temperature and wild velocity and

detrimentally affecting the canopy cover. Since Amazon forest acts as a trap for global carbon storage, its loss is likely to diminish that storage, adding more and more atmospheric carbon and leading inevitably to greenhouse effect and drastic climate change. Continued fire could lead to massive changes in landscape, turning rainforest into open grasslands or savannas. Another recent observation recorded extensive wildfire, surrounding two million hectares of land in Siberia due to extreme heat generated as a result of temperature increment to 30°C. During 2018, almost 9900 wildfires were noted in Russia, occupying a total area of 3.2 million hectares. The rampant anthropogenic activities and release of greenhouse gases like chlorofluorocarbons and methane in the environment have been considered as the major factors that further aggravate the warming effect. A team of researchers headed by Robert B. Jackson of Stanford University showed in their latest observation that 596 million metric tons of methane emission occurred in 2017. The level reached a record of 1,875 parts per billion in 2019, with a 50 million ton annual increase. This is expected to cause at least 4.3°C rise in temperature by the end of this century. The case of methane seepage in the High Antarctica reported recently, particularly due to permafrost melting as a result of global warming, also stands as an alarming signal, since such unregulated methane emissions are equally competent to catch fire and cause recurrent wildfire in the near future.

According to the Forest Survey of India (FSI), more than 53% of the forests in India are prone to fire attack, with anthropogenic activities being the root cause in 95% cases. The forests in the North Eastern states of India are 50% affected due to shifting cultivation, with Mizoram topping the list. Satellite data images taken by FSI showed that between April 20 and 26 of this year (2021), there were as many as 2,671 massive forest fire points, which originated from South Lungpher, a small village near the Myanmar border of Lawngtlai district in southern Mizoram, and spreading to the towns and villages of two neighboring districts, viz., Lunglei and Lawngtlai. Integrated forest fire management (IFFM) constitutes a systematic approach, encompassing the traditional efforts of fire prevention and fire suppression, along with the enforcement of forest law. IFFM provides certain guidelines, containing seven categories regarding fire management practices for tropical countries, and develops functional programs or recommended actions to deal with the problem. Depending on the local situation, it needs to be decided whether the recommended actions would be implemented as they are, or need to be modified, or considered unfit for application. Integrated forest management policies should also be framed to regulate environmental and economic activities, engage stakeholders and implement more sustainable forest practices. Issues like lack of public engagement and weak enforcement to curb illegal deforestation need to be properly addressed by harmonizing adequate policies at the international and national levels. The Ministry of Environment and Forest, Government of India, has prepared

a National Master Plan for forest fire control. This plan proposes to introduce a well-coordinated and integrated fire management program by encouraging people participation through Joint Forest Fire Management for fire prevention. It has also advocated the development of a National Fire Danger Rating System and Fire Forecasting System in the country for fire management, along with refining of the remote sensing technology for fire detection. Last but not least, if we really have sincere intentions to mitigate disasters arising out of extensive forest fire in future, we should have a genuine record of the actual forest cover at present in our country, the true reports of which are suppressed in most of the cases due to political reasons.

Positive Verve: Contemplating Positively on Positive Thinking

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Let us not think of life hereafter or bodily resurrection. Let us think of our transformation in this world itself with respect to holistic existence. According to existing religious beliefs, our life in this world constitutes a trial, an examination period, during which we prepare ourselves for the next life of infinite duration. But we, metacognitive beings on this globe, lie tormented with the horrifyingly loathsome surroundings and companions embracing negative energy or vibes with inescapable unawareness. It is a mandatory commitment, not only to make ourselves happy, but also to spread the positive vibes in people and surroundings we stay and associate with.

The best-selling books like '*The Secret*' by Rhonda Byrne and '*Chicken Soup for the Soul*' by Jack Canfield and Mark Victor Hansen teach us that we can make good things happen just by thinking positively, and that positive-minded folks are healthier and more dynamic and productive. Everyone goes through difficulties and trials. However, there are some people who are able to withstand even the most inconceivable problems and come out smiling at the end. It is a completely different outlook on a particular situation, just like viewing that streak of light beside the ferocious thundery clouds, and it has nothing to do with the circumstances that they are in.

Our body is made up of electronic vibrations. Each cell or a unit of life in itself has the capacity of reproducing itself. When any cell of the body becomes deficient in its required electronic energy, an equilibrium that is necessary for the sustenance of its reproduction, the manifestation may show up in the form of a disease, accentuated by external forces. The key players behind our emotional turbulence are conscious and subconscious feelings of the mind. Mindfulness meditation unlocks the door between the conscious and subconscious minds. Life energy, also called '*prana'*, or '*chi'* is the life force having magical power. Interestingly, it can't be measured via any technical instrument, but its existence is known to all. Without energy, life becomes a burden and then, it is necessary to recharge our cellular batteries. We are all electromagnetic beings; rather a series of interacting multidimensional energy fields. In the brain,

we have magnetite, a permanently magnetic form of iron oxide, so that brain cells respond to external magnetic fields. In acupuncture healing, the energy patterns of the acupuncture meridians simply correspond to the organic disorders and fundamental problems of affected individuals. Reiki is another form of alternative healing whereby, the energy blocks causing ailments can be removed and the overt flow of energy may be improved.

Energy medicine, the healing art of the modern century, therefore, simply works by eliminating the causes behind the myriad symptoms manifested in the form of a disease. Vibrational Medicine or energy healing represents the positive healing formula based on various energy principles and interventions involving the mind, body, and spiritual attributes. Even conventional medicine has arrived with certain energy methods of treatment, encompassing therapeutic radiation to treat cancer and electromagnetic fields to stimulate healing of fractures. However, the energy utilized in vibrational medicine exists in frequencies far beyond those tracked with conventional detection tools.

In the case of the hierarchy of organization, human beings are composed of cells, organs and systems, representing the structural levels while metabolic substances, enzymes and hormones, denote the biochemical level. Our thoughts represent our mental level while our feelings designate our emotional level. The meridians, chakras, and aura denote our energetic level, while our soul represents the spiritual level. So it is vital to nourish our organs such as the brain, heart, liver, and even, our soul. Real happiness is the manifestation of balanced energy flow pervading us. Recognizing the darkness in us and transforming it through healing activity, gives us the strength to change from a negative thinker to a positive thinker.

Various religious cults believe in the existence of '*Aura'*- the body of light or an existing energy field that surrounds living creatures. Ancient Egyptians strongly believed in the concept of the aura. While conducting certain scientific experiments, Nikola Tesla noted that human bodies were glowing under certain conditions. His belief can be perceived in his famous quote, "*If you want to find the secrets of the universe, think in terms of energy, frequency and vibration*." The aura, which is connected with the activity of the '*chakra'* or energy wheel reflects one's state of consciousness. Accordingly, the aura colors inform us about one's quality of consciousness and corresponding vital energies. The more positive mind we possess, the more our aura sparkles. Choa Kok Sui developed the method of '*Pranic Healing'*, one of the energy healing systems, shown to have immediate positive benefits on people, complementing conventional medicine. The acupuncture meridians, the chakras, the etheric body, and other higher organizations are portions of our multi-dimensional composition. A unique form of cancer

therapy known as '*Simonton Method*' is based on the mind-body connection, originally developed by Carl Simonton, whereby the mind-power, through meditation and mental imagery, was utilized to gain control over the patient's immune system to actively eliminate the cancerous cells from the body. Carl Simonton observed that positive- minded patients generally lived longer and exhibited fewer side effects of cancer therapy.

When our bodies are in resonance and producing positive vibes, we are in harmony. We have the capability to match the vibration of the globe and become consistent with the universal patterns. Positive vibrations denote high-frequency cognitions while negative vibrations designate low-frequency thought processes. In the fascinating book '*Becoming supernatural: How common people are doing the uncommon*', Dr. Joe Dispenza, the famous neuroscientist mentioned, "*The only way we can change our lives is to change our energy, to change the electromagnetic field we are constantly broadcasting. In other words, to change our state of being, we have to change how we think and how we feel*."

To remain healthy mentally as well as physiologically, we need to rely on harmonistic and holistic healing customs, along with mainstream medicines. A perfect harmony of positive vibes at every level of our existence needs to be maintained. Our mind has a great impact on the biomolecular mechanisms regulating our physiology and metabolism. The super bio-computer brain needs the conscious programmer called the *soul* to instruct the nervous system to perform its duties efficiently. Science is yet to recognize this spiritual domain, our so-called elusive energetic framework.

"You are Smiling, All Dressed Up; How can you be Depressed?"

Parama Mitra
Batch of 2016-21

"Why are you always sad?", "Why do you have mood swings so often?", "It's just a phase, you will get over it soon", "Why do you panic so much?", "Why do you need to go to a psychologist? Are you crazy or what?"

These comments are nothing new for patients suffering from psychological disorders. A huge fraction of the world's total population gets diagnosed with mental disorders every year, nevertheless a lot of cases go unreported due to the public stigma surrounding mental health. This is also a prime reason behind the inadequate attention and treatment received by the patients. Several psychiatric disorders even lead to the development of suicidal behavior.

Susceptibility to psychiatric disorders, just like any other physical health problem, is controlled by a lot of factors, including genetic, environmental and physiological ones. Structural and functional changes in the brain, and neurotransmitter imbalances have long been associated with the development of these disorders. Abnormalities in the abundance and improper functioning of the hypothalamic-pituitary-adrenal (HPA) axis, neurotrophic factors, sex steroids, inflammatory cytokines - all lead to altered gene expression, epigenetic changes, neurotransmitters and intracellular signaling that amounts to disrupted neuronal function in these cases.

One very important and widely studied protein involved in the major depressive disorder is the Brain Derived Neurotrophic Factor (BDNF), which is involved in the activity-dependent formation and maintenance of synaptic connections. Expression of the *BDNF* gene has been found to be significantly reduced in patients diagnosed with depression. A human BDNF polymorphism, Val66Met, is known to block the processing and release of mature BDNF, causing neuronal atrophy in the hippocampal and prefrontal cortex of brain in mice carrying this allele. When subjected to early life stress or trauma, carriers of this allele are at an elevated risk of developing depression. Considerable differences in DNA methylation levels of the CpG

islands of promoter I and promoter IV of the *BDNF* gene have been observed in healthy individuals in comparison to depressed individuals, and higher methylation of the promoter VI has been observed in depressed patients with a history of suicide attempts. The DNA methylation status of *BDNF* gene promoters has been shown to serve as a biomarker in psychiatric disorders. In mice models, a remarkable increase in the H3K27 dimethylation (H3K27Me2) in promoters P3 and P4 has been observed. In a study, reduction in BDNF expression was observed due to elevated Histone Deacetylase (HDAC) expression, which reduced H3K14 acetylation at exons 1, 4, 6 and 9. Factors such as sex differences and metabolic disorders like diabetes also affect the regulation of BDNF expression in depressive disorders.

Psychiatric disorders contribute a huge chunk to the global burden of diseases. It is difficult to exactly point out the reason for their onset and development, but psychological stress and trauma can act as strong triggers. Although psychotherapy, counselling methods and antidepressant treatments do help in treating depression and other disorders, these are not permanent cures. Extensive molecular, structural, genetic and epigenetic studies are being carried on, which might open up avenues for more reliable therapeutic strategies in the future. Till then, the least we can do is to be more sensitive and inclusive towards people suffering from these psychiatric disorders and refrain from making their life more miserable by stressing them out unnecessarily and passing hurtful and judgmental comments about them.

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The Jujurana

'Juju' meaning bird and 'rana' meaning king– hence 'Jujurana' means the 'King of the birds'. According to local legend, this bird has been created by God, with a feather each from all the birds in the world and is said to carry all the colours in this universe. We commonly know this bird as the 'Western Tragopan' or the 'Western horned Tragopan' (*Tragopan melanocephalus*). It is endemic to the Western Himalayas, and it has a disjunct global distribution ranging from north Pakistan through Jammu and Kashmir, Himachal Pradesh to the Bhagirathi basin in the northern part of Uttarakhand. However, during my dissertation project on Galliformes of the Bhagirathi basin (as part of a study by the Wildlife Institute of India, yet to be published) we did not detect any tragopan species in the entire basin by multi-year thorough camera-trapping exercise. This is indicative of a sad state of affairs - range shift due to global climate change (H. Singh et al., 2020) which has already begun and is not something we are waiting to witness in the distant future.

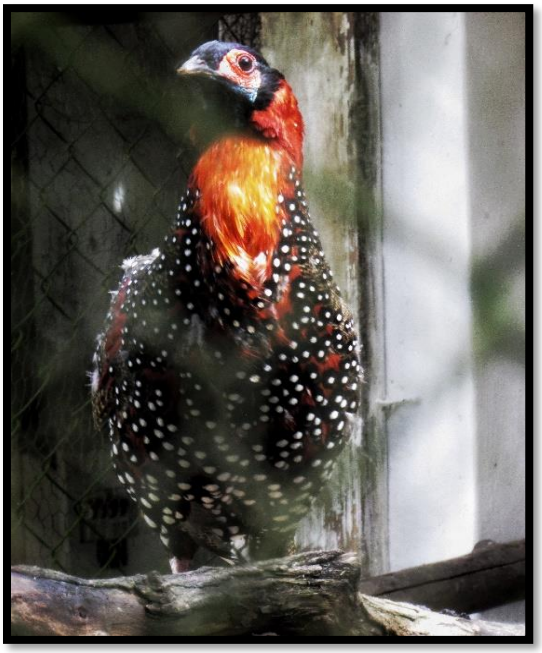


Figure 1: Western Tragopan (Male)

My introduction to these brilliantly plumaged pheasants started in a dark auditorium of Gorky Sadan, Kolkata, when Munmun Dhalaria's "The Jujurana's Kingdom" was screened at the IMF Mountain Film Festival. Little did I know that I would be fortunate enough to get a chance to work with them someday. My close acquaintances are aware of how terribly I crave to be in the mountains, and invariably consider conservation of the Himalayan landscape a top priority. To enjoy the mountains, the same should exist in its pristine glory!

Amidst the gloomy lockdown, a webinar by Narsimha Ranganathan - a former zoo biologist at the Sarahan Pheasantry, showcased footages of the mating dance

by a male tragopan and I kept wondering how nice it would be if I, too, could be doing something similar that would combine my passion with my profession? This thought triggered something inside me while I was watching a few scientists doing some serious rock climbing on a dormant volcano in search of a rare frog in Africa and fast forward a little over a year and here I am now, sitting in the forests of the Sarahan Beat, amongst the calling cicadas!

Figure 2: Western Tragopan

Starting as a rescue centre of Himalayan pheasants (occasionally housing mammals as well) in 1990, the Sarahan Pheasantry was transformed into a conservation breeding centre (SCBC) for the Western Tragopan in 2007 with support from the Central Zoo Authority and the Himachal Pradesh Forest Department. A quiet forested trail behind the Bhima-Kali temple leads up to the pheasantry, at an altitude of 2274 m. Sarahan was the summer capital of the erstwhile state of Bushahr which surprisingly extended upto the Nelong valley till early 1900s. The close proximity to the natural habitat of the pheasants provides the best possible conditions for rearing these remarkable birds which are habitat specialists. The adjacent Daranghati WLS has a significant population of wild tragopans. The Rupi-Bhaba WLS on the opposite side of the Sutlej River is the only other sanctuary that has known Tragopan population within the Sarahan Wildlife Division. Their scarce distribution and low numbers in the wild have led to their rightful inclusion under the 'vulnerable'(VU) category of the IUCN Red List. The goal of the breeding programme was to prepare a backup population of western tragopans which can be restored in the wild. After initial setbacks, the centre has successfully been able to breed the tragopans and at present, we have 50 individuals at the pheasantry. Besides the tragopans, it also houses two Himalayan monal (*Lophophorus impejanus*) and one Kalij pheasant (*Lophura leucomelanos*) for public display. The pheasantry is open to visitors round the year except in the breeding season (April-July). We also have assisted rearing facilities for incubator-born and mother-abandoned chicks.

Figure 3: Western Tragopan chicks: 3 months old Leo (left) and 2.5 months old Peo (right). Usually, the sex of the chick can be determined visually only after 6-7 months, but Leo has started showing male feathers early. Peo is still unidentified.

The quaint place of Sarahan was busy packing apples when I arrived there. It is a place where everyone knows everyone else and even most of the people from villages several kilometres afar. Similarly, they assumed I must be knowing every other Bengali from Kolkata. How simple their world is! They embraced me like family and within a fortnight I had two mothers and several brothers and sisters who were ready to turn up immediately in case I ran into any trouble.

"*Koi baat nahi beta, yahan bhi tera ek maa hain*", never fails to make me teary-eyed. Archana and Sunita's playful quarrel over who has greater rights over *bhaiya* sometimes made me reiterate Rajnish's thought - "*Ghar me bhi aapki itni izzat nahi hogi shayad*". Deep down we all know that *apne ghar me kisi ke bhi izzat nahi hota hain*!!! - I chuckle thinking about it.

I am sure I can call the Himalayas home, owing a lot to these wonderful people without whom the stories would always remain incomplete. While patrolling the upper reaches of Jadgi, we came across the nomadic Gujjars who were stuck between retaining their traditional forest rights and relocating. The ill-informed collector had issued them papers regarding land ownership despite thearea being included in the Daranghati WLS since

Figure 4: Gujjar kids have started going to school and want to change their destiny

2012. They were still waiting for the territorial and wildlife division to resolve the issue and were willing to relocate, provided alternate land allocation was done. Since they'd been staying in these forests for years, they were allowed to stay until their relocation is done, but as sanctuary guidelines state, they will not be able to make any permanent structures. Ismail was exclaiming, "*Humare bachcho ko aisi zindagi thori na jeeni hain?!*" and hence wanted the process to hasten.

Figure 5: Enclosures at the Sarahan pheasantry mimicking the natural habitat of Western tragopans as much as possible

Any conservation programme will be successful only when we can release the individuals in the wild and they survive to re-establish the wild population. The second phase of the re-introduction programme that started in 2020 is now underway. Two families (2 male, 2 females, 2 chicks) will be released as per IUCN guidelines (2009). The adult birds will be tagged with UHF tags and will be soft released in pens (solar fenced to keep away predators) for 15 days before finally being released into the wild. Predator training is to be imparted before the final release. Post-release, the birds will be constantly monitored using a Yagi antenna-connected pinger and base station. Last year, some peculiar movements of the birds were observed as most of them descended towards human-dominated areas and crossed the river Sutlej. Instead of using conventional habitats with dense understory (Delacour, 1977, Grimmett, et al., 1998, Ramesh, 2003), they used open spaces and were easily detected by predators. The homing tendency and bad weather might have forced them to descend. This year, certain changes have been made in the release site in order to reduce the chances of the released bird descending to human-dominated areas. Once successful, we aim to replicate the programme in other areas where the historical presence of this species has been recorded or areas with suitable habitats that can support a viable tragopan population.

One interesting thing we have noticed in our pheasantry stock is that the oldest females have started changing colours to male-like plumage, a phenomenon known as sex reversal. There is no reported case of sex reversal in tragopans. Birds mostly have only one functional ovary (left) which when damaged turns off the oestrogen control over Z-factors (male determining factors) which forms the basis of Z dosage hypothesis of avian sex determination (Chue and Smith, 2011; Ayers et al., 2013). The hormonal factor determining secondary sexual characteristics points to the theory of equipotentiality which assumes that male and female tissues react identically to sex hormones (Lillie, 1927). Rani, a 16-year-old female has completely changed its plumage to that of a male while Shalu, a 14-year-old, has started to show the transition to male plumage. These two are the oldest females in our stock and are absolutely disease-free. Atrophy of gonads in old birds (Keymar, 1980) seems to be the only possible reason (subject to investigations) for this. Wild birds have an average life span of 4-5 years, while in captivity, they are surviving long enough to showcase such anomalies!

Figure 6: Shalu (left)- 14-year-old female, started to show red colouration around the throat; Rani (right), 16-year-old, has already

Home / India / Himachal: Born in captivity, six Western tragopans released into the wild

Himachal: Born in captivity, six Western tragopans released into the wild

Addressing the team involved in the reintroduction, state Forest Minister Rakesh Pathania said that this is the first such reintroduction of Western tragopans anywhere in the world.

By: Express News Service | Shimla | October 10, 2020 12:28:47 am

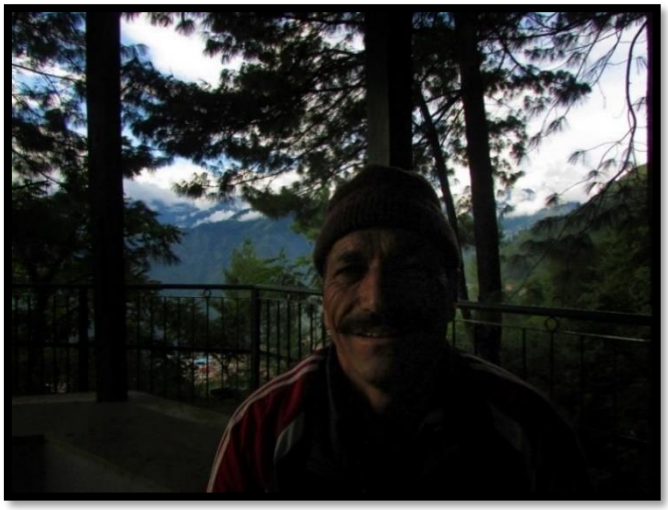
ADVERTISEMENT

Figure 7: Our first attempt in 2020

Roshanlal Dogra, who is serving the birds for 26 years now, was very sad when the released birds failed to survive. He said, "*humne inko apni bachche ke tarah pala hain*".

Figure 8: A UHF tag, a pinger/receiver, a basestation (left to right, bottom) and a Yagi antenna (top) are primary ingredients for monitoring the released birds by radiotelemetry.

He doesn't want to see them die anymore, unaware of the fact that reintroduction success is not achieved so easily and is almost always accompanied by casualties. The tremendous hard work the pheasantry staff puts in round the year motivates us to work even harder to try and not nullify their efforts. Life is very hard in the mountains, and it becomes even harder as winter arrives, but as they say, "*Asli maza to sardiyon me hi hain*". As we aim to achieve greater survival rates this year, learning from last year's results, I am now gearing up to face my first winter in the Himalayas!



A green warrior!

N.B. All the images were clicked by Sagnik Nandy and should not be used anywhere else without permission.

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The Sound of Silence

Arkopriyo Banerjee

Semester IX

Introduction

We all yearn for some peace and quiet away from the daily hustle and bustle of life. Some take vacations to secluded places while some confine themselves to their rooms tucked away under their blankets, with headphones on. But are these the quietest places on earth? Well, no, because the quietest place on earth is an anechoic chamber. It is literally so quiet that a person can hear blood rushing through their veins, beating of their heart, the grinding of the bones due to movement and various other sounds made by the body which would be impossible for us to register normally. It can be a frightening experience and can make people lose their balance and feel uncomfortable, so much so that they want to escape as soon as possible. Ironical, isn't it?

What is an anechoic chamber?

Anechoic means there will be no echo and no reflection of sound. Echoes, reflections of electromagnetic and/or sound waves are fully absorbed by an anechoic chamber. Such a chamber has been built by Microsoft at its headquarters in Redmond, Washington. The structure has been designed in such a way that all external sounds are cancelled out, and all internal sounds are completely stopped. It is a downright eerie experience as even clapping of sounds do not make any noise. The room's background noise is so low that it theoretically approaches the absolute zero of sound, as predicted by mathematicians; the next step down is a vacuum, or the absence of sound. It's constructed of six layers of concrete and steel, and it rests atop a series of vibration-damping springs, which isolates it from the surrounding structure. Inside, sound waves are broken up by fiberglass wedges installed on the floor, ceiling, and walls before they can reverberate back into the space. The floor is nothing more than a grid of sound-absorbing wires hung from the ceiling. The noise level inside was recorded at -20.3dBA which is 20.3 decibels below the normal human hearing threshold.

The Human Perspective

The human ear can detect sounds above 0dbA but in this chamber, the ambient sound is so low that humans can perceive surroundings devoid of sound which is terrifying in more than one way. The sound of breathing is generally at 10dbA and this chamber goes way below that! It is a rare sensorial experience where people due to absence of ambient noise can detect the faintest of

sounds. Every bodily movement generates a sound that seems too loud, as one can hear the ringing in the ears, gurgling of the stomach, friction between the bones, beating of their hearts and blood flowing through their neck and veins. People start to lose their sense of balance and need help to reorient themselves or stand properly.

What is the utility of such anechoic chambers?

The chamber's sole purpose is not to listen to rumblings and gurglings within the body rather, it has a wide variety of applications. Noises and sounds from a wide range of products are often tested in anechoic chambers with a high degree of scientific credibility. Microsoft utilizes it to analyze clicks and hums from computing devices including keyboards, mouse, fans, and backlight modules on touch panels and displays, as well as audio equipment like microphones, receivers, headphones, and speakers. The Surface tablet series, Xbox game consoles, and HoloLens VR goggles are among the devices that have benefited from the chamber, as well as software with a strong audio component, like as Skype and the Cortana virtual assistant. NASA uses these chambers to train astronauts for adjusting to silence they might face in space. Another anechoic chamber at Orfield labs has attracted various medical devices for testing within the silent room like hearing aids, heart valves, medical defibrillators, sleep-apnea machines, while it has shown promise in medical research involving neurodegenerative diseases like dementia, ADHD, autism, and schizophrenia.

Conclusion

When everyone is searching for some peace and quiet these days where loud sounds from machines and modern society are enveloping the planet, these chambers seem to a boon to us. But too much of anything is not desirable, as most people want to leave these chambers after seconds to few minutes. There is no "World Record" as such for staying the longest in such a chamber, but Microsoft has recorded it to be a maximum of 55 minutes! Nevertheless, spending a few moments inside an anechoic chamber is a rare experience but the search for peace might drive people crazy!

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“To edit or not to edit, that is the question.”

Arunima Bhattacharya

Semester IX

An overview of two documentaries, a film and a book based on gene editing tools, and their implications in the real world

A lot of research in developmental biology in recent years have been dealing with the intriguing ability of zebrafish (*Danio rerio*) to regenerate their organs. With the advent of gene-editing tools, including CRISPR-Cas9, in an era of unending waiting lists for organ transplantation, may we thus dare to speak of a future where humans too could follow suit?

Could a gene drive be an answer to fight the spread of lethal vector-borne diseases like malaria, notwithstanding the implications on ecological equilibrium? Should humans have the right to decide which organisms deserve to be extirpated?

Should patenting rights be given to pharmaceuticals that use the basic science of genome editing to create unimaginably expensive gene therapies for rare yet debilitating and fatal diseases like RPE65-associated IRD (Retinal Pigmented Epithelium 65-associated Inherited Retinal Disease) or SMA (Spinal Muscular Atrophy)? Is the war against such pharmaceutical giants legitimate, or are arguments like granting them property protection regarding something that simply is not theirs, naive and lacking foresight?

"~~Un~~natural Selection”, a 4-episode limiting series streaming on Netflix, each beginning with a pertinent quote by Charles Darwin, addresses exactly these confounding questions, among many others. Filmed between 2016 and 2018 and based on extensive research including interviews with indigenous populations, patients, pharmaceutical companies, bioethicists and scientists, directors Leeor Kaufman and Joe Egender have presented a bold and provocative perspective about the CRISPR gene-editing technology and its translational research in the current scientific scenario. The documentary series goes a step further and brings forward the stories of real biohackers and their opinions on democratization of the technology, even to the extent of being able to do such genome-altering science from one’s backyard.

Invariably, it also brings forward the burning questions of bioethics in current times - Should the moratorium on germ-line editing be revoked? Should parents have a choice in deciding how smart their kids will be? Would I, if given a chance, with my common knowledge, design my baby the way *I* want to, and risk playing God?

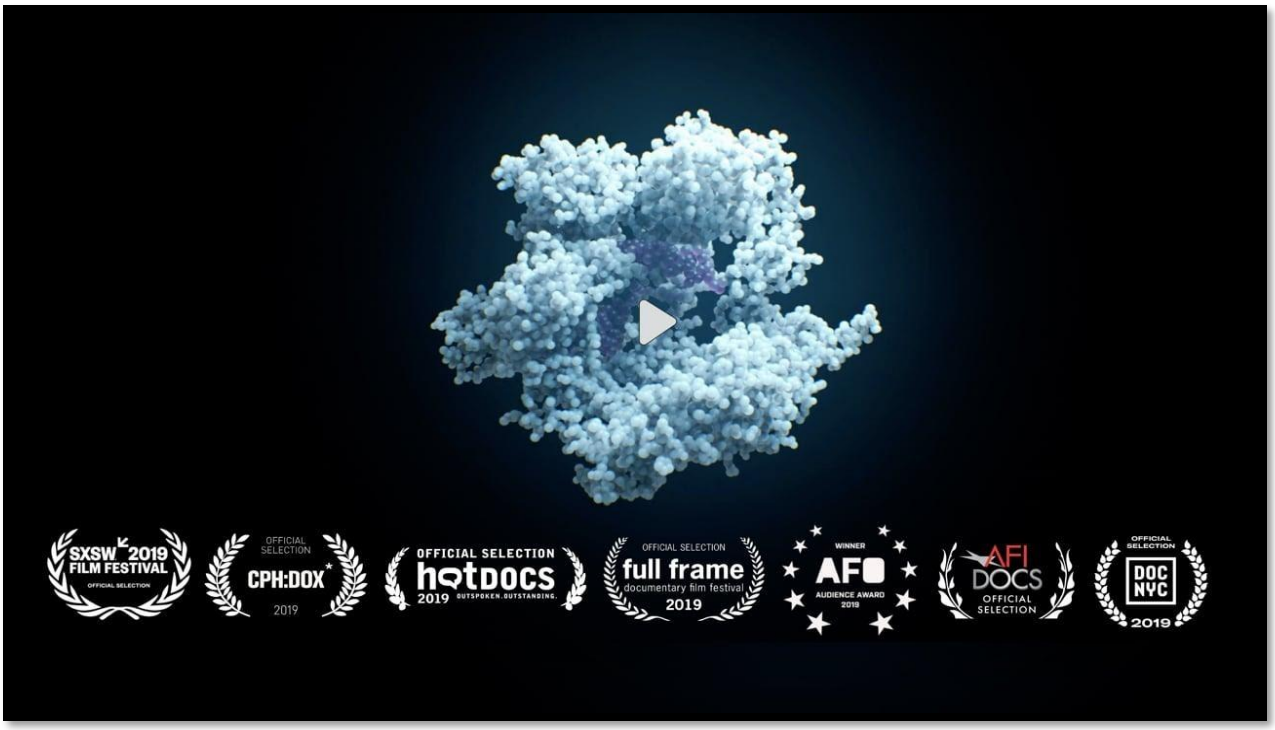
These questions in turn, are further addressed by the American political philosopher, Michael Joseph Sandel, in his book, “The Case Against Perfection: Ethics in the Age of Genetic Engineering”. Written in five chapters and putting forward questions ranging from the ethics of enhancement and bionic athletes to super-parenting and designing children to perfection before they are born, it is not only an engaging read for life sciences and bioethics enthusiasts, but would also appeal to the history aficionado, with insightful correlations and references to eugenics - old and new. To listen to the book on the go, it is also available as an unabridged album with narrations by Pete Cross, on Spotify.

"https://open.spotify.com/embed/album/0aIUzPOPYtdp74sMcywmjY"

But then, have we not, for ages, romanticized the unpredictability of life, its myriad mysteries and the concepts of fate and destiny? Does engineering, almost every aspect of it, with the power

of scientific knowledge destroy the apparent beauty of the uncertainty of life? Or is a structured and well-defined society based on the cognitive abilities and genetic constitution of organisms make perfect sense? This polemic is at the heart of the 1997 science fiction film by Andrew Nicole, "Gattaca". Starring Ethan Hawke, Uma Thurman, and Jude Law in lead roles, it describes the naturally born Vincent Freeman's struggle to outcompete the other genetically designed and superior humans in a not-too-distant future, and achieve an equivalent status, albeit assuming the identity of Jerome Morrow, a genetically enhanced friend who became paraplegic due to a car accident. With taglines like "The Prisoner. His Cell", Gattaca pulls a very delicate string in what was concerned as a projected alternate reality in the last century but is perhaps theoretically feasible today.

Moving on, if you have patiently read till here and still ask what exactly the CRISPR technology is, and what makes it so important that its discoverers, Emmanuelle Charpentier and Jennifer Doudna were awarded the Nobel Prize in Chemistry 2020, head forward to another documentary "Human Nature", directed by Adam Bolt. It not only breaks down the entire process into simple, lucid steps for the ones learning about the technology for the first time, but also discusses the implications, socio-economic-political, ecological, and evolutionary, of the technology which, as goes without saying, comes with an immense responsibility of wise use. While streaming on Netflix, it is also available on the PBS Video App.



The above four resources pose questions whose answers are not known with certainty, the debates are far from over, and in the years to come, especially post the pandemic caused by SARS-CoV-2 and the so-called biotech boom, heated conversations will but increase. The average person, if not equipped with a basic knowledge about these techniques, might risk being indecisive, should situations arise where an immediate medical choice and consent is necessary. Therefore, more popular scientific communications need to be disseminated and more opinions and perspectives require to be heard and considered.

And as the enthusiastic reader, I hope you too will let me know of related resources.

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Artificial Designing of High Tensile Spider Silk

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Semester-IX

Spider dragline silk is known to be one of the naturally produced strongest and toughest materials, even stronger than steel. The spider silk is composed of spidroin proteins MaSp1 and MaSp2. These fibres contain an ordered β-sheet arising from polyalanine sequences and a helical structure dominated by flexible glycine-rich sequences. The hydrophobic polyalanine sequences are responsible for the high tensile strength, whereas the hydrophilic glycine-rich regions are responsible for the links between the crystalline domains as well as the elasticity of dragline fibre. But natural silk cannot be obtained conveniently owing to the territorial and aggressive behaviour of the spiders. Recombinant DNA technology has been a great help in providing an alternative approach. One of the methods was obtaining the 60 kDa recombinant proteins from the spider *Araneus diadematus* and expressing them in *E. coli* host. The fibres spun with this recombinant spider protein exhibited mechanical property similar to the natural counterpart, but the crystallinity was compromised, and the tenacity was 4.2-fold lower. The pH gradient which persists in the silk gland of the spider triggers the transformation of spidroin that is initially stored as random coils, into β nanocrystals. Difficulty in replicating the natural pH environment artificially hampered the crystallinity of recombinant fibres. So, in order to develop a superior silk fibre that could achieve gigapascal tensile strength higher than 150 MJ/m^3 toughness, researchers integrated the use of amyloid peptides.

Amyloids represent a large group of structural proteins in which β-strands align perpendicular to the fibril axis and can form highly ordered cross-β protofilaments. The strong non-covalent interactions and hydrogen bonding between neighbouring β-strands conferred the extraordinary mechanical properties of the amyloid fibres. Polymeric amyloid peptides can form cross β structures which were implemented to produce β-nanocrystals. This property of amyloids was exploited to spin them into strong macroscopic silk fibres. A hybrid proteinaceous fibre material was designed where multiple β-sheet-forming amyloid peptides were connected by flexible glycine-rich peptide sequences of spidroin. A polymeric amyloid peptide sequence FGAILSS was chosen to create such a variant. The architecture of natural silk protein was mimicked by using the flexible glycine-rich sequence from MaSp1 to connect β-strand-forming amyloid peptides which generated a 16-mer polymeric amyloid protein 16xFGAILSS. 16xFGAILSS achieved 230 ± 34 MPa tensile strength, which is 1.8-fold enhancement from similar molecular

weight recombinant silk fibre. The Young's modulus obtained was 48% greater than the recombinant silk fibre produced initially. A major advantage was the ease of protein expression in microbial host. It was experimentally determined that 48x (143 kDa), 96x (284 kDa), and 128x (378 kDa) tandem repeats of FGAILSS protein constructs were successfully overexpressed in engineered *E. coli* host. Structural analysis based on X-ray diffraction of these amyloid fibres using synchrotron suggested high crystallinity which could be attributed to hydrogen bonding between the β-strands parallel to the sheet axis and strong side chain interactions. Also, this method spared the use of highly selective precipitation method required for recombinant spidroin, which was now substituted by purification using affinity chromatography. This paved a way for a more economical strategy. Experimentally determined tensile stress values of 48x-, 96x-, and 128xFGAILSS fibres were found out to be 0.44 ± 0.02, 0.65 ± 0.11, and 0.98 ± 0.08 GPa, respectively. The 128xFGAILSS fibre display a significant amount of strength and toughness which is about 161 ± 26 MJ/m^3, and this has surpassed most of recombinant silk fibres and naturally produced dragline spider silk fibres of *Abantiades sericatus*.

The high mechanical properties as well as overall ease of bio-production and purification makes the 128xFGAILSS an attractive candidate for biosynthesis of high tensile strength fiber which has opened a wide range of applications in industrial and biomedical sectors.

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The Tale Of Telomeres- All's Well That Ends Well?

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Semester IX

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Semester IX

Introduction:

"Telomeres are buffers. They are like the tips of shoelaces. If you lose the tips, the ends start fraying." – Elizabeth Blackburn

Telomeres are nucleoprotein structures located at the ends of chromosomes which provide stability. With each successive cell division, the telomeres progressively shorten leading to replicative senescence which eventually causes ageing and the ultimate death of the organism. Telomerase, a ribonucleoprotein complex is a cellular reverse transcriptase that adds new DNA onto the telomeres thus helping to maintain the length of telomeres. Thus, the secret to eternal youth seems to be overexpression of this telomerase gene, right? The answer however, is not so simple. This is because upregulation of telomerase increases the risk of certain cancers. This is also why the telomerase activity is kept very low to nil in somatic cells and is only active in germline, hematopoietic and stem cells. This repression of telomerase activity helps to prevent uncontrolled cell proliferation which can lead to tumorigenesis. In fact, telomerase upregulation or reactivation is a salient feature in more than 90% of cancers making the inhibition of telomerase an area of active research in cancer therapeutics.

Shorter telomeres leading to senescence is definitely an advantageous mechanism to arrest the development of potential cancer cells, however it is detrimental to the organism especially later in life as it leads to tissue degeneration and ageing. Cell senescence therefore is an example of antagonistic pleiotropy, a trait which is beneficial to the organism's fitness early in life but deleterious later on in life.

Telomeres in ageing:

With each successive cell division, the telomeres progressively shorten due to incomplete lagging strand DNA synthesis, oxidative damage, exonucleolytic processing events and other factors. Once the telomere length reaches a critical limit, the cell undergoes replicative senescence and/or apoptosis. Telomere length may thus act as a biological clock which governs the lifespan of a cell and an organism. In fact, evaluation of telomere length in elders have shown that the individuals

having shorter telomeres have a much higher mortality rate compared to those with longer telomeres. The over-shortening of telomeres leads us to see and feel signs of ageing. When skin cells start to die, wrinkles appear. Greying of hair is caused by the death of hair pigment cells. The death of immune cells increases the risk of infection at old age.

Telomeres and telomerase in cancer:

The Telomerase enzyme is composed of a catalytic subunit with reverse transcriptase activity called TERT (Telomerase reverse transcriptase activity), a RNA template called TERC (telomerase RNA component) which has sequence complementary to the sequence of telomeres and accessory proteins. TERT synthesises telomeric sequences using TERC as a template. The *hTERT* gene in humans which codes for TERT is normally silenced in somatic cells. However, TERT is up-regulated in almost all tumours which can happen via multiple genetic and epigenetic mechanisms. Several signalling pathways (mainly c-MYC, NF-κB, B-Catenin) are involved in the transcriptional reactivation of TERT in cancer cells.

Since telomerase is up-regulated in majority of cancer cells, telomerase has been a prime target for development of effective cancer therapeutics. Many approaches have been explored which include development of vaccines, antisense oligonucleotides and small-molecule inhibitors targeting *hTERT*. Imetelstat, a specific and effective telomerase inhibitor which binds with high affinity to TERC is an experimental anti-cancer drug which has been in human clinical Phase 2 and 2/3 trials. Moreover, immunotherapies that use dendritic cells, hTERT peptide or cryptic peptides are also being tested in clinical trials.

Can our life style impact the length of our telomeres?

That telomeres shorten with age is a well-established fact. However, certain lifestyle factors such as smoking, obesity, lack of exercise, and consumption of unhealthy diet can accelerate the rate of telomere shortening, leading to illness and/or premature death. Accelerated shortening of telomeres is related to the early inception of many age-related health disorders like coronary heart disease, heart failure, diabetes and osteoporosis.

Smoking increases the pace of telomere shortening. There is a negative correlation between cigarette smoking dosage and telomere length. A study has demonstrated that telomere abrasion caused by smoking one pack of cigarettes per day for a duration of 40 years is equivalent to 7.4 years of life.

Obesity leads to increased oxidative stress probably due to a deregulated production of adipocytokines. Oxidative stress can induce DNA damage and may thus accelerate telomere shortening. In obese individuals, the telomere loss was equivalent to 8.8 years of life.

Another group of researchers evaluated telomere length in leukocytes from office workers and traffic police officers exposed to traffic pollution. They found that compared to the telomere length in office workers, the telomere length in traffic police officers was shorter within each age group. Therefore, exposure to DNA damaging agents may accelerate the shortening of telomeres. Chronic stress may also accelerate telomere shortening. This maybe because the glucocorticoid hormones released during stress decrease antioxidant protein levels thus causing increased oxidative damage to DNA which leads to telomere shortening. A study conducted on biological mothers of chronically ill children (caregiving mothers) demonstrated that these women had shorter telomeres and reduced telomerase activity compared to control women (biological mothers of a healthy children). Moreover, more the number of years of caregiving, the shorter were the length of the mother's telomeres and lower was the telomerase activity. Interestingly, the more the women perceived their situation as being more stressful, the lower were their telomerase activity and shorter were their telomeres. Significantly, the difference in telomere length between these two groups of women was equivalent to ten years of life. Thus, people's life events and the way they respond to these events can change the length of their telomeres.

Conclusion:

While shorter telomeres lead to ageing, up-regulation of telomerase and longer telomeres leads to cancer. Ageing and cancer are thus two ends of the same spectrum. What is interesting to note is that we have more control on our telomeres than we can imagine and a healthy lifestyle can help us to optimally maintain the length of our telomeres.

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Adopting Intelligence from Cancer Cells: New Solution to Graft Rejection

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Semester IX

Introduction

Each year, millions of patients suffer the loss of composite tissue following accidents or diseases. In cases where traditional reconstructive strategies fail in terms of functional or cosmetic aspects or are insufficient, vascularized composite allotransplantation (VCA) can be considered as an option for the patients. Various kinds of VCAs have been carried out over the last decade, including hand and face transplants, with varying degrees of success. However, one of the major issues with VCA, as with any allotransplantation, is immunological rejection [especially in the case of Major Histocompatibility Complex (MHC)-mismatched VCA], in which the immune system recognizes the transplanted organ or tissue as foreign, triggering a response which ultimately leads to the destruction of the transplanted tissue or organ. Hence, recipients require lifelong regimens of immunosuppressive drugs, leaving them susceptible to various infections, among other complications. Thus, scientists have now developed a different approach to solve this problem which employs an immune evasion strategy used by cancer cells involving the recruitment of regulatory T cells (T_{regs}).

What is vascularized composite allotransplantation?

Vascularized composite allotransplantation refers to the transfer of a vascularized body part containing histologically different tissues (bone, muscle, nerves, blood vessels, and skin) as a structural and/or anatomical unit from a donor to a recipient, both belonging to the same species. The body part would require blood flow by surgical connection of blood vessels in order to function after transplantation. This is a special category of transplantation which borders between organ and tissue transplantation. VCAs can include limbs (e.g., hand, arm), face, abdominal wall, larynx, among other body parts. Immunological rejection remains one of the major challenges in VCA. Among all the different kinds of tissues (expressing varying degrees of antigenicity) involved in these allografts, the dominant immune response seems to be targeted towards the skin,

although this has not yet been proven conclusively. Due to the various side-effects and complications associated with the use of systemic immunosuppressive drugs, new strategies are constantly being developed to overcome graft rejection. One of these strategies is the development of donor-specific immune tolerance, whereby the immune system of the host is rendered unresponsive to specific donor-transplantation antigens, while the overall function of their immune system is maintained.

T_{reg} and Cancer Cells

Although the immune system serves as a barrier against abnormal cell growth and foreign pathogens, extreme and indiscriminate immune responses can compromise the survival of the host. For this very reason, many mechanisms exist within the body to regulate immune responses, one of which involve the T_{regs} which play a crucial role in creating and maintaining immunological homeostasis by preventing the activation of both $CD4^+$ and $CD8^+$ T cells through a variety of mechanisms. These mechanisms include expression of anti-inflammatory soluble mediators such as TGF-ß, consumption of IL-2 (necessary for the growth, proliferation, and differentiation of naïve T cells into effector T cells), expression of negative regulatory cell surface receptors such as CTLA-4 (which interacts with B7 on antigen presenting cells, blocking its interaction with CD28 on T cells, thus preventing the costimulatory signal for T cell activation), among others. Not only do these T_{regs} moderate self-reactivity, they are also involved in preventing the activation of alloreactive T cells which recognize non-self/allogenic MHCs, and are responsible for rejection of allogenic transplants. Certain tumours possess endogenous immunological regulatory mechanisms, one of which is the recruitment of circulating T_{regs} to the tumour environment through release of the chemokine CCL22, which binds to the chemokine receptor CCR4 which are preferentially expressed by T_{regs}. Thus, an alternative approach to the use of immunosuppressants could be to adopt this mechanism of tumour cells, and harness the body's inherent mechanisms of immune suppression in order to achieve allograft acceptance.

CCL22-Releasing Microparticles

In order to safely mimic this immune evasion strategy of tumour cells, scientists have developed a degradable, synthetic, controlled release microparticle system, which is capable of generating and maintaining a CCL22 gradient from the site of microparticle placement in vivo. This CCL22 gradient is essential for effective T_{reg} recruitment. The microparticles are made out of a biocompatible, biodegradable poly (lactic-co-glycolic acid) (PLGA) polymer and are spherical.

The surface of the microparticle is designed to be porous such that there is a continuous release of CCL22. Additionally, these microparticles are designed to be larger than 10μm in order to avoid uptake by phagocytes, and prevent their movement across the vascular endothelium, effectively immobilizing them at the site of placement. In order to test the ability of these microparticles to prevent graft-rejection, vascularized hindlimbs were transplanted from Brown Norway (BN) rat donors to Lewis (LEW) recipients such there is complete MHC mismatch between the donors and the recipients. It was observed that local (intragraft) administration of these microparticles prolongs graft survival indefinitely (>200 days), whereas in the control rats which were only receiving baseline immunosuppression protocol of FK506/ALS (anti-rat lymphocyte serum), graft rejection occurred 2-3 weeks after FK506 was discontinued 21 days post-operation. It was also observed that in the skin from microparticle-treated allografts, the proportion of T_{regs} was significantly higher compared to that in the skin from rejecting allografts. Additionally, biopsies from the rats treated with the microparticles showed intact cellular architecture and minimal cellular infiltration, similar to muscle and skin biopsies from normal rats. Moreover, the microparticle-treated hindlimb recipients also showed systemic donor-specific tolerance.

Conclusion

Graft loss due to immune-mediated rejection remains the biggest challenge in the field of transplant immunology. The standard post-transplantation care involving lifelong regimens of one or more immunosuppressive drugs not only makes the recipient susceptible to various infectious diseases, but also generates a variety of other health complications like renal dysfunction and cardiovascular disease. Therefore, it is imperative that alternative strategies for prevention of graft rejection be developed. Some malignant cells have the capacity to secrete the cytokine CCL22 in order to recruit T_{regs}, which play a pivotal role in assisting these cells evade immune responses. There is ample evidence that T_{regs} are also crucial in preventing allograft rejection and inducing tolerance. Thus, “borrowing” this strategy from cancer cells would allow the harnessing of the highly sophisticated immunoregulatory potential of a recipient’s endogenous T_{regs}. The promising results showed by the CCL22-releasing microparticles indicate that this treatment has the potential to prevent allograft rejection, and limit or even bypass the need of immunosuppressants. Perhaps this treatment could also have broader applications in the future for the treatment of acute or chronic inflammatory and autoimmune pathologies, for which the current treatments are limited, again due to their immunosuppressive or off-target toxic side effects.

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Long Non-Coding RNA: Culprits or Protectors in Neurodegenerative Diseases

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INTRODUCTION

Genetic information is passed on from one generation to another by the process of inheritance. Inside the cell, the information which is inherently present follows a pattern dictated by the central dogma according to which the DNA makes new RNA molecules using the process of transcription.

These RNA molecules, in turn, make proteins using the process of translation which helps in the functioning of the cellular processes. However, only a minute percentage of the transcribed RNAs encode for proteins. The non-coding RNAs (ncRNA) can be further classified depending on their length. The stretches of ncRNA that are shorter than 200 nucleotides are called the short ncRNA, and when the length of the ncRNAs are longer than 200 nucleotides, then they are referred to as long non-coding RNAs (lncRNAs). These long non-coding RNAs (lncRNAs) interact with other molecules like proteins, DNA, mRNA as well as micro RNAs (miRNA) thereby regulating the expression of genes at the epigenetic level. Due to these interactions, lncRNAs play a major role in the regulation of cell differentiation and the occurrence of various diseases in humans. One of the primary human medical conditions includes neurodegenerative disorders. This article throws light on the involvement of lncRNA in some of the most prevalent neurodegenerative diseases.

1. ALZHEIMER'S DISEASE

One of the most common neurodegenerative disorders increasing by leaps and bounds in the present day is Alzheimer's Disease. It was first identified by the well-known neurologist Dr. Alios Alzheimer, in his patient named Auguste Deter who was initially thought to be a sufferer of presenile dementia.

Recent molecular, cellular, and genetic studies have identified the presence of neurofibrillary plaques and tangles in the diseased brain. These plaques and tangles are oligomeric species of Aβ

(generated from the transmembrane amyloid precursor protein, APP) and tau protein. The most rhetorical observation associated with this disease is the conversion of soluble proteins into their solid states which subsequently leads to their aggregation into oligomers. These oligomers on gangliosides upregulate the immunological response pathway (the complement factors), triggering
these synapses for destruction by microglia, the neuronal macrophages. Synapse loss leads to a loss in neuronal cognition, thinking, and memory. 'Neurons that wire together, fire together.' Destruction of synapses disrupts these wiring and firing of neurons leading to the development of the key characteristic of Alzheimer's disease (AD), memory loss. Recent findings suggest that lncRNAs play a role in the development of AD. BACE1 or β-site amyloid precursor protein-1 is a membrane-bound aspartic protease which is involved in cleaving the transmembrane protein APP to generate Aβ. BACE1-AS, the antisense transcript from BACE1 gene, binds to BACE1 mRNA, increasing its stability thereby promoting further synthesis of BACE1 protein and an increase in the production of Aβ in the cells. Thus, BACE1-AS has been proven to be a culprit of AD. BC200 in humans induces mRNA translation of APP, in turn allowing aggregation of Aβ in the cells, causing AD. Several other lncRNAs such as 17A, 51A, GDNFOS have also been proven to be culprits associated with AD.

2. AMYLOTROPIC LATERAL SCLEROSIS

Amyotrophic Lateral Sclerosis (ALS) or Lou Gehrig's Disease has been recognized as a motor neuron disease leading to progressive paralysis of muscles involved in speech, swallowing, and gradual paralysis of motor neurons.
Stephen Hawking suffered from ALS which till date has no therapeutic measures. lncRNAs have also been associated with ALS. The repeated amplification of a six-nucleotide motif GGGGCC in the protein-coding gene on chromosome 9 ORF 72 (C9ORF72) was the first identified mutation leading to ALS. C9ORF72 has also been identified to code bidirectionally for noncoding transcripts. These are found to be upregulated in the brains of ALS patients. lncRNAs have also been found to recruit RNA-binding proteins like FUS and hence, regulate RNA metabolism. Recruitment of FUS at the genomic loci encoding Cyclin D1 represses Cyclin D1 production in response to DNA damaging signals and increases tolerance to motor neuron apoptosis. Thus, lncRNAs are found to contribute to pathological changes in ALS.

3. HUNTINGTON'S DISEASE

Huntington's disease (HD) is a very rare, heritable disease that leads to the gradual breakdown of the nerve cells present in the brain, also called neurodegeneration. Huntington's disease damages an individual's ability to function properly. It hampers the thought process and movement as well as induces cognitive and psychiatric disorders. HD is mainly concerned with the huntingtin protein (Htt) which accumulates in the brain over time, leading to the death of nerve cells.

HttAS_v1 is a lncRNA which is an antisense transcript of the Htt gene. There is a low-level expression of this transcript in the frontal cortex region of Huntington patients, and thereby it upregulates the expression of the Htt mRNA. This, as a result, promotes the pathogenesis of Huntington's disease. Htt induces the modulation of the nuclear translocation of the transcriptional repressor, RE1 silencing transcription factor/neuron-restrictive silencer factor (REST/NRSF). So, a mutant form of the Htt results in the abnormal nuclear-cytoplasmic transport of the transcriptional factor REST/NRSF and thereby promotes abnormal expression of the REST target genes.

Mammalian cells have certain subnuclear bodies called paraspeckles which are maintained by a nuclear enriched ncRNA called the Nuclear paraspeckle transcript 1 (NEAT1). One of the interesting observations which were seen in patients with Huntington's disease was an elevated level of NEAT1. This led to the analysis of NEAT1 to determine its biological effect on the degenerative action of neurons. The results obtained reflected that cells transfected with NEAT1 showed an increase in the viability of the cells under oxidative stress, thereby emphasizing that the upregulation of NEAT1 results in neuroprotective mechanisms against the damage caused to neurons, and thus, it plays the role of a neural bodyguard.

4. PARKINSON'S DISEASE

Parkinson's disease (PD) is a movement disorder that results from low levels of dopamine present in the brain. The symptoms seen in PD occur gradually such as tremors, impaired movement, and posture instability.

Recent studies have shown that the aggregation of α-synuclein is one of the major driving forces in the pathogenesis of PD. MALAT1, a highly expressed lncRNA, when overexpressed, causes an upregulation in the expression of α-synuclein. β-asarone causes a decrease in the expression level of MALAT1 which thereby results in the downregulation in the expression of α-synuclein. This suggests that β-asarone can be used as a potential therapeutic agent for Parkinson's disease.

Another driving force that emerged in the pathogenesis of Parkinson's disease is the Leucine-rich repeat kinase-2 (LRRK-2) which is involved in the progression of Parkinson's disease. HOTAIR, a lncRNA transcribed from the HOCX locus has been shown to promote the stability of the LRRK-2 mRNA, thereby causing an upregulation in the expression of this protein. This, in turn, induces the apoptosis of dopaminergic neurons.

CONCLUSION

With the coming of age of newer RNA technology and Computational Biology, the cure for neurodegenerative diseases using lncRNA has made considerable progress. There are also lncRNAs that have been used as molecular markers for the diagnosis of numerous diseases as well as drug design targets. This therefore further stresses the need for pursuing research on the complexities of the RNA world which play a major role in various mechanisms involved in the

homeostatic maintenance of the microenvironment of the human body, disruption of which might lead to different medical conditions.

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DNA Computing - A Hope for the Future

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Semester IX

As already known, DNA, the genetic material in almost all living organisms, is a double-stranded helix where the purine and pyrimidine bases in the two strands are hydrogen-bonded with each other in a complementary fashion. This Watson-Crick base pairing can be extensively utilized to implement logical calculation and solve complex mathematical problems. DNA computing, a field of applied biology that employs fundamental knowledge in biochemistry and molecular biology, has speedily progressed in the last three decades. However, it is still performed manually in most research projects in which the entire protocol of individual experiments is executed stepwise by hand.

In most existing research, multiple chemical reactions using different DNA sets need to be performed to solve of even a simple calculation. In each reaction, DNA is added manually into a single reaction tube, thus making the entire protocol inconvenient. Recently, scientists have brought to light a technique to automate DNA calculations by developing a computer-controlled microfluidic chip.

Scientists used 3D printing to fabricate the microfluidic chip to solve various DNA-based calculations of simple Boolean logic circuits. Boolean logic, one of the basic logics of computer programming, utilizes true-or-false logic that compares inputs and returns a value of either 'true' or 'false', depending on the type of logic gate operation performed. Here, the logic gate is comprised of different sets of single-stranded DNA templates used as inputs. If a major portion of an input DNA was complementary to the template DNA, it would pair to the latter to generate a double-stranded DNA. The output was declared true or false based on the size of the final DNA.

This microfluidic chip is an exceptional construction due to the introduction of a motor-operated valve system that can be operated via PC or smartphone. The microfluidic chip and software set-up together form a microfluidic processing unit (MPU) which could perform a series of reactions to perform a combination of logic operations with ease. This technique also aims at replacing traditional electronic computing in the future because the former consumes less power, thus preventing global warming. Hence, future research should focus on a complete solution of DNA computing with both DNA algorithms and storage systems.

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Stress? Leave it to Proline, the Professional

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Plants are always exposed to various adverse conditions which affect their overall growth and development. These detrimental impacts are known as stress. The stress in plant systems can be of two types: Biotic stress & Abiotic stress. Abiotic stress is responsible for the loss of a huge amount of crop yield worldwide & includes salinity, drought, heavy metal toxicity, radiation, etc. Plants exhibit a certain amount of tolerance against such environmental conditions. However, it affects their overall productivity in terms of crop quality and production. Plants under these types of stress conditions start to accumulate increased amounts of chemicals to tackle these detrimental effects. Accumulation of osmolytes like proline comes under such stress responses. Various osmolytes have been found to show an enhanced expression level under such abiotic stress conditions, such as polyamines, proline, glycerol, sorbitol, glycine betaine (GB) etc. These chemicals help in maintaining cell osmolarity and turgidity. Though a direct connection between abiotic stresses and proline upregulation is yet to be established, various research has made it prominent that proline does have a beneficial role for plants. It has been found that under stress, the proline can take up to 80% of the total amino acid pool, compared to the normal 5%. This huge increase in proline content has been documented due to its decreased degradation and increased synthesis under stress conditions. As an uncharged, small, and multifunctional amino acid, proline has diverse roles under various abiotic stress conditions, such as membrane stabilization, protection of subcellular structure, scavenging reactive oxygen species (ROS), stabilization of proteins, etc. Enhanced proline biosynthesis in the chloroplast has a major role in the maintenance of cellular homeostasis via dissipation of excessive reduction potential and stabilization of redox balance. The physiological role(s) of this amino acid has been explored experimentally via overexpression and suppression of proline biosynthetic and catabolic pathway related genes. Overexpression of proline biosynthetic genes under stress resulted in an increased shoot to root biomass ratio, changed inflorescence architecture and plant yield. In this article, we will discuss the roles of this important osmolyte, its biosynthetic and catabolic pathways, and how it can be used to generate abiotic stress tolerance.

Proline Biosynthesis:

The main gene involved in the biosynthetic pathway of this important osmolyte, Proline, is *Pyroline-5-Carboxylate Synthetase (P5CS)*. This bifunctional enzyme catalyzes two simultaneous steps. At first, the amino acid glutamate is converted into an intermediate Glutamate Semialdehyde which then spontaneously forms the compound D^1 -Pyroline-5-Carboxylate, under the action of the P5CS enzyme. Hu et al. (1992) first cloned the *P5CS* from the *Vigna aconitifolya* (moth bean) via complementation. Further experiments have proven that there are two different forms of P5CS (P5CS1, P5CS2) found in all plants, resulting from independent duplication events in evolution. These two different isoforms show different subcellular distributions. P5CS1 is more abundant in the chloroplast, while P5CS2 shows a prominent cytoplasmic distribution. In the absence of any stress, induction of P5CS1 remains more diffused throughout the compartments increasing the possibility of re-localization when the plant is subjected to adversity. Proline upregulation after any induction shows feedback inhibition, downregulating *P5CS* expression. As a result, the overall proline concentration inside the cell is maintained.
Plant hormone Abscisic acid (ABA) has a prominent role in proline upregulation. However, ABA treatment from outside without any stress induction was found out to be inefficient in the upregulation of this important osmolyte.

Role Of Proline Under Stress Condition:

Besides maintaining cell tonicity, proline has a plethora of other roles in the plant system under stress conditions. This important amino acid contributes to the stabilization of various subcellular structures and biomolecules. A majority of the abiotic stress responses in the plant system ultimately culminates in the generation of reactive oxygen species (ROS), like superoxide radicals, hydroxide radicals ($OH\cdot$), hydrogen peroxide (H_2O_2), etc. Proline being a free radical scavenger and cellular redox potential balancer can reduce the adverse impact of these ROS in plants. Apart from various supporting roles, proline breakdown after alleviation of stress appears to be an important event in the plant recovery stage. Hare and Cress (1997) had demonstrated that the breakdown of this amino acid provides the plant with sufficient reducing agents which are used in mitochondrial oxidative phosphorylation to generate ATP.
Proline also helps in the upregulation of stress responsive genes under specific adverse environments. For example, false stress responsive genes contain proline responsive elements (PRE) with the conserved sequence 'ACTCAT' in their promoter region.

Proline as a scavenger of ROS:

As mentioned earlier, abiotic stress conditions lead to the generation of ROS such as superoxide radicals, hydrogen peroxide, hydroxide radicals etc. These toxic compounds can pose a major

threat to cellular integrity via inducing oxidative damage to the cellular components, genetic material (DNA), and other biomolecules. Plants' own antioxidant machinery consists of a diverse array of enzymes like superoxide dismutase (SOD), ascorbate peroxidase (APX), Catalase (CAT) etc. These enzymes are maintained at a basal level during normal conditions. During adversity, this expression level is increased by several folds. It has been found out that, the amino acid proline also gets upregulated side by side at the same time.

Matysik et al. (2002) conducted an experiment to prove the ROS quenching activity of proline. Further research made it evident that apart from being a quencher itself, proline also shows an inductive effect in the antioxidant enzyme upregulation.

Conclusion:

One of the major challenges faced by agriculturally dominant countries like India is crop spoilage and wastage under the influence of biotic and abiotic stress factors. Sequential stress combinations or influence of multiple stress factors make the process more difficult. Plants' own defense response can tackle this to a certain extent. Various osmolytes like proline, glycine betaine are indispensable components in this regard. The study of different genes in the biosynthetic as well as catabolic pathways can be proved to be effective in the generation of stress tolerant crop varieties and solve the global hunger problem.

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The Next Pandemic: Mental Health Disorders

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Semester IX

INTRODUCTION:

Mental health related disorders are all set to become the leading cause of death worldwide, even exceeding the "Emperor of all maladies"- cancer, by 2050. Hence the whole of the world's scientific community is on its toes, actively looking every moment for possible insights into this deadly spectrum of disorders including depression, anxiety, post-traumatic stress syndrome (PTSD), among others. Such conditions are also recently seen to be associated with development of psycho-cardio-metabolic multimorbidity, which causes significant disability and mortality worldwide. Until recently, the key determinants of psychiatric disorders were major environmental factors which act as triggers, with a very less understood genetic predisposition.

The Role of Early Life Stress

It is now well understood that genes, family history, personality and environmental factors like stress, abuse, separation, neglect all increase the vulnerability to depression, and the effect of the environmental factors seem to be most pronounced in case of early life stress incurred by individuals. Unfortunately, childhood abuse is extremely common in our society, and yet not addressed enough to create an impact. Neglect, maltreatment, witnessing parental conflicts, pre-pubertal bullying, emotionally absent parents and physical and sexual abuse affect the child not just in a psychological and social view, but also manifest as underlying neuro-biological conditions. It is known that neuronal plasticity is especially heightened in childhood, to make learning experiences easier. Stress during this time of life leads to altered neuronal plasticity that later fails to adapt to and combat additional challenges, thus leading to behavioral manifestation that is clinically identified as depression. Early life stress experiences have also been linked with glucocorticoid resistance, increased levels of inflammation, decreased oxytocin sensitivity, and increased corticotropin-releasing hormone activity, reduced pre-frontal cortical volume, reduced hippocampus volume, increased amygdala volume, all of which were manifested as difficulties in social and emotional regulatory behavior.

Genetic causes of depression

Serotonin has been thought to play a significant role in major depressive episodes and a study by Caspi et al in 2003 gave some major insights about the same. They genotyped a polymorphic

region in the promoter region of a serotonin transporter gene. This polymorphic region is one of the major targets of antidepressants and any genetic mutation leads to alteration in transporter function. Carriers of the short allele (-S) for this gene were more vulnerable to environmental stressors and more susceptible to development of depressive symptoms.

Polymorphism at the corticotropin receptor 1 (CRHR1) gene locus also play a role in manifestation of depressive behaviour and interacts with early life stress and abuse to further predict depressive symptoms. Some haplotypes of this gene have been shown to have a protective function, and it is thought to mediate early life stress triggered dysregulation of HPA (Hypothalamus-Pituitary-Adrenal) axis.

Dopamine, a neurotransmitter involved in the brain's reward system, regulates mood, motivation and euphoric feelings. As dysphoria is one of the direct implications of depression, depression is certainly linked to dopamine transport, perceiving and function. Hence all the enzymes involved in dopamine biosynthesis, the transporters which help in the reception of dopamine, and the families of G proteins activated by dopamine all control our behaviour and mood, and genetic abnormalities in all these genes will downregulate dopamine function.

Epigenetic Mechanisms underlying Depression

Epigenetics is the layer of regulation of transcriptional processes, that doesn't alter the DNA sequence, but relies on transient reversible modifications on the DNA or histones which form the chromatin landscape. DNA methylation has priorly seen to be strongly associated with stress and traumatic experiences. Overexpression of *Dnmt3a* in the nucleus accumbens (NAc) triggers depression like behaviour, and inhibitors of *Dnmt3a* cause antidepressant like calming effects. Hypermethylation at the *Crf* gene in the paraventricular nucleus of hypothalamus is predicted to have role in sex specific regulation of HPA axis function, as studied in rat models.

Hypermethylation or demethylation of glucocorticoid encoding gene and the gene encoding arginine vasopressin (AVP), a neuropeptide, has been correlated to incurring of early life traumatic experiences. These changes lead to heightened glucocorticoid function causing dysregulation in the HPA axis.

Chronic social stress in adult animals have been associated with long term hypomethylation of corticotropin releasing factor (*crh*) gene at its promoter, which leads to overexpression of CRH leading to stress and anxiety related behaviour. It also recruits a repressive chromatin remodeller complex at the NAc, which was seen to lower transcriptional activation marks like H3K16ac, H3M4me3 and increase repressive marks like H3K9me2.

HDAC inhibitors have notably antidepressant like functions, and injections of the same at NAc, amygdala, hippocampus or prefrontal cortex alleviates depressive symptoms. Methylation of histones also play a role in depression and other allied disorders, as loss of repressive methylation mark H3K9me2 at the *Ras* gene in NAc leads to overexpression of this monomeric G protein,

which in turn induced ERK signalling and ultimately CREB activation which leads to manifestation of depressive symptoms. A study in socially defeated mice showed increase of repressive mark of H3K27me3 in the promoter region of *Rac* gene, which decreased Rac levels and led to increased susceptibility to depression.

Conclusion:

Mental health disorders like depression, PTSD, anxiety, among others are major ailments that cause significant degradation of human resource, and mortality. These disorders are not merely effects of environmental stimuli but often have a well established genetic and epigenetic basis which causes notable physiological changes in the neurocircuitry of the brain. These disorders need to be addressed more seriously with the aid of mass education, accessible therapy and medical help, and banishing the taboo associated with them especially prevalent in Indian societies. Special care must be adopted for pre-pubertal children as early life trauma remains ingrained as characteristic marks and heightens the susceptibility to psychological disorders.

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Can Infectious Agents Treat Malignancies?

Suparna Dey

Semester IX

I am the commander-in-chief of all the leukocytes in your body. In a time of need, I direct my platoon to help destroy the bug invaders. What am I?

Easy, wasn't it? Yes, I am the immune system of your body!

More than a year into a global pandemic, people need not be reminded of how crucial one's immune system is for their salubriousness. As long as the immune system is running smoothly, we don't even notice it's presence. But if it stops working properly – because it's weak or can't fight particularly aggressive germs – one gets ill. Almost as complex as the brain, it's an intricate network of cells and molecules residing in the blood and tissues like the bone marrow, lymph nodes, and spleen, that execute a well-defined coordinated function to protect us from dangerous intruders like viruses and bacteria.

So, the question arises: What triggers this network?

When a pathogen successfully crosses the body's structural and chemical barriers to gain entry to the interior, it is bound to be faced by the two fundamental branches of the immune system. The innate immunity is the first antigen-independent immunological mechanism that is activated to fight the intruding pathogen. This rapid immune response is initiated within minutes or hours after aggression and has no immunologic memory. Adaptive immunity, contrarily, is antigen-dependent and antigen-specific; and has the capacity to mount a more rapid and efficient memory immune response upon future exposure to the same antigen. There is a great deal of cooperation between the two systems, and defects in either of them can provoke illness or disease, such as inappropriate inflammation, autoimmune diseases, immunodeficiency disorders, and hypersensitivity reactions.

Understanding the immune system's power and perils has inspired scientists over the years to harness one's "natural" immunity to fight certain infectious maladies. In this regard, an early strategy was to deliberately cause a mild infection with the unmodified pathogen followed by

long-lasting protection against reinfection. This idea was first conceptualised in the 1800s and stems from the works of Jenner and Pasteur who are credited for developing the world's first vaccines. Although the early twentieth century saw multiple advancements in infectious disease treatments, this sadly wasn't the case with the malignant ones. Cancer therapy evolved from surgical excision of tumours to modern treatments like radiotherapy and chemotherapy - but no comprehensive cure applied to all tumours at all stages. Surgical cure was not possible all the time; irradiation or intravenous delivery of poisons didn't yield durable results either; even a combination of these modalities was proven to be insufficient in many cases. Thus, it seemed plausible to turn to microbial infections that provided some early reports of tumour regression.

OV Immunotherapy- A Modern yet Pragmatic Outlook

Since the mid-1800s, there has been a steady trickle of cases reporting temporary periods of clinical remission in cancer patients contracting an infectious disease. Most often these patients were young and diagnosed with haematological malignancies, like leukaemia or lymphoma, known to be associated with significant immunosuppression. While no cases of long-lastingcure were reported, yet these seemingly nebulous observations didn't go unnoticed by the medical community, who subsequently begun employing viruses in cancer therapy-thus giving birth to the concept of Oncolytic virotherapy (OV).

As the name indicates, oncolytic virotherapy is a kind of targeted therapy deploying viruses to kill and eliminate neoplastic cells. This up-and-coming approach gained popularity in the late 19th century where, cell and tissue culture systems allowed *ex vivo* virus propagation, enabling researchers to evaluate the oncolytic properties of numerous viruses (e.g., hepatitis, Epstein-Barr, West Nile, Uganda, dengue, yellow fewer), first in human tumour cell lines, often implanted in immunosuppressed rodents, and subsequently in humans.Consequently, two principle modes of antitumour activity were reported- First, the selective replication followed by direct lysis of neoplastic cells; and second, the induction of systemic host antitumour immunity. The relative contribution of these mechanisms may vary depending on the nature and type of cancer cell, the viral vector, and the interaction between the virus, the tumour microenvironment and the host immune system.

One might say, undoubtedly, that the most fascinating part of this therapeutic approach is the extraordinary susceptibility of malignant cells to viral infection and this has been attributed to the defective viral sensing mechanism, tumour-driver mutations, and the lack of antiviral type I

interferon signalling, all of which are characteristics of tumour cells.Once the cellular protein factory has been hijacked, the cytokines or chemokines produced by the infected tumour cells, in addition to the tumour derived antigens released by the dying cells, can attract an army of immunogenic cells including the B and T lymphocytes, NK cells, dendritic cells, and macrophages, to establish an"immune-associated" bystander effect, causing damage in nearby uninfected tumour cells, even without direct antigen expression.Surface representation of viral antigens also signals the acquired immune system of the body through damage-associated molecular pattern (DAMP) and pathogen-associated molecular pattern (PAMP) receptors, that retarget the cytotoxic CD8+ T cells and helper CD4+ T cells towards the tumour and interferes with the immune-suppressive tumour microenvironment. While Tumour-picky replication can be "natural" in some viruses, better patient outcomes are expected by rational design of viruses rendering them tumour selective ("oncolytic") and non-pathogenic.

In an effort to control virulence and avoid the problem of rapid virus elimination resulting from pre-existing antiviral immunity, two steps were undertaken- OV genomes were genetically modified to enhance the specificity of the virus; and appropriate Cell carriers like myeloid-derived suppressor cells (MDSC), or cytokine induced killer cells, were developed that could shield viruses from neutralization while ensuring selective virus delivery to the tumours.

Currently, the two leading fronts in which oncolytic viruses have been increasingly used are tumour diagnosis and tumour treatment. Genetically Modified OVs can selectively infect tumour cells to replicate and express specific reporter genes, such as luciferase and green fluorescent protein (GFP), whose protein products facilitate a non-invasive real-time molecular imaging of neoplasms in vivo. This has proven to be more beneficial compared to advanced imaging technologies like CT and MRI where, early detection of primary tumours and small metastases was a major concern. Precise imaging has enhanced understanding of tumour behaviours, including amplification, invasion, and metastasis.

In the treatment front, the three oncolytic viruses that have achieved good therapeutic effects up till now, are RIGVIR, Oncorine, and T-VEC. Of the three, Rigvir (or the Riga virus) became the first OV to obtain a regulatory approval around the globe in 2004. It's an inartificial Enteric Cytopathogenic Human Orphan type 7 (ECHO-7) picornavirus that has been approved for the treatment of melanoma in Latvia, Georgia, and Armenia so far. Oncorine, on the other hand, is the world's first recombinant OV and the only approved adenovirus by the Chinese State FDA (SFDA) in 2005. It is used for the treatment of patients with head and neck cancer. The most

recently approved OV by the US FDA in 2015, is the Talimogene laherparepvec or T-VEC, which is a recombinant human HSV-1 deployed for the treatment of cutaneous high-grade melanoma.

While single-agent efficacy has been reported for many oncolytic viruses, a combinatorial therapy approach seems more propitious. This has clearly been demonstrated in two early-phase clinical trials where, patients with melanoma who received T-VEC along with one immunotherapy, like the checkpoint inhibitor anti-CTLA4 antibody ipilimumab - had higher response rates than those who received just the checkpoint inhibitor. Besides, the combination of vaccinia virus with paclitaxel, a chemotherapeutic agent, and/or radiotherapy, has shown a synergistic effect in tumour regression. With all these findings in place, the goal is to look for certain biomarkers for developing effective combination therapies and to select patients who are most likely to benefit from certain combinations. It's henceforth believed that as we continue to explore the mechanisms of oncolytic viruses with an increased number of clinical trials, better treatments for malignancies with higher degrees of biosafety will soon be on the horizon.

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The Prospective Anti-Ageing Potion of the Immune System

Suravi Mukherjee

Semester IX

INTRODUCTION:

$CD8^+$ T cells are equipped with variable T cell receptors (TCRs) which rely on heterogeneity and can convey antigen specificity. They contribute to the host's defense and anti-tumor responses, playing a key role in adaptive immunity. For the immunogenic response to be effective, the repertoire of naive $CD8^+$ T cells need to encounter an antigen, get activated, proliferate, differentiate and become effector cells called cytotoxic T lymphocytes (CTLs). After infection, most effector cells die, but a subset of cells can survive and differentiate into memory cells. These cells protect against the secondary infection caused by the pathogen. The observation that individual naive T cells can generate different progenies implies that their fates are not pre-determined. How memory and effector cells are differentiated is still not fully understood, but it has been found that specific transcription factors, epigenetic changes during the course of immune responses, metabolic profiles and asymmetric cell division (ACD) have contributions to this process. The effects of ageing on our adaptive immune system include a decline in production of new naive T cells, a restricted TCR repertoire and weaker activation of $CD8^+$ T cells in response to an intracellular infection.

WHAT IS ACD?

Asymmetric cell division (ACD) is a crucial mechanism by which the diversity of T cells is generated. Asymmetry depends on the formation of a polarization axis in $CD8^+$ T lymphocytes, which is achieved through their interaction with antigen-presenting cells at the contact interface between the two types of cells. This setting up of what is called an **immunological synapse** remodels the cytoskeleton of T cells leading to the asymmetric partitioning of their surface molecules (like TCR, cytokine receptors, CD4/CD8), cell fate determinants (like transcription factors) and metabolism (like mTOR activity). The two emerging progenies have different potential fates and transcriptional profiles - the distal daughter is expected to become a memory cell, while the proximal daughter has an effector cell fate. Microscopic observations, as well as transcriptional profiling of individual cells in immune responses, have shown that an early bifurcation of gene expression occurs after one cycle of mitosis to set up this polarity.

mTOR INHIBITION AS A METHOD OF REJUVENATION

mTOR (mammalian target of rapamycin), the catalytic subunit of two distinct protein complexes, mTORC1 and mTORC2, regulates T cell differentiation among many other functions, and its inhibition shows a beneficial impact on memory formation. It was hypothesized that inhibiting mTOR could improve or re-establish the ability of T cells to divide unevenly. mTOR is very relevant to the process of ageing in different eukaryotic organisms, and its inhibition has shown potential to produce an extended life span and improved immune functions in old mice and humans. Studies in yeast have shown that the use of rapamycin or other mTOR inhibitors can lead to higher ACD rates in naive and memory cells. Subsequent findings support the notion that ACD can be modulated only by transient mTOR inhibition following TCR engagement. So when $CD8^+$ T cells were taken from mice constitutively lacking mTORC1 or mTORC2 activity and stimulated under *in vitro* ACD conditions, the ACD rates did not increase. Furthermore, it was proved that changes in symmetry do not cause a permanent change of metabolism, as mTOR activity was restored within a few hours of the removal of drug treatment.

Another link between ACD and enhanced memory potential was obtained by selective polarisome destruction during first mitosis. Polarisome is a protein complex that helps in determining cell polarity by driving the assembly of actin filaments at polarization sites. Conditions that normally support ACD in $CD8^+$ T cells fail to do so when a component of the polarisome called PKCζ is inhibited. The polarisome complex is key to establishing asymmetry, so silencing of PKCζ defects the establishment of polarity and therefore defects T cell memory. These experimental results show that transient mTOR inhibition cannot create polarity, but benefits the formation and continuity of asymmetry in polarizing conditions. All these observations open up new areas of research where enforcing ACD by various means can be used to improve memory potential and "rejuvenate" exhausted $CD8^+$ T cells in cancer and chronic infections.

VIRTUAL MEMORY T CELLS - AN ADAPTATION TO AGEING

Ageing causes a progressive decline in the efficacy of the immune system and makes the system more vulnerable to infections and autoimmune diseases. This multifaceted phenomenon called **immunosenescence** threatens the diversity of T cells as a result of thymic involution and antigen exposure history. The decline of thymic output with age causes an alteration in the T cell composition, with fewer naive T cells migrating to the periphery and memory $CD8^+$ T cells becoming dominant, accumulating by cytokine-driven homeostatic proliferation.

Memory phenotype $CD8^+$ T cells that are not previously exposed to a foreign antigen are called virtual memory T cells (T_{VM} cells). They are a population of semi-differentiated $CD8^+$ T cells that arise from naive $CD8^+$ T cells in the periphery, driven by cytokine signaling. The characteristics of T_{VM} cells pose a paradox - on one hand, they express some markers of memory cells, facilitating long-term survival by proliferation; on the other hand, they show features of effector cells, resulting in protection against infection in aged individuals in spite of low proliferation potential. T_{VM} cells have been found to produce cytokines readily, even in the absence of antigenic exposure. They also constitutively express effector molecules and transcription factors that facilitate their effector functions. The composition of T cells undergoes a drastic change with ageing, where levels of naive T cells drop and that of T_{VM} cells rise. Lower ACD rates were found in naive $CD8^+$ T cells taken from aged animals, which could be reversed by transient mTOR inhibition. However, T_{VM} cells from the same source showed an intrinsically high rate of asymmetric division and were found to be unresponsive to mTOR inhibition-mediated enforcement of ACD. Since it was previously shown that ACD can lead to diversity in T cell responses and increase memory potential, T_{VM} cells appear to be an adaptation of the immune system in response to immunosenescence.

CONCLUSION

Despite the potential shown by ACD modulation to become a tool for enhancing memory responses or rejuvenating exhausted $CD8^+$ T cells in aged individuals, the specific mechanisms underlying these observations remain unknown. The molecular details, of mechanisms by which mTOR inhibition and increased cell polarity promote ACD without altering other cellular processes, is yet to be understood. However, the observations open up new doors to use this functional trait of T cells to develop vaccinations and T cell-based immunotherapies. The T_{VM} cells were found to compensate for the loss of memory potential of the naive $CD8^+$ T cells, which open up new perspectives for the enhancement of immune functions in the elderly population.

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Cleaning Stations in Marine Environments: A Unique Mutualism in Fishes

Swarnavo Mitra

Semester: IX

Introduction:

Marine environments, as we all know, covers three-fourths of the entire planet's environment and yet we all know very little of the vastly varied ecosystems and biodiversity exhibited in such environments. As we all know, marine environments cover three-fourths of the entire planet's environment. Nevertheless, we all know very little of the vastly varied ecosystems and biodiversity exhibited in such environments. However, like all the basic rules of ecology in this environment too, the basic relationships of ecological interactions also prevail, in which symbiotic relationships is no exception. In this article, a very peculiar kind of relationship is observed, which is a peculiar kind of fish cleaning behaviour, where one fish species, the cleaner, feeds on the ectoparasite load of the other fish species, the host, thereby getting rid of its ectoparasite load

Multiple studies were conducted in the six Caribbean Islands and also on a fringing reef off the coast of Barbados by the BellAirs Research Institute in the West Indies. It was done in several locations to understand the variability of these interactions based on ectoparasite availability in those regions. Sometimes the cleaner gobies tend to cheat on their host by removing their scales when the ectoparasite load is lower in the host. This type of behaviour typically has a negative impact on the host. It might decrease the fitness or survivability of the host. The organisms which were chosen to study these interactions were between the Longfin Damselfish (*Stegasteus diencaeus),* and 1the host, and Sharknose Cleaning Gobies (*Elecatinus evelynae).*

Materials and Methods: -

Sample of the two interacting species were collected from six different islands in the Caribbean- Barbados, Curaçao, Tobago, Puerto Rico, St John (US Virgin Islands) and Jamaica. In the six of them, the ectoparasite diversity is quite varied. The host Longfin damselfish are normally found in shallow water fringing reefs where they compete and defend territories in feeding between them. The Sharknose cleaning gobies reside predominantly in pairs of a group within sponges. Their feed of choice is ectoparasite gnathiid larvae from the body surface of reef fishes. For their study, between 14 and 25 Longfin Damselfish were selected randomly, and then they were

observed. Following observations, for determination of the ectoparasite load, individual longfin damselfish were caught using barrier and hand nets, and then placed into hermetically sealed plastic bags and then euthanized using clove oil. Then each fish was placed in a 0.4 % chloretone bath for 1 hour to remove all ectoparasite loads. For the collection of this ectoparasite load, the liquids in the fishnet were rinsed thoroughly and then filtered. The ectoparasites were removed from this filter paper and then transferred into a Petri dish for identification through a binocular microscope.

Along with this, adult cleaning gobies were also collected (12 -17) using an excess of clove oil and preserved in 75% alcohol immediately. Their gut was then dissected and examined under a light microscope to estimate the quantity of each food item category (crustacean parasites, scales, mucus, crustacean non-parasites, etc. Non –parasitic cleaning materials were that of scales and mucus and provided evidence for 'dishonest' cleaning.

Observations: -

A net of 4-15 minutes of observation time was allotted for each damselfish, along with which the time spent by each damselfish with cleaning gobies was also recorded.

a. Variation in cleaning, and its benefits: -

It was observed that the damselfish individuals who had a cleaning station in their territory spent more time with cleaners than the damselfish individuals who did not have any cleaning stations. Now, along with this, a second variation was noted in the meantime spent in cleaning stations, location wise (8.1 + 2.4,0.6+0.4 with and without cleaners in Tobago and 16.4 + 5.7,3.8 + 1.3 with and without cleaners in Puerto Rico. Overall, damselfishes without cleaning station spent only 7-23% as much time with cleaners as their counterparts with a cleaning station.

In different islands, the average ectoparasite loads varied for fishes with and without cleaning stations in their territories. Significant differences in ectoparasite load between fishes with and without cleaning stations in their territories were observed in the islands of St. John, Puerto Rico, and Curacao. The differences in ectoparasite loads were calculated as a mean difference in ectoparasite loads between fishes with and without cleaning stations in their territories. These differences could be linked to the benefit of being cleaned.

b. Variation in the cost of getting clean: -

The diet of the cleaning gobies was analyzed to determine whether they had actually consumed any ectoparasite or other non-parasitic material like the scales or mucus of the host, which are all examples of dishonest cleaning. Significant variation was also observed in

non-parasitic material for the six different islands. Nearly two-thirds of the digested material of cleaning gobies were of non-parasitic nature (mucus, scales). The results were plotted statistically, and it was found out that non-parasitic gleaned material of the host's body was negatively correlated with the mean ectoparasite load of each Longfin Damselfish on each Island. A statistical analysis of the results was performed, and a table was plotted. The data revealed that of the six Islands, the highest amount of non-parasitic material was detected in Jamaica, Barbados and Curacao, mainly in the presence of Scales and Mucus in digested material. Coincidentally, these regions showed the lowest population of ectoparasite i.e., gnathiids larva, in digested material of the cleaning gobies.

Conclusion:

How much do we really know about such peculiar interactions in the marine world remains elusive till date. Further investigation and scientific exploration can bring up more of such peculiar interactions that is nothing short of getting our laundry to the dry cleaners!

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RNA Therapeutics and Delivery Systems

Dhrisaj Ray

Semester VII

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Semester VII

What are RNA Therapeutics?

RNA therapeutics involves the use of exogenous RNA in order to upregulate or downregulate the production of certain proteins. This is a rapidly expanding category of therapeutics that comprises drugs that are cost-effective and easy to manufacture. RNA therapeutics have the potential to make personalized medicine a reality and completely do away with the concept of "undruggability".

The term "undruggable" is given to those proteins which are yet to be targeted pharmacologically.

Conventional therapeutics involves the use of small molecules which are able to target the active site of certain proteins in order to inhibit or bring about a change in their function. The drawback of such a strategy lies in the fact that only 1.5% of the genome codes for proteins and of those proteins only 10 to 14% have active sites which are "druggable." This thus greatly limits the range of small molecular therapies.

An improvement on this strategy comes in the form of using recombinant proteins as therapeutics. This method too comes with its fair share of drawbacks which arise due to the large size of proteins and the possibility of improper folding. This coupled with the fact that some proteins may need post-translational modifications to fold and carry out their functions, further complicates the process of their synthetic creation.

Nucleic acid therapeutics overcome these flaws by making use of our own protein synthesis machinery and by not needing "druggable" targets.

The function of RNA therapeutics varies based on the type of RNA used.

1. **mRNA** is used for protein upregulation. It may be used as:

1. *Replacement therapy*, wherein the mRNA is administered to an individual in order to compensate for a defective gene or protein, such as the use of mRNA to treat *cystic fibrosis*, caused due to a mutated *cystic fibrosis transmembrane conductance regulator (CFTR)*, a chloride channel. The drug is delivered to the lung epithelium where it codes for fully functional CFTR.

2. A *vaccine*, where the mRNA encodes for a protein that would normally be absent in the cell, such as the *modified SARS-CoV-2 spike protein* in COVID-19 vaccines.
3. *Cell therapy*, whereby the mRNA is transfected into cells ex vivo (in an external environment), following which the cells are delivered into an individual.

2. siRNA is used for protein downregulation via RNA interference. There are a large number of siRNA drugs currently undergoing clinical trials, one being *Patisiran* for the treatment of *transthyretin amyloidosis* (abnormal build-up of amyloid deposits consisting of misfolded transthyretin protein).

3. miRNA is generally also used for the downregulation of certain proteins. However, a rare subset of miRNAs is also known to enhance protein synthesis. There are many miRNA-based drugs undergoing clinical trials such as *MesomiR-1*, a miRNA mimic (dsRNA molecules which mimic endogenous miRNA) containing the *tumour suppressing transcript miR-16* which targets an antibody against *epidermal growth factor receptor (EGFR)* which is deregulated in *lung cancer cells*.
However, the use of RNA as therapeutics also has various drawbacks such as:

- ssRNA is prone to degradation by nucleases.
- Exogenous RNA may lead to an immune response in the recipient.
- RNA is too large and negatively charged to pass through the cell membrane passively.

These drawbacks can be overcome by using the right RNA delivery system. This makes the delivery system vital to RNA therapeutics.

Delivery Systems

RNA delivery systems are divided into *viral* and *non-viral systems.*

Viral-based delivery systems involve the use of *retroviruses, lentiviruses*, and *adenoviruses*. The genomes of these vectors are made to undergo certain modifications which hamper their ability to replicate. They allow for high transfection efficiency. They have some drawbacks as well, such as toxin production and the possibility of an inflammatory response due to their high immunogenicity.

In contrast to this, non-viral delivery systems are much less toxic and immunogenic but provide a lower transfection efficiency.

There are many types of non-viral delivery systems. Some of these include:

1. *Lipid-based Nanoparticles*, which involve the use of liposomes. They serve as flexible drug delivery particles as their surface can be modified based on application. Liposomes are less stable, may even fuse with the cargo RNA, entrap less RNA, and can get oxidised to harmful products. These problems can be overcome by modifying the liposome surface.

Other lipid nanoparticles (LNP) composed of cationic lipids and lipids like *polyethylene glycol (PEG)* and *cholesterol* protect the RNA from degradation and are relatively more stable.

2. *Polymer-based Nanoparticles*, which include synthetic polymers like *PLA (polylactic acid), chitosan, gelatin, polycaprolactone*, and *polyalkyl-cyanoacrylates*. They have a long shelf-life and are capable of targeted delivery. Cationic hydrophilic polymers with hydrophobic modifications are able to self-assemble and encapsulate RNA. They are more stable than LNP but promote inflammation due to their long shelf life.

Other delivery systems include *silicon-based nanoparticles*, *N-Acetylgalactosamine (GalNAc)*, etc.

While these different systems may have different drawbacks, the common drawback shared by all is their *ability to generate an immune response*. This can be overcome by making use of a delivery system encoded by the body of the patient itself.

SEND

Recently a novel delivery system has been discovered which makes use of the natural proteins present in our body. These proteins form virus-like particles and house RNA and could be less immunogenic than the other methods. This is *Selective Endogenous eNcapsidation for cellular Delivery (SEND)*. The protein in question is *PEG10* which is a *retrotransposon-derived protein* and was chosen for its ability to package specific RNA (it can be modified to carry the RNA of interest). In addition to this, the PEG10 protein particle surface was decorated with *fusogens* (proteins involved in membrane fusion, like *SNARE proteins*) that bind to specific target cells and help in targeting the capsule to a particular cell.

Although research regarding this novel system is still going on, it could possibly pave the path for a revolution in an already revolutionary field.

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MicrObesity: Looking at the Gut Microbiome and How Its Dysbiosis Can Lead to Obesity

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Semester VII

As human beings, we share our bodies with millions of microbes living harmoniously within us. All organs, including our skin, our gut, liver, etc., have a population of microbes residing in them. However, the most interesting is the population that resides in the gut. The gut microbiome has a variety of roles hugely beneficial to our existence as they help with metabolism, fighting pathogens, optimum utilisation of energy, etc. Recent experiments have shown to indicate the composition of the gut microbiome is directly in correlation with fat deposition in adipose tissues after metabolism in the gut. Experiments conducted in mice showed the bacteria free mice were more likely to be lean and have lesser fat deposition, while a control group had more fat deposition despite being fed less. More interestingly, when these axenic mice were treated with the microbiome of lean mice, they gained total body mass even with decreased amount of food intake. The weight of the axenic mice increased even more when they were treated with the microbiome of genetically obese mice, directly correlating the role of the microbiome with fat deposition. The composition of the gut microbiome has been shown to play an important role, where in obese mice there was a larger population of Firmicutes in contrast to Bacteroidetes while lean mice had the opposite ratio.

Scientists suggested multiple mechanisms as to how the gut microbiota could regulate this kind of fat deposition. One group suggested the increase of monosaccharide absorption was due to the fact that the walls of the small intestinal epithelium present in the villi was doubled. Another group believed that the axenic mice had activated AMP-driven protein kinase activity which induced fatty acid oxidation in skeletal muscles and liver and was repressed by normal gut flora in mice. Another mechanism suggested that the microbiota extracted energy from undigested food materials and induced de novo lipogenesis via two enzymes ACC (Acetyl-CoA Carboxylase) and FAS (Fatty Acid Synthase). Both FAS and ACC are regulated via ChREBP (Carbohydrate Responsive Element Binding Protein) and SREBP-1 (Sterol Responsive Element Binding Protein) but a direct correlation could not be established between lipogenesis and the microbiota even though axenic mice were seen to have elevated mRNA levels of ChREBP and SREBP-1. This led people to believe that it was the adipocyte Lipoprotein Lipase (LPL) which was being repressed directly by the gut microbiome by an LPL inhibitor called Fasting Induced Adipose Factor (FIAF). FIAF repressed LPL which stopped the release of fatty acids from triglycerides in axenic mice.

The reverse happened with a normal flora inhibiting FIAF which induced more fat storage via increased LPL activity.

Alternatively, it has been proposed that increased gut permeability may be associated with obesity and fat deposition. Under healthy conditions, the epithelial tissues of the gut act as powerful barrier and prevent LPS-induced bacterial translocation. Various factors like alcohol consumption, stress, exposure to radiation may lead to a 'leaky gut' due to changes in two tight junction proteins, ZO-1 and 151ccluding, in the intestinal tissue, which leads to bacterial translocation and increased adipose deposition.

The gut microbiome is found to regulate the gut permeability via the LPS-eCB system. LPS stimulates endocannabinoid synthesis by blocking the CB1 receptor, which controls the gut barrier function and helps reduce inflammation and obesity. The gut microbiota and changes in its composition were found to alter eCB levels – both genetically obese mice and dietically-induced obese mice had increased levels of eCB in the intestine. CB1 blocking reduces gut permeability via improved ZO-1 and 151ccluding localisation and distribution.

So, from these observations, we can safely conclude that gut microbiome and its constitution play a vital role in the regulation of fat deposition and can be used as a therapeutical target for treating acute obesity and other weight related problems.

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Secret Messaging Through Origami

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Semester VII

"I will write peace on your wings and you will fly all over the world."

-Sadako Sasaki (aged 12), a victim of the atomic bombings (*Hibakusha*).

Often associated with the Japanese culture since time immemorial, origami (折り紙) comes from "ori" meaning "folding" and kami meaning "paper". Thus, origami is simply the art of folding paper. Traditionally it has been practiced since the Edo period (1603–1867). Origami is a form of entertainment within families. Ihara Saikaku, in 1680, mentioned a paper model which describes a traditional butterfly design used during Shinto weddings in a short poem. Since then, people have attached noshi to gifts, much like greeting cards used today which is the earliest record of the origin of origami to date. Senbazuruis is considered a symbol of peace, and hence, on November 11 in 1918, when WWI ended, a time of short-lasting peace settled upon the world. So, this day, 11.11 makes an origami paper because four "1" indicates each side of a square. November 11 since then has been celebrated all over Japan as "National Origami Day", wherein various competitions are held to commemorate the day of peace.

However, even Akira Yoshizawa (March 14, 1911 – March 14, 2005), considered to be the grandmaster of origami, might also have not envisioned how this art could one day gradually come to change the face of research. In the early 1980s, the idea of using DNA as a construction material for creating origami shapes was first introduced by Nadrian Seeman. Paul Rothemund developed the current method for creating DNA origami at the California Institute of Technology (CalTech). The idea was so amazingly breathtaking that it became the cover story of Nature on March 16, 2006.

DNA origami is an ingenious technique that uses staple strands consisting of hundreds of short DNA oligonucleotides to fold a long single-stranded DNA, called a scaffold strand, into various designer nanoscale architectures. DNA origami has a high degree of customization and spatial addressability. So, it is a versatile platform to engineer nanoscale structures and devices that can

become potential biosensors. As a result, opportunities for a broad range of applications in various fields, such as chemistry, biology, physics, material science, and computer science which have often needed programmed spatial control of molecules and atoms in three-dimensional mode, have opened. The core of the technique involves Watson-Crick base pairing (A with T and G with C). A raster fill of a single long DNA molecule is used to draw images. These images are then fed into software that calculates the location of individual staple strands. The staples bind to a specific region of the DNA template by base-pairing. Hence, the necessary sequences of all staple strands are known and displayed. The DNA is then mixed, heated, and cooled, and the staples pull the long strands into the specified form. The designs created can be directly observed via electron microscopy, atomic force microscopy, or if the DNA is coupled to fluorescent tags, then fluorescence microscopy.

Fascinatingly, DNA origami has also been used in cryptography to hide messages. Ciphers have been used since the time of Julius Caesar, who used Caesar's cipher for his correspondences. Information security which is based upon the "CIA triad" of confidentiality, integrity, and availability in recent years, has been facing severe challenges due to the development of next-generation cryptography that can crack currently used cryptography protocols within good time by brute-force attacks. In contrast, using prime factorization via Shor's algorithm, the emergence of novel quantum computers can crack keys. Thus, biomolecular cryptography has come into the spotlight in the recent decade because of the utilization of highly specific, thermodynamically controlled biomolecular interactions instead of computational schemes for data encryption.

In "DNA origami cryptography" (DOC), messages are encrypted into sequential spot patterns that are physically implemented into a combination of scaffold strands, each carrying a set of message-specific biotinylated strands. To decrypt the message, the scaffold strand is folded into a DNA origami structure using a specific set of staple strands. Stenography is used as the secret weapon for messaging, and the whole process has three layers. These layers are encryption of the message into a dot pattern - the outer layer, followed by steganography- the intermediate layer and eventually DNA origami encryption (DOE)- the innermost layer.

We take a particular scenario where the communication is happening between Alice and her colleague, Bob. Alice wants to send "HEY" to Bob. So, she converts her plaintext into binary numbers, letter by letter, followed by encryption of the numbers for each letter and their respective positions in the message into a braille-like spot patterned cipher which is already pre-defined. Every spot within the pattern represents a definite digit of the binary numbers coding the letters or their positions. The key to the technique is the permutation of the spots to represent the secret information.

A DNA origami folding scheme is then used for the next encryption step. A custom DNA scaffold sequence is routed through a defined geometry covering the spot pattern. Notably, the origami structure is not physically folded with DNA staple strands at this stage. Instead, a set of biotinylated message strands ("M-strands") are hybridized to the scaffold strand. For making a structurally symmetrical DNA origami form, an extra M-strand is usually introduced as a "marker", therefore facilitating the distinctive identification of the pattern further downstream. During this process, the initial pattern gets encrypted into a mixture of scaffold strands carrying the M-strands. The key to the puzzle is the precision of folding of the scaffold with a particular length, sequence, and folding shape. To any potential adversary, the biotinylated positions are invisible and due to steganography, there is additional protection. Every M-strand contains a three-thymine spacer close to the biotin and a 40–48 nucleotides segment which perfectly matches the scaffold. This ensures that the occurrence of biotin is at the desired spot site. The M strand does not get displaced from the scaffold by the shorter origami staple strand when the origami structure is being physically folded during the thermal annealing process from 57 °C to room temperature (sufficient for single-layer DNA origami folding) in 1x TAE buffer containing 12.5 mM Mg^{2+}. This is because of its length. Only after removal of the unbound M-strands, collection of the scaffold strands carrying different M-strands is possible. They are subsequently delivered in a test tube or adsorbable paper.

Bob then must fold the DNA origami structures physically with the corresponding staple strands to reveal the biotin patterns to read the secret message sent to him by Alice. He has the other secret weapon, streptavidin. To visualize the biotin patterns under an atomic force microscope (AFM), Bob uses streptavidin to observe the dot patterns. Bob decrypts the patterns one by one to obtain the plaintext message “HEY” based on the defined array for pattern encryption when the braille-like pattern of the streptavidin-biotin binding shows up. Alternatively, fluorescently labelled M-strands can also be used to define the DNA pattern, which would require stochastic optical reconstruction microscopy (STORM) for the big revelation.

This powerful and versatile DOC tool has been used to transmit other data formats such as musical notes and images and shows great promise in the information security sector as needed in this era where every country has nukes and is always at competitive wars with each other to protect the privacy of their governments, leaders, and citizens. We can only hope to see how far DOC goes from here in the future.

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Neurobiology of Addictive Smartphone and Social Network Use, and its Antidote

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Semester VII

Introduction

Smartphones and social media have become an inseparable part of our lives, and we seem to be increasingly addicted to it, which translates to a deterioration of the general quality of life, especially for the youth. This article aims to discuss certain strategies that Social Network Companies use to encourage addictive behavior, hijacking our basic neurobiology of "reward". Some counter-strategies we can use to regain control over our technology usage, are also discussed.

The Neurobiology of Addiction

The Nucleus Accumbens of the basal forebrain, which is a hub of neurons from different parts of the brain, remains a vital component in the mesolimbic reward pathway, which controls our sense of pleasure and pain. Our addictive behavior can be partly explained by the tonic-phasic model of the dopamine neurotransmitter (DA) action, dopamine being a key player in motivation.

In response to certain drugs or behaviors, DA neurons in the Ventral Tegmental Area (VTA) release DA in the nucleus accumbens. There are two kinds of DA release. "Phasic" release is a rapid spike in DA levels in synaptic clefts in response to stimuli. This is in a high enough concentration to stimulate the low affinity D1 receptors, responsible for the "rewarding" nature of these stimuli. To end the DA transmission, this DA is rapidly reuptaken by the DA neuron terminal before it can diffuse into the extracellular space.

In contrast, "Tonic" or baseline levels of dopamine is contributed by sustained increases in DA neuron firing by repeated exposure to excitatory stimuli. This dopamine escapes from the synaptic cleft into the extracellular space. At this concentration DA cannot stimulate the low affinity D1 receptors but is enough to stimulate the high affinity D2 receptors at the presynaptic

neuron, which *inhibits* the phasic release of Dopamine from the terminal, which is the main source of reward from a pleasurable stimulus. Now, repeated administration of drugs which cause huge DA spikes increase tonic levels of dopamine, by leaking out of dopamine into the extra-synaptic space. The D1 receptors are also downregulated, to desensitize the neurons. At this point, if the drugs are withdrawn, the elevated tonic DA levels now downregulate DA release from the presynaptic neuron. This is further worsened by the involvement of the neurons of the cerebral cortex that project into the nucleus accumbens, which, in response to withdrawal, release glutamine into the nucleus accumbens. Glutamine stimulates tonic release of DA which further suppresses phasic release.

This means that activities previously pleasurable will now no longer be pleasurable, resulting in a general state of dysphoria. This is relieved only when the addictive substance is taken, in increasingly greater amounts, to bring back the tonic-phasic DA levels in equilibrium.

Why is social media addictive?

Connectivity tools were "designed" to be addictive, with real financial incentive. When users spend time on these platforms, this "user engagement" is sold to advertisers in exchange for ad revenue, who can now supply users with targeted advertisements. Two of the many tools that these companies use are – **Intermittent Positive Reinforcement** and **Exploitation of the Drive for Social Approval** – to modulate user behavior to their advantage.

"This thing is a slot machine"

Casino owners have long known the strategy of Intermittent Positive Reinforcement. One does not always win a game, but wins enough to keep up expecting a win every time they play.

This is attributed to a feature of our dopamine pathways, called reward prediction error (RPE) encoding. An unexpected reward educates the reward circuit that the activity is pleasurable. Next time, dopamine is released to motivate *pursual*, not during the reward. When we don't receive the reward, we lower our expectation, nevertheless still pursuing, especially if the investment to pursue is low, for example, taking our phone out. Now when we get the reward, it comes off as *unexpected* and releases a greater dose of Phasic dopamine.

How is this implemented in practice? After a post, we might have noticed, Instagram delivers "likes" in bursts, not as they come. This can also explain mindless scrolling – majority of posts

we come across are uninteresting, but, every now and then a post evokes strong emotions in us – and it knows exactly what kind of posts we interact with, backed by algorithms analyzing our preferences – these emotions can be of strong hatred or joy, which keeps us "playing".

Drive for Social Approval

Survival in Paleolithic times necessitated awareness of social standing. Thus, dopamine mediated motivation for social approval is not surprising. This very drive has inspired the design of the "Like" button. "A little dopamine hit" provided by each "Like" encourages users to upload more content". Tagging people, which requires practically no effort on our part, due to facial recognition algorithms, provides a huge social validation for the person being tagged.

This also explains our urge to check our phones multiple times or immediately reply to texts, *irrespective of notifications*. Ignoring a text, to our primitive mind, means ignoring a fellow tribe member, which releases stress hormone Cortisol, making us anxious. To relieve this anxiety, we check in.

What can we do about it?

Psychiatrists often advise patients suffering from addictions, to abstain from their addictive behavior or substance for 30 days. During abstinence, our tonic dopamine levels normalize, allowing ordinary activities to be pleasurable. Dr. Newport in his book, "Digital Minimalism" provides a guide on structuring abstinence of digital technology.

To start, one must limit technology delivered through screens, like social networks, as far as possible and, set strict usage protocols for the indispensable, like messaging. During abstinence one should look for fulfilling 'analogue' recreations, which were possibly neglected due to entertainment from digital devices. Post 30-days, technology reintroduction must be judicious, carefully weighing the actual benefits versus possible harms. It's suggested that the nuances of these strategies be delved deeper into, and hoped that this can help us cultivate a healthier relationship with our technology.

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3D Bioprinting:

The Future of Organ Transplants

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Semester VII

An organ transplant is one of the most common strategies suggested by medical practitioners as a means to treat patients in organ failure. However, organs matching the specific blood type and other antigenic specificities for the patient in question are often difficult to come by. As such, it is reported that an average of 20 people die each day, while waiting on the Transplant List in the USA. Moreover, in a patient having undergone a successful organ transplant procedure from a donor fitting all the required criteria, the transplanted organ still runs the risk of facing graft rejection, initiated by the recipient's humoral immunity system.

One of the emerging methods to overcome all of these issues is hidden in the field of 3D Bioprinting. Three-dimensional (3D) organ bioprinting refers to the use of 3D printing technologies for the assembly of multiple cell types or stem cells/growth factors together with other biomaterials using a layer-by-layer fashion so as to produce bioartificial organs that imitate their natural biological counterparts to the maximal possible degree. In this process, 3D Biological structures are fabricated by accurate layer-by-layer positioning of biomaterials, biochemicals and living cells, along with spatial control of the positions of the functional components. One of the major challenges of this technique lies in the immense difficulty associated with the reproducibility of the complex and intricate micro-architecture of tissues and the Extracellular Matrix with resolution that is sufficient for reiterating their biological functions.

There are 3 major approaches taken towards 3D Bioprinting:

a. Biomimicry – The cellular/extracellular components of a tissue/organ are reproduced identically by the reproduction of various cellular functional components of tissues. For example, it may include exact mimicry of the branching pattern of the vascular tree in an organ/tissue.

b. Autonomous Self Assembly – In this approach, early embryonic organ development is used as a guide and early cellular components of developing tissues, together with their own ECM components, cell signaling machinery and autonomous organization are used to achieve the required micro-architecture and associated functionality.
c. Mini tissues – The term refers to smaller structural and functional units of a tissue which may be fabricated and assembled into the larger tissue/organ construct by efficient and logical design, self-assembly or an overlap of both. For example, the nephron is the structural and functional unit of a kidney, a large number of which may assemble to form a kidney in the appropriate conditions and under the appropriate cue.

An important prerequisite before moving on to the bioprinting step is having a comprehensive and elaborate idea of the 3D structure of the organ/tissue being printed in the recipient. This is done using extensive imaging techniques such as a CT Scan or MRI Scan. Computer Aided Design and Computer Aided Manufacture (CAD-CAM) tools are also used for accurate mathematical modeling of the dimensions and architecture of the same, before printing.

Another important prerequisite is the selection of the appropriate biomaterial for printing. Such material must satisfy a few properties before its use as a biological scaffold is popularized:

a. Printability – Various properties of the material, such as its rheological properties, gelation and viscous properties contribute to the printability of a material.
b. Biocompatibility – The scaffold material must not induce any undesirable response, local or systemic, from the host and must also sufficiently contribute to the biological functionality of the organ.
c. Material Biomimicry – The material properties must match, as far as practicable, the properties of the endogenous tissue.
d. Degradation kinetics and byproducts – Degradation byproducts must be non toxic and the rates of degradation must be matched to that of ECM formation by cells.
e. Other Structural and Mechanical Parameters must be maintained strictly.

Biomaterials used for 3D Bioprinting include both those derived from natural sources (such as alginate, gelatin, fibrin) and even those obtained synthetically (such as Polyethylene Glycol). Both these classes of materials have numerous advantages and disadvantages in comparison to the other. However, in recent years the use of synthetic hydrogels has gained momentum over its natural counterparts, owing to the relative ease of manipulating their physical properties during synthesis so as to yield a biomaterial tailor made for a specific application.

Another important choice that needs to be made in this process, is the choice of cells that will be used to seed the construct. Not just the functionally important cells, but also the structurally important cells along with various other classes of cells (including those needed for vascularization, stem cell maintenance and differentiation) need to be accurately positioned in the printed matrix to yield a stable bioprinted tissue/organ. Cells may be printed using either of the two approaches listed below:

a. Depositing the various primary cell types in patterns mimicking the native tissue.
b. Printing stem cells that are capable of proliferation and subsequent differentiation into each of the required cell types.

It is also extremely important to accurately monitor and control the rates of cell proliferation so as to maintain the physiological ratio of structurally and functionally relevant cells. The timing of cell proliferation also needs to be intricately regulated so as to avoid hyperplasia while maintaining tissue homoeostasis. In order to bypass the problem of graft rejection that is commonplace in context of conventional organ transplants, autologous host cells are usually obtained from biopsies. Another emerging alternative to the use of autologous host cells is the use of embryonic stem cells or induced Pluripotent Stem Cells (iPSCs).

Being an emerging field, the use of 3D Bioprinting technologies in organ transplants continues to face a large number of challenges as it strives for continued and popular use. Despite being in early stages of development, this technology has been successfully used to produce 2D tissues (skin), 3D hollow tubes (trachea) and even a 3D Solid organ (Kidney). Interdisciplinary research in this field towards the production of more number of complex organs with increased complexities, bears promise to revolutionize the field of organ transplant in the near future.

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Jumping Genes: From Junk to Gem

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Semester VII

Over 60 years ago, Barbara McClintock made her Nobel prize winning discovery and in doing so she left the entire scientific community completely baffled. McClintock at that time had been studying chromosome breakage in ear of a corn and that's when she came across certain mobile segments of the chromosomes which could shuffle between different genes, and when these mobile elements got inserted into different genes, they could reversibly alter the expression of those target genes. Paying homage to their ability to exhibit transposition, she referred to these mobile DNA sequences as 'jumping genes' or 'Transposable Elements (TEs)'. Although it was eventually accepted by maize geneticists, it took some time for the scientific community to grasp the true gravity of her discovery.

As time progressed, it was observed that transposons are abundantly present in a majority of prokaryotic and eukaryotic organisms. In fact, the TEs make up more than 65 % of human, 12 % of *Caenorhabditis elegans* and more than 85 % of the maize genome. In eukaryotic genomes, these TEs are present in both euchromatin and heterochromatin regions.

Although they were once considered to be 'junk', transposons play a vital role in transcription regulation, maintenance of chromosomal architecture and genomic stability. Additionally, they impart an epigenetic effect on host function and fitness.

TEs have a way of promoting havoc in the system by getting inserted in different sites within the genome and thus disrupting the target gene's function. Insertion of transposons into introns may not allow events such as transcription, polyadenylation and alternative splicing to occur properly, and as a result, they have been reported to cause several life-threatening disorders including cancer and neuropsychiatric disorders like Schizophrenia.

Classes of Jumping Genes

Jumping genes can be predominantly classified into two major classes: retrotransposons and DNA transposons.

Retrotransposons: Retrotransposons comprise the class I TEs. Retrotransposons can jump to different locations within the genome by forming RNA intermediates via reverse transcription. They achieve this with the help of reverse transcriptase enzyme which is encoded by the retrotransposon itself. Depending on the fact whether the retroelement main body is flanked by Long Terminal Repeats (LTRs) or not, retrotransposons can be classified into LTR

retrotransposons and non-LTR retrotransposons, respectively. LTR retrotransposons are also known as Human Endogenous Retroviruses (HERVs). Although HERVs gradually lost their ability to jump due to accumulation of mutations, they still play a very crucial role in multiple arenas. For example, certain HERV-encoded proteins are vital for proper placental developmental, whereas other HERVs influence host gene expression during early embryogenesis. This is one of the primary reasons why transposons are tightly regulated from early embryonic stages throughout one's adult life via epigenetic mechanisms.

Non-LTRs are also known as poly(A) retrotransposons and are represented by LINE-1 or L1 and Alu elements. Alu, due to its relatively small length, is also known as Short Interspersed Transposable Elements (SINEs). Both L1 and Alu are found in human genome. Non-LTR TEs are the only active class of transposons still present in the human genome, whereas the other classes of TEs, through subsequent mutations over the years, have been inactivated and thus are no longer capable of jumping and exist in our genomes as ancient, inactive relics.

DNA Transposons: DNA transposons are autonomous TEs and fall under the second class of TEs. They can translocate via the cut-and-paste mechanism, which is carried out with the help of translocases, which are proteins encoded by DNA sequences comprising the transposons. They may encode some additional proteins; however, they do not rely on RNA intermediate formation for translocation. DNA transposons possess 9-40bp long Terminal inverted repeats flanking each end which are recognised by transposases.

Both classes of TEs possess certain sequences called flanking direct repeats. They are not part of the TEs themselves and are left behind as 'footprints' after transposition has occurred. These footprints are capable of modulating gene expression even after the TEs have moved to a new location in the genome.

Jumping Genes in Cancer

It has been seen that HERV-encoded accessory proteins may be involved in certain types of malignancies. Studies suggest that transposons can act as stealthy players in tumour growth. In certain cancers, these transposons, upon activation, cause some genes to be continuously expressed, even when they should be switched off, and this in turn results in rapid tumour growth. Researchers also observed that TEs were not equally important in all types of tumour growth. Rather, their importance varied in different types of cancer. It was observed that in 12 % of gliomas, a single type of jumping gene was activated, and 87 % of lung squamous cell carcinomas displayed activation of jumping genes. Additionally, activation of a specific jumping gene was also observed in melanomas.

LINEs and SINEs are the two most essential TEs in cancer. Active transposons are highly susceptible to mutations, and thus are frequently found to be associated with the development

and progression of certain types of cancer. De novo insertions of LINE and LTR sequences have been shown to promote alternative transcription of a new isoform of *ALK* (Anaplastic Lymphoma Kinase) gene and this new isoform has been linked to 11 % of melanomas.

In another study, researchers have observed that the DNA of certain types of colon cancer cells, LINE-1 had been copied and inserted at multiple positions within the DNA. In fact, certain regions of their insertions had already been identified as key players in the development of tumours. Through NGS analysis using DNA from 16 colons with tumour and 16 normal colons, the DNA from the tumours exhibited insertion of nearly 17 new LINE-1 insertions, compared to the DNA of normal colon cells which had none.

Discussion

We know so much about cancer, yet we do not know enough. By knowing how TE-mediated oncogene activation occurs and by finding a link between transposons and different types of malignancies, we can use these elements as markers in the future to enable earlier detection, thus permitting better disease prognosis in cancer afflicted individuals. They may also be used as novel targets for cancer therapeutic interventions. Thus, transposons may hold the key behind successful development and application of personalised cancer therapies. As a matter of fact, certain preclinical and clinical trials are being undertaken to treat solid tumours and haematological malignancies with epigenetic agents such as demethylases and bromodomain inhibitors.

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Orphan Non-Coding RNAs - The New Player in Understanding Cancer

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Semester VII

For years, scientists believed that 98% of our genome was junk, simply because it was non-coding. However, as research has progressed, such non-coding segments have grown to be of paramount importance. Non-coding RNAs (ncRNA) are of two types- the small ncRNA which are 18-200 nucleotides in length, and long ncRNA that are greater than 200 nucleotides in length. Small ncRNAs include chief regulators of cellular processes like microRNA (miRNA), small nuclear RNA (snRNA) and small interfering RNA (siRNA).

Recently, a new category of small ncRNAs has been characterized by Dr. Goodarzi and his team, named as the orphan non-coding RNAs (oncRNA). The oncRNAs are novel and have exhibited specific expression in cancer cells, while remaining largely undetected in normal tissues. The idea behind this discovery was that cancer cells might have the capacity to engineer novel regulators, that are absent in normal cells to achieve malignancy. Cancer cells can adopt these oncRNAs to promote metastatic progression by carrying out new regulatory functions. One such oncRNA that has been discovered in breast cancer cells is the T3p, mapping to the 3' end of the *TERC* gene, the gene responsible for coding the RNA component of telomerase. Telomerase is an enzyme that maintains the length of telomeres, which are repetitive sequences at the end of the chromosomes, functioning in protecting the chromosome from damage.

T3p was found to be a by-product of digestion of TERC RNA by TARBP2, an RNA binding protein and the endoribonuclease DROSHA, both of which were present at elevated levels in breast cancer. This finding suggested that the cancer cells could hijack the existing machineries to generate a pool of RNAs that could be adopted for their own functions. T3p inhibited the miRNA-RISC interference pathway by competing with miRNAs for binding sites on the target gene. T3p was found to specifically bind to miRNA-10b and miRNA-378c and form stable duplexes, whereas the TERC RNA did not. In highly metastatic breast cancer cells it was observed that, T3p got upregulated which suppressed miRNA-10b and miRNA-378c. This in turn, resulted in upregulation of the prometastatic genes *NUPR1* and *PANX2*, both of which are associated with more deteriorated outcomes in patients. Additionally, since T3p was detected in extracellular vesicles originating from the cancer cells, there lies a significant possibility that they educate non-tumor cells.

Since the oncRNAs are specific to cancer cells, they serve as potent biomarkers for cancer detection. More than half the oncRNAs screened were detected in extracellular vesicles, that were isolated from patient's serum or conditioned medium of breast cancer cell lines. This indicates their potential to be detected by liquid biopsy, a minimally invasive method which evades the need to perform biopsy of the tumor tissue and may allow for earlier diagnosis. Furthermore, oncRNAs directly correlate to the level of underlying tumor tissue, that other biomarkers like miRNAs did not.

However, cancer being such a heterogenous disease can hardly have one answer to it. It is unclear whether oncRNAs are universally exploited by other cancers or the variation in expression within a single heterogenous tumor. Yet, the discovery of this class of ncRNA, revealed novel functions of small ncRNAs and how they act as miRNA decoy. This contributes to further investigation of the cancer specific RNA landscape, providing a new possible diagnostic and therapeutic approach.

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A New Insight into Parkinson's Disease - The Role of α-Synuclein in the Impairment of Vesicular Processes

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Semester VII

Extensive research and various genetic studies showed that α-synuclein is an important player in a complex neurodegenerative disease such as Parkinson's disease (PD). The loss of dopaminergic cells in the substantia nigra (SN) leading to a deficit of dopamine in the striatum causes loss of motor features which is seen in PD. Several point mutations in the *SNCA* gene encoding for α-synuclein (α-Syn) have resulted in varied forms of α-Syn expression in neurons, resulting in a lot of downstream defects, especially impairing vesicle trafficking and synaptic vesicle exocytosis, which in turn impairs dopamine release from the affected neuronal cells. α-Syn toxicity is linked to trafficking defects, and this could be modulated by phosphorylation-dependent and -independent pathways.

Besides the presence of α-synuclein in Lewy bodies, which are the inclusion bodies consisting of abnormal aggregations of protein in the neurons, prominently α-Syn aggregates are formed within the cytoplasm presynaptically. This blocks the components of the SNARE complex, leading to impaired dopamine release. They have been also seen to get accumulated in close affinity to neuronal organellar membranes, such as the ER, Golgi apparatus or mitochondria, subsequently resulting in toxic effects on such membrane-associated compartments for aggregation in the initial stages. For example, α-Syn aggregation within the mitochondrial-associated membrane, which links the ER to the mitochondria, could lead to calcium signalling disruption. This may lead to disruption of trafficking in ER-Golgi and ER stress. It is known that α-Syn is in part normally degraded within lysosomes, which would be disrupted due to aberrant interactions in lysosomal membrane. The localization of α-Syn within vesicles supports the hypothesis that if organelle trafficking is compromised, it can be a putative driver of PD pathogenesis.

Research into the actions and dysfunctions of the genes and their proteins have highlighted several common pathways in PD affecting mitochondrial dysfunction, autolysosomal dysfunction, oxidative stress, vesicular dysfunction and abnormal proteostasis.
At each of the stages of intracellular trafficking, i.e., vesicular fusion, endocytosis, the *trans*-Golgi network and lysosomal functions, genes have been identified to be risk factors associated with PD.
There was an indication of the binding of α-Syn to vesicular membranes in the clearance process, implicating a possible link between these vesicular mechanisms and the accumulation of α-Syn. Furthermore, studies have shown that Golgi trafficking network is disrupted by α-Syn. Abnormal

vesicular dynamics contribute to α-Syn transition from physiological to abnormal forms, and this transition is involved in the onset of PD and maybe other related neurodegenerative diseases like Alzheimer's disease, dementia, etc.

Complex interactions between vesicular proteins and the role of multiple pathways and networks in maintaining vesicular homeostasis implies that disruption at various points in vesicle regulation in the human brain can result in neurodegeneration and PD development.

It is still under study, but evidence has been found that under physiological conditions, α-Syn can bind directly to SNARE proteins and regulate vesicle trafficking and exocytosis of neurotransmitter at the synapse. Moreover, α-Syn acts as a chaperone for formation of soluble N-ethylmaleimide-sensitive factor attachment protein receptor (SNARE) complexes. VAMP2 is an R-SNARE protein that is highly expressed in neurons and localized on vesicles. It forms the SNARE complex together with the Qb-c SNARE SNAP-25 and the Qa SNARE syn1 which are present on the plasma membrane, and it is important for the release of the neurotransmitter. Often, R-SNAREs can act as v-SNAREs and Q-SNAREs can act as t-SNAREs.

SNARE complexes mediate membrane fusion, which in turn allows synaptic vesicle exocytosis. Following this, they rapidly disassociate to an unfolded state. Disassociated SNARE proteins are prone to misfolding and non-specific interactions, which could be another contributing factor to the onset of PD.

As is clear, the formation of the SNARE complex is a necessity for vesicle fusion, vesicle recycling and neurotransmitter release. So, inhibition of the SNARE complex formation, defects in the SNARE-dependent exocytosis and altered regulation of SNARE-mediated vesicle fusion have been associated with neurodegeneration.

But it has been discovered that a few more SNAREs, such as syntaxin-17 and VAMP4, have a role in causing PD onset. Accumulation of α-Syn in synapses has been associated with a redistribution of the SNARE proteins. The presence of oligomeric α-Syn impairs SNARE function by decreasing inter- vesicular space, decreasing the number of synaptic vesicles and impairing dopamine release. Impairments of key steps of vesicle exocytosis like docking, priming and fusion of vesicles with the presynaptic membrane are generally responsible for the onset and progression of the disease, and SNARE proteins are fundamental components of the machinery that allows membrane fusion and neurotransmitter release at the axon terminal. Thus, SNARE proteins become important targets for drug development.

An important link between trafficking impairment at the levels of the synapse and the soma or cell body of the neuron is the observation that direct interaction between α-Syn and ER-Golgi SNARE complexes causes the α-Syn-induced disruption of ER-Golgi trafficking. Several other

key membrane fusion pathways with relevance to PD rely on SNARE machinery (for instance, autophagy pathway). The accumulation of α-Syn potentially disrupts these pathways.

Understanding how different molecular species of α-Syn affect synaptic vesicle trafficking remains a key step toward understanding and elucidating the pathological mechanisms that lead to synaptic dysfunction and clinically significant neurodegeneration.

The 'toxic' effect of α-Syn assemblies involves more than a single pathway. Therefore, a drug that influences only one pathway will have a smaller effect than a drug focused on several pathways and that can target the specific proteins involved in each step in the complicated intracellular trafficking pathway.

Thus, drug development strategies could be designed to target either the monomeric disordered form of α-Syn in solution or bound to membranes, oligomeric α-Syn, fibrils, α-Syn modified by enzymes, or bound to chaperones.

Thus, this development of drugs targeted to proteins involved early in the development of PD, or for reducing α-Syn to prevent its aggregation, gene level therapy and other novel strategies like chaperone therapy are being worked on to find a more permanent cure, unlike dopamine replacement therapy which only delays the severe effects of PD.

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Opening a New Era in Gene Editing with CRISPR-Cas9 system

Adithya Joseph

Semester: V

INTRODUCTION:

With the possibility of bringing back extinct animals like Woolly Mammoth to controlling the growth of mosquitoes using "precision-guided sterile insect technique" (pgSIT), the RNA-guided CRISPR-Cas9 system used in gene editing is revolutionizing genetic engineering.

So, what exactly is the CRISPR-Cas9 system?

CRISPR, or Clustered Regularly Interspaced Short Palindromic Repeat, are repeating DNA sequences that are short and partially palindromic.

It's a unique organization observed in the genomes of primitive microorganisms that's essential for bacteria's immune systems.

The bacterial CRISPRs are interspersed with spacers. Spacers are short variable sequences that are derived from the DNA of viruses that have attacked the host bacterium previously. If the same virus infects the bacterium again, the CRISPR defence system cuts up any viral DNA sequence that matches the spacer sequence, protecting the microorganism. If the bacterium is invaded by a previously unseen virus, then the genome of the invading virus is processed into short segments and are inserted into the CRISPR sequence as new spacers. This prevents any further infections by the same virus. After this adaptation step, the CRISPR sequence is transcribed and processed to create CRISPR RNA molecules, which associate with and "guide" the molecular machinery of the bacteria to the corresponding target sequence of the invading viral genome.

The CRISPR-associated protein 9 or Cas 9, in a process termed targeting, uses CRISPR sequences as a "guide" to recognize complementary DNA sequences in the genome of an organism. And when it recognizes the specific DNA sequence, the molecular machinery cleaves and destroys the invading viral genome.

CRISPR-Cas9 technology, used to edit genes within organisms, is based on the Cas9 enzymes which work together with CRISPR.

This editing process has a wide variety of applications which includes biological research, development and improvement of biotechnological products, and treatment of diseases including cancer, blood disorders, HIV, and many more.

For the development of the CRISPR-Cas9 genome editing technology, Emmanuelle Charpentier and Jennifer Doudna were jointly awarded the Nobel Prize in Chemistry in 2020.

CRISPR has a wide range of uses. It comes in handy in companies that use bacterial cultures. CRISPR-based immunity can be used to improve the sustainability and productivity of bacterial cultures by making them more resistant to viral attacks. Scientists can use CRISPR technology to edit individual genes and make precise changes in organisms' genes.

Short RNA molecules called 'guide RNA' are designed by scientists, that match a specific DNA sequence in the cell. The Cas 9 protein forms a complex with guide RNA. This complex attaches to a matching genomic DNA sequence adjacent to a spacer and shuttles molecular machinery to the target DNA. The Cas 9 RNA complex cuts the double strands of targeted DNA. This leads to gene silencing. For editing genes, a template is added to the cell. The template has a specific change that is incorporated into the genome of the cell such that the targeted DNA now has this modified sequence.

CRISPR has become a valuable tool in research and has a great potential in medicine for treating various genetic disorders, making more specific antibiotics that target only disease-causing bacterial strains while sparing beneficial bacteria in industries, and much more.

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Sustainable Advancements in Filters and Masks in the Pandemic Era

Ananya Biswas

Semester V

Abstract:

Individuals afflicted by respiratory infections like SARS-CoV-2 release tiny droplets and aerosolized particles into the air through their coughs or sneezes. These particles are smaller than 0.3 µm and can stay airborne for hours. Thus, materials that can trap these particles are best suited for use in face masks and air filters. However, some of the existing filter materials have certain disadvantages. For example, fibreglass, carbon nanotubes, and polypropylene fibres are not sufficiently durable to undergo repeated decontamination procedures. At the same time, some rely on electrostatics and thus cannot be washed, resulting in large amounts of waste. This led researchers to look for better materials for constructing face masks and filters.

Introduction:

Face masks play an essential role in preventing the spread of the coronavirus, thereby helping to limit the number of people affected by COVID-19. They filter spit or mucus droplets that may carry this infectious agent. Homemade fabric masks, though capable of preventing the spread of COVID-19, are mostly not very durable.

Therefore, now researchers have thought of a new sort of filter to be used in masks. This filter is made of copper - such that it is sturdy and lightweight. The material is like a sponge and is easy to clean. It can even be recycled. As per the tests conducted on this material, its filtration capacity is as good as N95 masks. According to the developers, it might even be able to trap and kill bacteria.

The masks currently available worldwide are made up of many kinds of materials, such as:

1) Fabric masks that use cotton, silk, or synthetic fabric - where multiple layers are used to boost their filtering ability. However, durable cloth masks do not filter very well as their maximum filtration capacity is only 35%.
2) Some masks use a kind of paper that resembles coffee filters.

In the fight against this pandemic, properly wearing good quality face masks has become a necessity. Hence, researchers are looking for new and better filters.

Copper foam filters:

Kai Liu - a materials scientist, and his team at Georgetown University in Washington, D.C., had a head start in this quest for better filters. While testing materials to filter out the small particles from the polluted air, they observed that the size of tiny droplets carrying viruses was the same as that of some atmospheric pollutants. Following this observation, they started testing their materials to see if they would make good filters. Their material was called copper foam.

According to Kai Liu, they first made copper nanowires - each of diameter around 200nm, i.e., less than one ten-millionth of an inch. Then these wires were immersed in ultrapure water and subsequently flash-frozen in liquid nitrogen. Later this copper-filled ice was placed in a vacuum chamber - thereby freeze-drying the wires, resulting in a loosely packed mass of tiny copper wires. Finally, this mass of wires was heated to 300° C (572° F). These chemical reactions helped to bind them into a mesh. However, while conducting durability tests, it was found that the mesh would collapse if someone breathed on it, which made it unsuitable for use in masks. Hence, the researchers kept experimenting with the procedure.

The weak mesh was subsequently bathed in a liquid with copper ions in it, and then an electric current was passed through this chemical bath. This deposited more copper onto the nanowires, thus thickening them. This also helped weld the wires at points where they touched each other. Some samples of this material could support approximately 10,000 times their weight without collapsing in subsequent tests. The same result was obtained even when there was 85% air in the material.

This 85% air foam was able to filter out tiny particles. A sample of thickness 2.5 mm (0.1 inches) captured 97% of particles between 0.1 - 0.4 μm in diameter. Particles of such small size are the hardest to trap and are also the size of the smallest aerosol droplets capable of carrying virus particles.

As per Kai Liu's explanation, these particles do not get trapped by the material's minute pores, but get attracted to the enormous surface area provided by the nanowires. So, they get stuck on this surface area as they try to move through the wire mesh between the outer and inner edges of the filter.

From their calculations and tests, it was found that the breathability of this foam was like that of the commercially available polypropylene N95 face masks. As the new material is copper-based, these filters are resistant to cleaning agents, allowing many disinfection options. The antimicrobial properties of copper help kill trapped bacteria and viruses. Additionally, they are recyclable. As per their estimate, currently, the material would cost around $2 per mask. Considering the disinfection and reusability of this material, the lifespan of the mask increases, thus making them economically competitive with current products.

Semali Perera- a chemical engineer at the University of Bath in England, considers the material and method of production of copper foam designed by Kai Liu and his team in Georgetown to be interesting and innovative. However, she has concerns regarding the feasibility of scaling up the production of the thin foam to be used in masks.

Polyimide filters strengthened with copper and nickel:

Semali Perera and her team have taken a different approach to germ filters. Their initial target was to collect and kill bacteria. Now they are trying to design filters that can trap viruses as well. A material that her team is exploring is a plastic-like foam made from a polymer called polyimide, and this material shows great promise. To make it capable of killing germs, researchers added copper and nickel to the material. Nickel helps slow down the growth of bacteria, and copper helps kill them. These metals constitute around 80% of the material.

In this case, all the ingredients are mixed in one container. There, a chemical reaction occurs, producing large amounts of CO2, which makes the material frothy. As it foams, it expands into a mould, which within 3 seconds, hardens into its final shape. To scale up the production, the researchers mix higher amounts of the ingredients in a bigger container.

Currently, Perera and her team are collaborating with companies to design new products. One potential use for this material is as filters for home air-conditioners.

Conclusion:

The emergence of COVID-19 resulted in people wearing masks worldwide as a preventive measure. This increased demand for masks so much so that the demand and supply chain has led to environmental pollution by adding 250,000 tons of plastic pollution per day due to disposable face masks.

Thus, new technologies to replace these plastics or sterilize the infectious waste generated by disposable masks are urgently required. Reusable face masks provide a simple and efficient method for reducing plastic contamination of our environment. Also, the use of biodegradable polymers or natural materials, such as cellulose or cotton, along with changeable filter layers in masks, is a possible solution. Researchers are making efforts to incorporate advanced features in the designs of masks, making them self-sanitizing and self-cleaning.

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Radioisotope and Radiation Technologies for the Welfare of Mankind System

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Semester: V

INTRODUCTION

Isotopes consist of a group of elements which have a variable number of neutrons but the same number of protons. Atoms that have an unstable nucleus i.e., an unstable combination of neutrons. Isotopes and protons are radioactive isotopes of an element. They undergo radioactive decay and have various useful applications for the improvement of quality of human life. A stream or wave of particles carrying energy from radioactive isotopes is called radiation. In treating cancer cells, the type of radiation used is called ionising radiation because it forms ions in the cells of the tissues through which it passes.

TYPES OF RADIATION:

There are two types of ionising radiations used:

1. Photons like X-rays and Gamma rays.

2. Particle radiation like electrons, protons, neutrons, alpha and beta particles.

RADIOISOTOPE PRODUCTION:

- **BY NUCLEAR REACTORS:**

Uranium-235 is used in nuclear reactors to produce most radioisotopes with low cost and in greater quantities. Neutrons trigger on the fissions in a target which contains Uranium-235. To enable the transport, the radioisotopes produced in this way should have a long half-life

- **BY CYCLOTRON**:

Cyclotron is a particle accelerator which propels a beam of charged particles repeatedly in a circular path. A nuclear reaction takes place when this beam of protons interact with stable isotopes. This nuclear reaction converts stable isotopes into unstable radioisotopes.

RADIOISOTOPE APPLICATIONS IN HEALTHCARE:

RADIOPHARMACEUTICALS:

When radioisotopes are bound to biological molecules which can target specific organs or tissues within the body then these are called radiopharmaceuticals. They are used for diagnosis and therapy.

DEVICES FOR NUCLEAR MEDICINE IMAGING:

1. **SPECT (Single-Photon Emission Computed Tomography):** A SPECT scan produces 3D pictures of internal organs whose functions are then analysed. Usually, gamma emitting tracers are used in SPECT.

2. **PET (Positron emission tomography):** The metabolic and biochemical function of the tissues and organs are mainly assessed by this device. The PET scanner detects the concentration of the radioactive tracers in different organs and tissues and is mainly used in detecting cancer.

3. **SPECT-CT:** This is an imaging procedure that shows the flow of blood into tissues and organs of our body. SPECT-CT is helpful to detect seizures, strokes, infections, and tumours in the spine. In this case, the gamma radiation is measured.

4. **PET-CT:** In case of PET-CT scans, the decay of the radiotracer used produces small particles called positrons, which are positively charged and have the same mass as that of an electron. When PET scan is done along with a CT scan then it is called PET-CT.

5. **PET-MRI (Positron Emission Tomography- Magnetic Resonance Imaging):** This is a hybrid imaging technology where the morphological imaging of the soft tissues (by MRI) along with functional imaging by PET can be done simultaneously.

APPLICATIONS OF RADIOPHARMACEUTICALS FOR DIAGNOSIS AND TREATMENT:

DIAGNOSTIC RADIOPHARMACEUTICALS:

For diagnostic purposes, various radioisotopes are attached to biologically active substances. When these substances are injected into the body, they can be used to examine blood flow into the brain to assess the functioning of the heart, lungs, kidney, or liver. These are also used to assess bone growth. Radioisotopes used for diagnostic purposes must emit gamma rays with sufficient energy which can escape from the body.

THERAPEUTIC APPLICATIONS:

The therapeutic applications of radiopharmaceuticals are based mainly on the property of radionuclides to emit particles of alpha and beta radiations which can destroy diseased tissues. Therapeutic applications include Radioimmunotherapy (RIT) to treat non-Hodgkin's Lymphoma, Iodine-131 to treat thyroid cancer, in palliative treatment of bone metastasis (Samarium-153, Strontium-89) and in treatment of arthritis (Erbium-169).

APPLICATIONS IN CANCER MANAGEMENT:

1. BRACHYTHERAPY (INTERNAL RADIATION THERAPY):

Brachytherapy means short-distance therapy. In this therapy, radioactive containers are placed into the tumour or into the body cavity nearer to the tumour. In brachytherapy, a high dose of radiation can be delivered to a small area where the malignant tumour has developed.

2. TELETHERAPY (EXTERNAL RADIATION THERAPY):

When an external beam of gamma rays is applied from a distance into a specific diseased tissue then this type of therapy is called teletherapy. Cobalt-60 is the most widely used source of radiation. Teletherapy is often used for the treatment of malignant tumours which are located deep within the body.

APPLICATIONS OF RADIOISOTOPES IN:

CROP IMPROVEMENT:

Radioisotopes are nowadays widely used in the field of agriculture. Many agricultural problems are now solved more precisely in a shorter time by radioisotope tracers. Some of the applications are listed below:

• To study the effectiveness of fertilizers (by N-15 or P-32).

• To kill pests and parasites and to help in ripening of fruits.

• To study induced genetic mutation for raising disease resistant strains.

• S-35 is used to study the effectiveness of fungicides.

• P-32 is used to study metabolism of plants.

FOOD PROCESSING:

The shelf life of foods can be extended by the application of ionising radiation. Irradiation makes the food safer to the consumer by eliminating harmful microbes and insects from the food. Canning of fruits and vegetables and pasteurization of milk are some of the examples. For this purpose, Cobalt-60 or Caesium-137 along with high energy X-ray machines are mostly used.

CONCLUSION:

So, it is very evident from the above discussion that application of radioisotopes plays a very significant role in the improvement of the quality of human life. Isotopes are used in the field of medicines and diagnostics, in therapy of diseases as tracing markers, in the field of radiography and in the field of food preservation and sterilization.

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COVID- 19: A Stepping-Stone for Anthropocene Mass Extinction

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Semester V

INTRODUCTION

Everything around us is continuously changing and evolving- be it living organisms or the climatic conditions. As the COVID-19 pandemic continues to rage on, its spread and effects in relation to the mass extinction of species is now under study. For over 3.5 billion years, living organisms have multiplied and diversified and are now indispensable components of all ecosystems. As a specie disappears and becomes extinct, it helps to drive the evolution of new species by creating niches or openings for them in the ecosystems.

Mass extinction events lead to a significant decrease in biodiversity, with more than 75% of the total species in existence having been lost across the span of a few million years, which is a relatively short time span in the evolutionary timescale. Such a mass extinction event is said to occur when the loss of species, i.e., extinction surpasses the rate of speciation.

Five major extinction events have been identified in history since the Cambrian Explosion. The first mass extinction is called the Ordovician-Silurian Extinction (440 Mya) followed by the Devonian Extinction (365 Mya). The third and largest of these, the Permian-Triassic Extinction (250 Mya) saw the end of over 90% of the Earth's species which made way for new organisms to evolve. The fourth extinction, the Triassic–Jurassic Extinction event (201 Mya) wiped out 75% of all species, leaving dinosaurs with little terrestrial competition. After the fifth extinction called the Cretaceous–Paleogene Extinction (66 Mya), ended the age of dinosaurs. As a result, mammals thrived and became dominant.

ANTHROPOCENE EXTINCTION

Anthropocene Extinction is widely believed to be the ongoing sixth extinction event where the current rate of extinction of species is 100 to 1,000 times higher than natural background extinction

rates and is mainly a result of human activities and population growth, deforestation, climate change, ocean acidification, among others.

As humans continue to put pressure on nature without allowing time for simultaneous recovery, we will continue to experience drastic changes to our planet, including extreme weather conditions, bringing about disasters such as flooding, drought and wildfires. Over 70% of land surfaces and three-quarters of freshwater resources are being used and modified directly and indirectly by humans, leaving species in their natural habitats vulnerable and causing a competition for resources. Invasive species threaten ecosystems by competing with native species, reducing biodiversity of the area and driving them towards extinction.

The pandemic is a consequence of pressure on the biodiversity

Ecological destruction and the abuse of animals on a large scale is the primary reason for the current pandemic which has been linked to wildlife trade. The SARS-CoV-2 that causes COVID-19 originated in bats according to genomic research and was transmitted to another animal in the wet markets of Wuhan before spreading to humans, but it must be noted that confining animals in these cramped conditions increase the chances of interspecies transmission. Many other viruses — including, filoviruses, retroviruses, lyssaviruses also reached humans through wildlife.

In healthy ecosystems with complex interactions, pathogen spread is seen far lesser today by virtue of a phenomenon called Dilution Effect. As we persecute wildlife and harvest live animals for open markets, we break the natural defense against pathogens, increasing our exposure to them. Thus, biodiversity and human infectious diseases are closely associated.

Due to the COVID-19 pandemic, many areas are facing deforestation, illegal mining and wildlife poaching and an increased pressure on natural resources as people from cities return to their rural homes. Climate can control the rate at which viruses infect and spread in humans, and at the same time propagation and severity of future disease outbreaks will be influenced by the increasing global temperatures. Studies warn that the effects of extinction will worsen in the coming years leading to variability and changing of ecosystems. Therefore, we must understand that ecological factors and human health are inseparable and continued collapse of ecosystems will push us towards the end of civilization.

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Photographic Memory: Reality or Hoax?

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Semester V

"Memory"

Memory is simply a glance at how we perceive the world around us. It is the process of collecting, storing, and retaining information inside our brains. Everyone aspires for a better memory, a memory that would last for a lifetime just by seeing something once or maybe twice. This concept of photographic memory first started as a work of fiction, in novels and movies. Inspired by such work of fiction, people grew more and more keen on aspiring for a better and non-perishable memory. This article would help you build your opinion on the existence of photographic memory in the 21st century.

A Look Inside Our Brain

The hippocampus and the limbic system are the two critical structures in memory formation. These fabricated memories are ultimately stored throughout the cortex. Furthermore, the rest of the brain is involved in strategies for learning, recalling, and attention, all of which are crucial for effective learning and memorization.

Encoding is the process of coordinated crosstalk with the hippocampus to organize and select which information should be stored in the compartments of the brain permanently. Therefore, there is no particular lifespan of a memory. It depends on the process of **encoding** entirely.

In addition to encoding, the cortex is also involved in pulling memories out of storage in a process called **retrieval**. People are often seen to have problems with memory retrieval even if encoding was done properly. For example, we have all had the experience of struggling to remember where we had kept our keys, even though the incident was just a few hours ago. Suddenly, maybe a few days or weeks later, we remember where we had actually kept them. This

happens because sometimes one can have problems in retrieving a particular piece of memory from the vast storage.

Where are the Memories Organized?

Memories are categorized into mainly three types, depending on which their locations vary.

- **Episodic memories** are generally stored in the hippocampus, neo-cortex, and amygdala.
- **Motor memories** are stored in the basal ganglia and cerebellum.
- **Short-term memory** resides in the pre-frontal cortex i.e., it sits right in the front of the brain.

The hippocampus is also involved in the process of **memory consolidation**. This is a gradual process by which **memories are converted from short-term to long-term memory**. This process of consolidation may take up to a couple of years.
Now that we have learned quite a bit about the anatomy of the brain and its link with the ongoing memory mechanics, let's understand the basics of photographic memory.

What is Photographic Memory?

Photographic memory is the ability by which one is believed to recall an incident from their past with utmost accuracy and details, just like a snapshot taken by a viewfinder. This memory is supposed to last long-term, which means that there must be an intervention of the hippocampus, which will lead to memory consolidation.

There are millions of people who claim to have a photographic memory, but most of these cases are not true. However, there are cases where people are indeed blessed with an exceptional memory, for example, **eidetic memory.** People with this extremely rare condition are able to recall incidents that just took place, and they are able to describe the nitty-gritty with high accuracy. But unlike basic photographic memory, here people are not able to retain their memory for the long term. These memories last just for a few seconds and gradually fade away.

Are Eidetic Memory and Photographic Memory the Same?

No. Although people often confuse photographic memory with eidetic memory, they are not the same. Eidetic memory, even though rare, has been proved to be true, mostly in toddlers. It has been seen that children have something similar to 'eidetic' memory, where they are able to

remember fine details of a picture which they just saw. But most people gradually lose this ability as they grow up, so scientists refer to this as an **'immature form of memory.'** For example, if a toddler is shown a beautiful picture of a landscape, most probably he/she will be able to recall quite minute details of the picture, but it won't be stored permanently in his/her brain.

Instances from the Past

In the entire history of scientific research, there has been only one documented case that shows the existence of something which could be loosely stated as 'photographic memory.' In 1970, a Harvard student, Elizabeth claimed that she had a photographic memory. To test her claims, her mentor Stromeyer showed her a collection of 10,000 dots. The following day he showed her another set of 10,000 dots, assuming that she had memorized the previous set of dots. According to researchers, the combination of the two sets of dots would meld together to form a 3D image called a **stereogram.** When enquired, Elizabeth stated that she could see the stereogram.

This revelation made worldwide headlines, opening millions of doors to further research about photographic memory in humans and the science behind it. Unfortunately, this incident soon became suspicious, as the student-mentor duo never appeared for any subsequent tests, which could prove their previous claims.

Conclusion

Till now, scientists have been unable to prove the existence of 'photographic memory.' Many researchers believe that the science behind photographic memory remains hidden from humans, while some scientists from around the world believe that it is simply a hoax that was created as a work of fiction and art. Therefore, the decision lies on you, whether to believe its existence or dismiss it as a hoax!

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Rohita Sarkar

Semester III

20,000 Leagues under the Sea

Anushree Sadhu

Semester III

Discussing the role of marine organisms in biomedical research with special emphasis on their anti-viral capacity against COVID-19

Billions of years ago, it was the oceans from where life first arose. Starting from mere macromolecular aggregates, its inhabitants have now evolved into intricate physiological and biochemical systems. Evolutionary history even suggests that marine organisms are more diversified than their terrestrial counterparts. Consequently, the deep oceans host vast ecosystems of organisms that are potent sources of medicinally significant biological compounds.

Research on marine organisms has already led to breakthroughs in several physiological processes. The ionic mechanism of action impulses was studied in the vast axons of the longfin inshore squid *Doryteuthis pealeii,* while the studies of horseshoe crabs, skates and rays helped us understand how our own visual system functions. The surf clam (*Spisula solida*) oocytes serve as excellent models for cell cycle processes and their regulation, while the sea urchin embryo is an effective prototype to understand developmental mechanisms during embryogenesis. Thus, deviating from the general notion of small mammals being the typical model systems, marine models have proved both effective and essential in that regard.

Marine-derived biomedical compounds have been playing an increasing role in solving some of the contemporary medicinal challenges that affect humankind. This includes, but is not limited to, the treatment of cancer and developing anti-viral drugs against viruses like HIV, HSV, Ebola virus, hepatitis virus, and perhaps most significantly in modern medical history, against COVID-19. The sea squirt *Lissoclinum patella* had priorly exhibited anti-tumor activity. Later, University of Utah researchers discovered a cyanobacterium *Prochloron didemni* that resides in a symbiotic association with this sea squirt. This bacterium produces small cyclic peptides of eight amino acids called patellamides, that are detrimental to cancer cell lines.

Two chemicals, spongothymidine and spongouridine, isolated from the sponge *Tectitethya crypta* found in the Caribbean Sea were used as models to develop anti-viral and anti-cancer drugs. These drugs include AZT, the anti-HIV drug that led to a breakthrough in AIDS treatment, and cytarabine, an anti-leukemia drug that helps kill cancer cells by blocking DNA polymerase function. Cytarabine is the first marine drug approved for the treatment of cancer in 1969.

In 2012, when MERS-CoV emerged, it was discovered that lectin, a carbohydrate-binding protein isolated from the red marine alga *Griffithsia*, was an effective inhibitor of infection. It also expressed excellent anti-viral properties against viruses like HIV, HSV, Ebola virus and hepatitis virus. Now, the same alga is being explored to make a molecule, Q-Griffithsin (Q-GRFT), to develop a nasal spray to prevent COVID-19 infection in frontline workers. The marine algae *Padina tetrastromatica* and a molecule from the dinoflagellate *Vulcanodinium rugosum*, have been found effective against HIV. Since it is a single-stranded RNA virus like SARS-CoV-2, there is also a high chance of finding a cure for COVID-19 from such marine organisms. The anti-viral nature of marine organisms can thus be a significant key in the treatment of COVID-19.

Current research shows that natural inorganic polyphosphate (polyP) from marine bacteria and sponges can bind to the spike protein present on the surface of the SARS-CoV-2. These spike proteins contain a Receptor-Binding Domain (RBD) that is recognized by the human ACE-2 receptor. Usually, this unique RBD can specifically bind to a lysine residue on the ACE-2 receptor, but polyP can bind to the RBD through its basic residues. This inhibits the interaction of the viral particles with the human ACE-2 receptor, and this disruption in the ligand-receptor interaction essentially prevents viral infections from occurring. polyP is a compound expressed in marine bacteria, cyanobacterium *Synechococcus*, sponges and human blood platelets where it helps to mediate blood clots. COVID-19 patients show deficiencies in platelets and polyP, molecules that can lead to blood coagulation. In asymptomatic patients, polyP plays a protective role.

Another promising marine resource for COVID-19 treatment is lambda-carrageenan, a polysaccharide purified from marine red algae. Jang et al., through experiments, proved that this polysaccharide can decrease the expression of viral proteins and suppress viral replication of SARS-CoV-2. It was shown in the experiment that an increase in the dose of lambda-carrageenan from 0 to 300 µg/mL caused a significant decrease in the presence of spike viral proteins on Sars-CoV-2. Favourably, no host cell toxicity was observed at concentrations up to 300 µg/mL. The study also found that when lambda-carrageenan was given to SARS-CoV-2 virus-infected mice, the latter showed a 60 % survival rate.

A study was done by Zahran et al. using two specific microbial metabolites, terphenyllin and tirandamycin A, found in *Scleractinia*-associated bacteria and fungi. The study showed that these two metabolites could form hydrogen bonds and dock with high affinity to the main protease (Mpro) in SARS-CoV-2. This interaction inhibits the main protease in its life cycle. Mpro is an essential enzyme of the virus that helps mediate the replication and transcription of viral particles.

Similarly, Gentile et al. found that phlorotannins isolated from the brown algae *Sargassum spinuligerum* have seventeen more potential Mpro inhibitors.

It is thus well-established and even widely acknowledged that marine natural products have immense potential as pharmaceutical agents. Yet, research in this sphere is relatively new, and this is mainly due to the difficulty in the collection of these organisms. Most of the research on marine organisms has focused on creatures from the shallow and tropical ocean waters, leaving more than 80 % of the oceans unexplored because of the extreme environmental conditions that make them inaccessible. The highly pressurized, non-photic regions with extremes of temperatures like the freezing Antarctic waters or the deep hydrothermal vents (places that are least accessible) are where the organisms have undergone the most incredulous of adaptations, developing extremely unique, thermostable bioactive compounds. With advancing technology and an increasing interest in these denizens of the sea, marine biomedical studies could just cause the revolution we need to solve the different health crises of the 21st century.

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Sleep is Not Unnecessary

Dattatreya Roy

Semester III

Sleep has always been perceived as a behavioral phenomenon. However, a recent study by researchers at the Massachusetts General Hospital (MGH) showed that genes have more influence on human sleep than previously thought of. The benefits of daytime napping have always remained a hotly debated topic. While some populations wholeheartedly practice it and believe it to have positive effects on mental sharpness, many believe it to have quite some detrimental effects on the body and general productivity. Until recently the cause of daytime naps was considered to be mere laziness or exhaustion.

Genetic analysis of natural short sleepers (people who had unusually short natural sleep time, say 4-5 hours/day) was done and a mutation was observed in the *DEC2* gene (present near the C-terminal histone deacetylase interacting region of BHLHE41). This *DEC2* gene led to the expression of the orexin protein, which is responsible for the wakefulness of a subject, hence *DEC2* has a negative impact on sleep. *DEC2* mutation seems to increase orexin production, which helps the subject to cope with sleep deprivation in spite of the short hours. *DEC2* also regulates the circadian rhythm in humans. During evening, *DEC2* binds to and inhibits another gene *MyoD1* (*MyoD1* turns on orexin production), which causes decreased levels of alertness. This, coupled with the normal hot and humid evening conditions of the places where daytime napping is frequent can justify the tradition of nap prevalent in these populations.

Natural short sleepiness is conferred by another gene mutation - a mutation to the gene *NPSR1* (Neuropeptide S receptor). Not only does this mutation promote short sleep, it also prevents the memory loss associated with sleep deprivation. Since NPSR1 is a cell surface receptor, specific drugs could be developed and targeted to stimulate or inhibit the activity of NPSR1, which would help in coping up with the sleep requirements of the body.

Because of the heightened exposure to blue light, a large portion of the world population, especially in the economically developed sections of the society has adapted to a nocturnal

lifestyle. Though there are genes which controls whether a person is a morning lark or a night owl, the difference in bedtime between the top 5% with the most morning-ness genes and bottom 5% should be about 25 minutes. This however is not what we observe. The difference observed is far more than that. A 2005 study on the effects of blue light exposure on the expression of circadian genes in jaundiced neonates was done (Blue light phototherapy is actually used to cure jaundice by converting serum bilirubin into water soluble photo isomers which can be excreted through bile and urine without liver conjugation). The following observations were made:

- Increased level of crying and jitteriness in the light exposed neonates.
- *Bmal1* (gene for BMAL1, which is a positive regulator for sleep) expression decreased (hence likely chance of sleep getting hampered).
- *Cry1* (gene for CRY, blue light receptor) expression increased (so that the body can process the increased dosage of blue light).
- Melatonin secretion is inhibited in the light; dark promotes it (Melatonin is a hormone released by the pineal gland at night and is associated with the sleep-wake cycle).

From these results we can infer that even though blue light might, to some extent, increase alertness during daytime, it can be deleterious during the night. The use of blue light emitting electronics has become so rampant that the night sky has a corona of such radiations now and hence minor changes in circadian patterns could not be helped and eventually our population might fix such changes in the genome. Another direct effect of the reversal of the normal circadian cycle is the increased frequency of daytime napping, though this habit too has heavy genetic influence, and may even be present in population groups who are not that affected by the circadian rhythm disruptions caused because of blue light (say, the rural population of the Indian subcontinent). In a genome wide association study (GWAS) by MGH, it was found out that 123 loci in the human genome were related to daytime napping. Three potential mechanisms were found to promote napping:

- Sleep propensity- some people need more sleep than others.
- Disrupted sleep- A daytime nap can make up for a disrupted sleep the night before. As the other side of the coin, it might lead to subsequent disrupted sleep at night.
- Early morning awakening- People who rise very early may catch on sleep in the afternoon.

The test subjects were asked to self-report the frequency with which they take a daytime nap as ‘frequent’, ‘never’ or ‘sometimes’. Accelerometer-measured daytime inactivity duration was

used to cross-check the results. Such napping is normally prevalent in Mediterranean culture, but in the recent times have been adapted by non- Mediterranean cultures (such as the USA) as well.

Whether daytime napping has any effect on cardiometabolic wellness of the subject was an important clinical question that this study threw some light upon. Findings from Mendelian randomization analyses (using a measured variation in genes of known function to examine the causal effect on a disease) suggests that daytime napping indeed has effects of increased blood pressure and waist circumference. Though the mechanisms for such causal effects remain blurry, the increased blood pressure might be because of disturbed night sleep. Cluster analysis [A gene cluster is a group of 2 or more genes in an organism's DNA (within a few 1000 base pairs of each other) which code for similar polypeptides having similar function]. Associations with higher blood pressure was found for Cluster 1 and adiposity traits were found for clusters 2 and 3. Sleep, in general acts as a natural scrubbing process. Amyloid ß, the protein responsible for Alzheimer's disease, is highest before sleep (at night) and least in the morning.

Thus, sleep, unlike perceived by many is not just a luxury. It is a necessity which much be addressed at all costs. Our busy lifestyles should not make us forget that.

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A Non-Invasive Way to Detect Cancer Using Nanoparticles

Diyasa Banerjee

Semester III

INTRODUCTION:

Early detection of cancer has the potential to scale down cancer mortality. Survival percentage rises to a greater extent if identification of cancer can be done at early stages, for the tumours are often surgically removed or treated with effective drugs. Detection of tumours at the earliest stage relies on an effective screening test. Currently, a limited number of screening tests exist for diagnosis of few cancer types –Colonoscopy, Mammography, and Cervical Cytology, Sigmoidoscopy, Computed Tomography (CT) scans, Magnetic Resonance Imaging (MRI) scan— which are based on imaging. Most cancer types currently lack an efficient non-invasive early screening option.

As a non-invasive way to detect cancer, MIT (Massachusetts Institute of Technology) engineers have developed new diagnostic nanoparticle that can detect specific cancer-associated molecules which circulate in body fluids like blood or urine. It is an easy, cheap, paper test which may improve diagnosis rates and help people get treated earlier. The diagnostic works very similar to a pregnancy test and may reveal results within minutes, provided a urine sample.

Now what are these nanoparticles?

Nanomaterials – These are ultrafine particles having diameter between 1 and 100 nanometres – have been widely used in medicine and pharmaceuticals for the detection of biological molecules, imaging of diseased tissues and therapeutics. Nanomaterials have been detected as promising tools for the advancement of diagnostic biosensors, diagnosing diseases more rapidly and sensitively, helping in drug and gene delivery, and biomedical imaging.

Here, they have used the diagnostic property of these minute nanoparticles satisfying two purposes: these can reveal the presence of cancerous proteins through a urine test, and function as an imaging agent, pinpointing the tumour location by triggering a urinary signal. Thus, "Nanoparticle" – this diagnostic might be employed to detect cancer anywhere within the body

(like colon cancer), including tumours that have metastasized from their original locations to the lung and liver.

Application of 'Synthetic Biomarker':

Over the past several years, Sangeeta Bhatia, the John and Dorothy Wilson Professor at MIT has been working on improving cancer diagnostics that work by generating synthetic biomarkers. Nanoparticle in the form of "**Synthetic biomarker**" can interact with tumour proteins to release peptide fragments, detected in a patient's urine sample.

Role of cancer-detecting nanoparticles:

Most cancer cells can escape their original locations by cutting through proteins of the extracellular matrix and this is achieved by proteases called matrix metalloproteinases (MMPs). When these nanoparticles encounter a tumour, the peptides with which they are coated are cleaved by MMPs and accumulate in the kidneys and then excreted in the urine, where they can be easily detected.

Process of detecting cancer using test strips – Lateral Flow Assay:

Antibodies have been first coated with nitrocellulose paper that can capture the peptides. Once the peptides are captured, they flow along the strip and are exposed to several test lines made from other antibodies specific to different tags attached to the peptides. If one of these lines becomes visible, it means the peptide is present in the sample indicating cancer positive. The technology can also detect multiple types of peptides released by different types or stages of disease.
According to the protocol, patients would first receive an injection of the nanoparticles, then urinate onto the paper test strip. To make the tactic more convenient, the researchers are now trying to make further improvements in this technology as to how these nanoparticles might be implanted under the skin for longer-term monitoring.

Locating Tumours:

Now, to reveal the exact location of the tumour or whether the tumour has spread beyond its origin, the MIT researchers developed a "multimodal" diagnostic, which can perform both

molecular screening (detecting the urinary signal) and imaging, to let them know exactly where the native tumour and any metastases are located.

Positron Emission Tomography (PET) imaging:

Positron Emission Tomography (PET) is a functional imaging technique that uses radioactive substances known as radiotracers to visualize and measure changes in metabolic processes of the cells of body tissues, and in other physiological activities including blood flow, absorption. To modify the nanoparticles so that they could also be used for Positron Emission Tomography (PET) imaging, the researchers added a radiotracer called "Copper-64". Copper was chosen because of its well-established coordination chemistry which allows it to react with a good sort of chelator systems which will potentially be linked to antibodies, proteins, peptides, and other biological molecules plus delivering copper-64 with their nanoparticles offers a plus over the strategy that's typically used for PET imaging. Once these nanoparticles reach a tumour, the peptides insert themselves into cell membranes, creating a robust imaging signal above ground noise.

Use of FDG:

FDG([^{18}F]-labelled 2-fluorodeoxyglucose) is a **PET radiotracer** which is **used in the medical imaging** and thus used for routine clinical evaluation, primarily for oncological imaging.
FDG, a radioactive glucose analogue that is acted upon by metabolically active cells, including cancer cells. FDG uptake reflects the glucose metabolism in tissues and is high in high-grade tumours and low in low-grade tumours.

Imaging using PET Scan:

A **PET scan in case of heart** is a non-invasive nuclear imaging test. It uses radiotracers FDG to produce pictures of heart. A heart PET scan can detect whether there's a heart damage or connective tissue within the heart, or if there is a build-up of abnormal substances within the cardiac muscle. Thus, PET scan will detect biochemical changes within the body related to cancer also because the extent of spread. In this case, a prominent PET signal is generated by the heart with exposure from FDG, and this can obscure weaker signals from nearby lung tumours.

CONCLUSION:

By this method, every year one can get a urine test as part of a routine cancer test. If the urine test turns positive, one will have to do a radioactive imaging study to find out where the signal is coming from, where the disease had spread. Thus, this kind of diagnostic could be useful for long-term monitoring of tumour recurrence or metastasis, especially for colon cancer.

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Decoding the Prolonged Life of Tumboa

Swayambhik Mukherjee

Semester: III

Abstract:

Welwitschia mirabilis (common name: Tumboa), that is indigenous to the Namib Desert, is the best dwelling species withinside its own circle of relatives Welwitschiaceae. This species has a long lifespan of as much as 2,000 years and bears an unmarried pair of contrary leaves that persist even as alive. However, the underlying genetic mechanisms and evolution of the species continue to be poorly elucidated. Here, we record on a chromosome stage genome meeting for W. mirabilis, with a 6.30-Gb genome collection and contig N50 of 27.50 Mb. In total, 39,019 protein-coding genes had been anticipated from the genome. Reconstruction of populace dynamics from genome information coincided properly with the aridification of the Namib Desert. The genome collection elaborated in the present study should open further avenues into the evolution of *W. mirabilis* and is expected to be a vital source for progress on gnetophyte and gymnosperm evolution. This study focuses on a chromosome-stage meeting of its genome collectively with methylome and transcriptome information to discover its marvelous biology. The gnetophytes are a possible ancestor of the gynosperm *W mirabilis*. The *Welwitschia* genome has been designed by means of a lineage-particular traditional, complete genome duplication and more recently by episodes of retrotransposon activity. High ranges of cytosine methylation are related to retrotransposons, even as lengthy-time period deamination has led to an exceedingly GC-negative genome.

Introduction:

Welwitschia is the sole species of the plant's own circle of relatives of *Welwitschiaceae* even though latest molecular information advocates there are genetically and geographically specific populations which could correspond to the sub-species. Most studies of evolutionary relationships conclude that gnetophytes have a common ancestor, with *Welwitschia* and *Gnetum* forming a biological group which has a relation to Ephedra. The divergence of *Welwitschia* and *Gnetum* has aged over a hundred and ten million years, according to a welwitschioid fossil seedling and a Cratonia cotyledon, discovered in early Cretaceous beds of Brazil. Contrary to the various Whole-genome duplication (WGD) occasions recorded for angiosperms, the records of the non-flowering gymnosperms paint a totally exclusive picture. Although, a way fewer gymnosperm species exists nowadays in comparison to the angiosperms, and as such many lineages containing proof for WGD occasions might have been lost, polyploidy occasions,

historical or extra latest, in those seed flowers appear rarely. Similarly, as with the angiosperms, those conifer unique WGDs may have contributed to the survival and achievement of the conifer lineage for the duration of intervals of drastic environmental change. Clear remnants of WGDs in cycads had been no longer uncovered, possibly because of the shortage of public Expressed Sequence Tag (EST) information, ensuing in inadequate decision to name a historical WGD occasion on this lineage. The dramatic lowness in variety became possibly because of demanding situations inclusive of at the least 3 mass extinction occasions, in addition to the advent of, and primary opposition from the angiosperms. Despite the lineage itself has aged over approximately 270 million years, maximum extant cycad species arose in the recent past to a great deal mostly dating within the last 65 million years. Therefore, the famous referral to cycads as dwelling fossils isn't absolutely accurate, because the lineage itself is historical, however, maximum species have originated incredibly recently. Here, we affirm that cycads have gone through a historical WGD and display that this occasion became possibly shared with *Ginkgo biloba* before the divergence of those lineages.

Interpretation of *Welwitschia*'s genetic data:

The pseudo-chromosomes represent 93.65% of the overall assembly length of *Welwitschia mirabilis* and 86.47% of *Gnetum gnemon*. The pseudo-chromosomes of Tumboa disclosed that the longest chromosome was more than 3 times longer than the shortest chromosome. These results consider previous cytogenetical observations showing the constitution of *Welwitschia mirabilis* to comprise body structure chromosomes differing significantly in total length. A complete of 26,990 protein coding genes were foretold of that 89.11%, were valid by transcript proof gathered from RNA sequencing of multiple tissues.

Benchmarking Universal Single-Copy Orthologs (BUSCO) investigation proposes that 83.47% of the genes had been recouped. For *Gnetum*, the improved assembly shows a substantial improvement over the previous unleash, with scaffold N50 lengths of 157.93 Mb, and 27,354 genes, regaining 84.6% of BUSCO genes.

The significant endurance of the two leaves:

Unlike alternative plants, the shoot top plant tissue of *Welwitschia mirabilis* dies within the young plant following the emergence of true leaves and the plant tissue activity moves to the basal meristem. This plant tissue generates the two durable, extremely fibrous, and strap-like leaves, that show indeterminate growth and emerge from 2 terminal grooves at the highest portion of the stem (like a conveyor belt). Co-expression of *ASYMMETRIC LEAVES1*/ *ROUGHSHEATH2*/ *PHANTASTICA* and *KNOX 1* genes within the shoot top plant tissue and leaf primordia in flower have conjointly been connected to the extended leaf basal plant tissue activity within the development of unequal cotyledons. During this study, we tend to discover overlapping organic phenomenon of *ARP3*, *ARP4*, and *KNOX 1* within the basal

meristem, a scenario that's not discovered in most simple-leaved species. To search for additional signatures of indeterminate leaf growth, we tend to characterize sequence activity within the basal plant tissue compared with leaves exploiting GO (Gene Ontology) enrichment and weighted sequence co-expression network analyses. One class of genes that was upregulated within the plant tissue belonged to the class: brassinosteroid physiological state and metabolic process. Brassinosteroids play a vital role in driving plant tissue growth and cell proliferation.

Discussions:

The increasing aridity might have triggered a cascade of events currently visible within the *Welwitschia* genome, like the burst of LTR-RTs (Long Terminal Repeats Retrotransposons) inside the last 1–2 million years since these components were identified to be activated by environmental stress. Since LTR-RTs are metabolically harmful and capable of damaging sequence activity, an associated adaptative response might have caused extended genome-wide pyrimidine methylation to silence their activity, given the increase in levels seen across the genetic material. High levels of pyrimidine methylation over scores of years would, in turn, have led to the hyperbolic frequency of deamination of alkyl cytosines towards thymine, resulting in *Welwitschia*'s GC-poor ordination. Apparently, a GC-poor genomic data can also confer selective blessings under the nutrient stress of *Welwitschia*'s habitat, as ascertained in different plants and bacteria, as a result, GC dinucleotides' demand for N is lesser than that of AT dinucleotides.

An ancient WGD, ~86 MYA, coupled with the genome variations associated with a high frequency of LTR-RT elimination resulted in a decrease in genome size since the last WGD event. This is different from other gymnosperms that are predicted to be slowly increasing in genome size. It is likely that under nutrient and water stress there has been selection for a smaller genome, which helps to reduce the nutrient requirements of the cell and to enhance water use efficiency and prolongs the age of the plant to an unusual extent. The genome now provides a benchmark from which further comparative studies will be possible to intensify our understanding of the adaptations that have enabled extreme longevity in harsh and arid environments.

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BASKET OF OPPORTUNITIES
Invited Extramural Article

Medical Writing as a Career: Opening New Horizons in Careers for Students of Biological Sciences

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INTRODUCTION

Let's start with a question we have all asked ourselves at various points of our academic career – "What's next?" Sometimes we do have the answer right away; sometimes it takes a little bit more time, and information.

Being a student of biosciences in Kolkata and following a traditional educational path, information is something we did not have. So, if you have done B.Sc., you do M.Sc. next, follow it up with a PhD degree, and finally either land a job in a college or pursue a series of post-doctoral projects. What if you did not want to pursue a career in academics? Well, your options were slim to none.

After moving to a different city and deciding that a career in academics was not for me, I started applying for jobs. I became aware of the insane number of opportunities that the healthcare industry offers. Medical writing was one such profile which I felt combined my educational background with my love of writing.

According to an analysis conducted by CenterWatch in 2008, the medical writing market has doubled in size in the last five years, increasing from an estimated $345 million in 2003 to $694 million.[1] The Global Medical Writing Market is estimated to be $ 3.36 billion in 2020 and is expected to reach $ 5.95 billion by 2025, growing at a compound annual growth rate of 12.1%.[2] Moreover, in 2017, medical writing is also the fourth most frequently outsourced service.[3] Most of the top 20 global pharmaceutical companies currently outsource their medical writing work to India.

To be successful in the field of medical writing, it requires an understanding of medical concepts along with a strong aptitude for writing. In addition, pharmaceutical industry being a highly regulated field, keeping up to date with the relevant guidelines is a must. The job profiles also allow a flexible work environment that ensures optimum work-life balance.

WHAT ARE DIFFERENT AREAS OF MEDICAL WRITING?

There are multiple types of documents that relay medical information to multiple types of audiences, but some of the most common branches of medical writing are:

1. ***Regulatory medical writing*** –creating documents related to conduct and reporting of clinical trials of potential lifesaving drugs and devices. Generated throughout the life cycle of such drugs or devices, these documents aid in achieving market approval and continued availability of the drugs or devices in the markets around the world.
   Representing the major bulk of medical writing, pharmaceutical companies and Clinical Research Organizations or CROs employ medical writers to prepare these regulatory documents.
   Most of these documents prepared are meant for regulatory authorities comprising of experienced medical and healthcare professionals who review the data presented and decide whether it is adequate to allow the drugs and/or devices to be sold in specific markets.
2. ***Publication/Scientific medical writing*** – prepare articles/manuscripts for scientific peer-reviewed journals, abstracts, posters, and scientific presentations for national/international medical conferences.
   Most pharmaceutical companies and CROs employ scientific writers who prepare manuscripts, abstracts, and posters to present data generated from clinical trials. Scientific writers also prepare case studies for doctors or hospitals, and prepare review articles for universities.
   These documents are generally intended for other medical and healthcare professionals, or the scientific community.
3. ***Educational medical writing*** – writing medical textbooks, creating content for e-learning platforms, digital science communication (videos, podcasts, slideshows and whiteboard lectures), and medical knowledge repositories.
   Apart from pharmaceutical companies or CROs, several specialized companies prepare such contents which are then utilized for training medical and healthcare professionals, even other medical writers. Apart from medical knowledge, this area of medical writing may also require knowledge of specialized applications like Adobe Illustrator, Articulate 360, Snagit, etc.
   Consumers for these contents are aspiring and existing healthcare professionals, employees in pharmaceutical industries and CROs, researchers, etc.
4. ***Medical marketing*** – creating promotional literature (in print or in websites) for pharmaceutical companies, explaining benefits of their products (either drugs, medical devices or diagnostic devices) that target doctors, pharmacists and other healthcare professionals, and even patients.

These documents help pharmaceutical companies reach their financial goals and also benefit the patients, providing them access to new medicines or procedures.

5. ***Medical Journalism*** – writing or reporting for newspaper or magazine articles (sometimes in websites or blogs, even in television and radio as well) written on medical topics like latest happenings in the medical field or feature articles on trending topics in medicine.
   All leading newspapers run medical journalism columns or publish feature articles on healthcare issues; there are dedicated journals, including business journals, both print and e-publication, blogs, podcasts, and even YouTube channels that require medical journalists.
   The main audience is the general public; therefore, key requirement is the ability to explain complex medical concepts in plain language that will be easy to understand.

WHAT SKILLS SHOULD A MEDICAL WRITER POSSESS?

There are 3 main attributes that help a career in medical writing:

1. ***Understanding of medical concepts and terminologies including data interpretation*** – this is a key requirement as the clinical trial processes generate complex medical data that need to be interpreted and presented to suit the needs of various target audiences. Apart from domain knowledge, knowledge in the drug development process, biochemistry, pharmacology, and statistics may come in handy.
2. ***Strong ethical and moral backbone*** – being part of the pharmaceutical industry bears a huge ethical burden. It is very important to be familiar with ethical concepts of patient safety and legal concepts like anonymity and confidentiality. There are guidelines that govern ethics in medical publication, and as a medical writer it is important to aware of them.
3. ***Excellent language and grammar*** – a very important part of being a medical writer is being able to communicate in clear and concise written language. Familiarity with formatting and editing, various referencing styles, difference between US and UK English are some of the attributes that impact your value as a medical writer.

WHERE ARE THE MEDICAL WRITERS EMPLOYED?

The easiest answer to this is the pharmaceutical industry. However, currently the scope has expanded beyond that considerably. Most employers will provide on-the-job trainings relevant to the job profile. You may find medical writers in:

1. Pharmaceutical or healthcare product companies like Pfizer, Novartis, Sanofi-Aventis, GSK, Eli Lilly etc.
2. Contract research organizations like IQVIA, Parexel, Icon, Siro Clinpharm, Syneos Health
3. Business process outsourcing companies (BPOs) or knowledge process outsourcing companies (KPOs) like TCS, Cognizant, Accenture, Sciformix, Indegene, Cactus Communications
4. Functional service provider companies specializing in scientific content and communication
5. Media and publishing houses; healthcare websites
6. Medical Journal publishing companies like Elsevier
7. Academic institutions
8. Knowledge repositories

HOW TO TRAIN FOR A MEDICAL WRITING PROFILE?

Well, there are no recognized formal degrees, diplomas, or even certification courses for medical writing in India. The hiring organizations provide necessary trainings along with on-the-job trainings. Several pharmaceutical companies, CROs, and BPOs have internship programs that may result in hiring. It is a good idea to explore the internet to check out various resources prepared by professional organizations like the American Medical Writers Association (AMWA), the European Medical Writers Association (EMWA), and the Indian Medical Writer's Association (IMWA). These professional bodies also conduct workshops that you can enroll in to understand the latest trends in the field of medical writing.

IN CONCLUSION

Medical writing is a fairly new field in the Indian job market. Majority of the business that Indian medical writers handle is from global biopharmaceutical companies. The Indian pharmaceutical industry has shown a compound annual growth rate of >20% from 2005 to 2011, according to the Confederation of Indian Industry. It is likely to be among the top 10 global markets in the coming 10-20 years if growth continues at the same rate.[4] There is a rise in requirement of medical writing among Indian pharmaceutical companies as they are targeting products to developed and emerging markets globally. Therefore, a demand for medical writers with experience in preparing complex regulatory documents for global submission is expected to rise.[5]

As pharmaceutical companies outsource more and more work to Asia, particularly to India, graduates can look at medical writing as a valuable career option, and develop knowledge and skills required to take this up as a full-time profession.

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Fostering Epigenetics Start Ups for New Age Medical Interventions

We all know that; Epigenetic Variation holds the promise to provide information on cellular states and developmental histories better than genotype information. Along with that, the plasticity of epigenetic patterns holds immense therapeutic promise towards correcting aberrant, disease-causing epigenetic marks in contrast to fixed genome sequence. A large number of epigenetic drugs are currently in their developmental stages with the major envisaged drawback being their non-specific effects. Numerous startups around the world are engaged in the development of locus-specific epigenetic modifiers which are to be used in conjunction with epigenetic biomarkers of response, which should enable precision interventions.

Five epigenomics startups are in the news for providing affordable solutions to medical and Livelihood issues around the world. They were earmarked from over 170 such startups; for their annual turnover and reach since their inception (Figure 1).

Figure 2: *Distribution of major start ups related to Epigenetics/genomics products and services around the world as of May 2021 with the top 5 startups highlighted.*

EpiQMAx and Histone Modification Assays

Histone modifications are epigenetic markers linked to disease development and progression in cancers. Quantifying histone modifications is, therefore, crucial to understanding their molecular role in diseases. This is why biotech startups are developing histone modification assays for use in biotech, pharma, and healthcare. These solutions quantify levels of a large number of histone modifications across cells to present a global picture of changes in gene expression. **EpiQMAx** is a German startup that provides histone modification assays. The startup's solution simultaneously measures up to 80 histone modifications using Mass Spectrometry. Mass spectrometry is a powerful tool for the genome-wide, unbiased, quantitative analysis of histone modifications. The method allows the study of crosstalk between different histone modifications under a certain cue or condition. Study of such combinatorial nature of histone post translational modifications has revolutionized the ability to study the histone code.

What is their USP?

The mass-spectrometry based kit from **EpiQMAx** further provides an added advantage that they provide detection and quantification of histones from even a very small sample amount. This is an added advantage over the conventional NGS method where small starting amount often becomes a challenge. The test has high sensitivity and works with very low sample volumes. The

startup's services include validating antibody targets, assessing *epidrug efficacy (drugs that target epigenetic marks, especially DNA methylation and the enzymes responsible for prevention of tumorigenesis)*, and other custom epigenomics solutions to quantify epigenomics role in diet or health.

EpigenCare and Personal Epigenomics Testing

Present world of consumerism and business now has a new boom and guess what it is all about? Recently companies have started to relate epigenetics with skincare products. Yes, you are reading it right and what is the advertising tagline? "We match products to your skin's Epigenetics"!! Beauty and aging have never gone together and hence the natural instinct for age-denial. While search for the secret to long life or reverse aging has been an "age-old" quest, mankind thus far has never really been able to make breakthrough. It now seems that the scientific answer to such a quest lies in the form of a molecular prophesy, that centers around epigenetic regulators. While the rigid genetic make-up and genomic composition of our cells is generally not prone to significant changes during a lifetime, epigenetic modifications of an individual is dynamic and prone to continuous changes. Such changes are based on our daily activities, our lifestyle adaptations and can give us a peek into our future in terms of our health, diseases, aging and consequently longevity.
Based on these revelations, now epigenetic features of an individual have been linked to effectiveness of skincare products. Apparently, skincare products that worked wonders for an individual often reaped no benefit for others. People have been so far putting this blame on genetic differences. Now, it seems very likely that it is mostly due to epigenetic changes that have long-lasting effects on a person's health. Epigenomics underlines how two people – even identical twins – react differently to different products. This is why biotech startups offer personal epigenomics tests to produce epigenetic profiles of an individual. US-based startup EpigenCare develops a personal epigenomics test.

What is their USP?

SKINTELLI is a consumer biotech product that *measures DNA methylation levels of genes that control aging, elasticity, moisture retention, and other factors of skin health.* The startup's kit uses non-invasive adhesives to collect skin samples that are sent to a lab for sequencing. EpigenCare then recommends skincare products that best match each person's skin.

Genknowme and Preventive Medicine

As diverse lifestyle and exposure to different environmental factors can alter epigenetic patterns in an individual, the consequent effect on health and biological aging is also unique in every

individual. Hence, ability of an individual to react to preventive or therapeutic medication will also be variable. To quantify this, startups are now offering epigenomics solutions to measure the impact of external factors on the health of a person. Compared to genomics solutions alone, such approaches provide more accurate insights into how susceptible an individual is to a particular disease, as well as effectiveness of specific medications on an individual.

What is their USP?

Swiss startup **Genknowme** advances *epigenetic testing for preventive medicine.* The companies are performing an epigenetic assessment on blood samples to determine a patient's biological age. It then delivers an epigenetic profile that quantifies the impact of environment and lifestyle on DNA structure-function of a specific individual. Such evaluations enable effective drug prescriptions for disease prevention and consequently may increase longevity.

Epify and Epigenetic Biomarkers

Epigenetic changes are pivotal in regulating gene expression and consequently fidelity of cellular functions. Based on this, startups are developing epigenetic modulators as biomarkers. As one of the founders have rightly mentioned "Epigenetic events are driving a significant proportion of cancer cases and are still underutilized for the earlier detection of disease and disease relapse". Such an approach in collaboration between industry and academics is an essential call of the day. Alteration in epigenetic landscape including DNA methylation and post-translational modification of histones can be efficiently used as biomarkers for early tumorigenesis and cancer progression. DNA methylation is a labile modification and is affected across our life span, from early developmental stages through adulthood. It is especially vulnerable to environmental factors such as diet. Nutrition has trans-generational effect that influences overall health and metabolic competence of an individual. Changes in DNA methylation may modify cancer risk and tumor behavior, and have been proposed as biomarkers for detection of cancer stages, tumor prognosis, and prediction to treatment response. Startups are thus using epigenomics approaches to find novel, better epigenetic biomarkers for multi-target assays.

What is their USP?

Epify is a Dutch startup developing *epigenetic biomarkers* for cancer diagnosis. The startup's solutions detect different kinds of *epigenetic modifications, including DNA methylations, histone modifications, and RNA transcript modifications.* It helps companies set up their biomarker discovery pipelines, or use Epify's biomarkers, to develop their diagnostic tests. Additionally, it also aids the development of clinical practices using epigenomics as the platform.

Epigeneron and Epigenetic Drug Discovery-

Many diseases such as cancers, central nervous system (CNS) disorders, and fibrosis are linked to abnormal gene expression. While previously intractable, developments in epigenomics allow researchers to explore these mechanisms. As a result, pharma startups are now increasingly focusing on epigenetic drug discovery. These drugs generally target and inhibit particular epigenetic regulators.

What is their USP?

Epigeneron, the Japanese startup provides epigenetic drug discovery. The startup uses the *locus-specific chromatin immunoprecipitation (ChIP) method to find gene-specific epigenetic regulators*. It also identifies genes that contribute to pathological expression in diseases. The startup contracts its services to other pharma companies in addition to developing its in-house portfolio.

The future:

Epigenomics startups, focus on biomarkers and drug discovery, as well as preventive medicine and testing molecular assays. While all of these technologies play a major role in advancing biotechnology, they only represent the tip of the iceberg.

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"Biotechnology – Looking Beyond Academics"

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Background:

Bioeconomy in India is on the rise. OECD defines bioeconomy as a *"set of economic activities relating to invention, development, production, and use of biological products or processes"*. Two main factors contribute towards its emergence - development in science and technology and societal changes. The convergence of multiple disciplines such as biology, chemistry, materials science, and engineering along with computational biology has enabled the amalgamation and application of interdisciplinary concepts and processes leading to a boom in companion diagnostics, synthetic biology, and personalized medicine. The application of advanced sequencing methods in agriculture has enhanced the field of genomics-assisted breeding which holds the promise of combating issues with food security all around the world. All these innovations have resulted in the emergence of the 4th paradigm - the data generated. Society and its interactions have also changed over the years, and we are now looking at a more mobile society, which on one hand has the potential to increase chances of employability but also may lead to healthcare challenges under conditions of epidemic. Added to this, continuous loss of habitat in coastal areas as a result of climate change has led people to migrate inwards, resulting in more deforestation and thus upsetting the balance of the environment, increasing man-animal conflict, and this may lead to a rapid increase in zoonosis.

Transitioning to a career in Industry:

It is a well-known fact that most countries produce more PhDs than the number of jobs available in the higher education and research sectors. But you should not get demoralized by this as there is a wealth of rewarding job options in many fields outside academia and research. Some of these include industry positions such as R&D, production/manufacturing, QA/QC, marketing, regulation, IP, consultancy, equity research, as well as sectors such as science policy, technical writing, science communication, bioinformatics, core facility management, etc.
The biotechnology industry can be broadly classified into four categories, viz. biopharmaceuticals, bioagriculture, bioservices, and bioinformatics.

1. The Biopharma sector covers biosimilars, molecular diagnostics, vaccines, natural product-based drug discovery, biomedical devices, genomic testing and regenerative medicine.
2. The Bioagri sector consists of crop biotechnology (transgenic crops, hybrid varieties, molecular marker-assisted breeding, plant tissue culture, biofertilizers, biopesticides etc.), animal biotechnology (animal breeding, drugs, vaccines, diagnostics, nutraceuticals, feed, etc.), aquaculture, biofuels, etc.
3. The Bioservices sector includes clinical and contract research services and finally,
4. Bioinformatics has applications in all biotechnology sectors, including creating and managing databases and software tools, in silico drug designing, genome sequencing, etc.

Career opportunities in the biotechnology industry can be broadly classified into the sectors of Research & Development (R&D), production/manufacturing, Quality Assurance (QA) and Quality Control (QC), marketing/management, technology procurement/transfer, management of intellectual property and regulatory affairs, technical writing, etc. Career opportunities under each category require general scientific qualifications along with sector-specific training and specialization.

"When immuno-oncologist Martijn Bijker decided to move from academia to industry, he asked a friend to review his CV. His friend — who had worked in the pharmaceutical sector for two decades — told him to relegate his lists of publications, posters and presentations to the back of the document. The focus, he said, should be on teamwork skills and the ability to perform the job requirements." The advice was an eye-opener for Bijker. He was used to the academic hierarchy, which values individual achievements above all else. But in corporate research, candidates must focus on collaboration.

Alaa Abdine, a PhD-trained biophysicist; now an executive recruiter for Crossover Search in New York City, opines that "Junior researchers who are considering industry should aim as soon as possible to develop the skills and expertise that will be attractive to hiring managers. In last year's graduate-student survey, just 20% of respondents had sought the advice of a researcher who held the job they wanted, and only one-third received input on non-academic careers from their advisers. He further adds, "Don't wait until your eighth year of a postdoc and then come to a recruiter looking for a job."

Innovate and Prosper:

Bioentrepreneurship is projected to be one of the key drivers leading to job creation, improved productivity, increased prosperity and improvement in quality-of-life standards. The opportunities for application of innovative technologies in the areas of healthcare, clean energy, food security and other environmental issues, etc. can contribute towards the strengthening of the economy. As Indian academia relies on the melting pot doctrine in imparting education, bright young minds are aplenty and if nurtured properly they have the ability to excel in global competitive scenarios.

With the above objective, the Department of Biotechnology (DBT) has initiated several novel programmes and schemes to promote bioentrepreneurship amongst students, research fellows, young faculty and scientists. Several programmes of other government departments such as Department of Science and Technology (DST) and Department of Scientific and Industrial Research (DSIR) have also been developed and aligned to provide opportunities and support to promising innovation-led entrepreneurship ideas. Multiple public-private partnered incubation centers have been set up in different parts of the country and are creating a dynamic atmosphere for the entrepreneurial minds in the domain. Incubators, accelerators, angel investors and venture capitalist funding are also acting as enablers to realize the life sciences start-up dreams of potential entrepreneurs.

The key objectives of the Start-up India Action Plan and its achievements with implications on the Biotechnology Startups are as follows:

1. Policy for Reducing Compliance and Enabling Operations
2. Fiscal Policy Initiatives
3. Infrastructure Support
4. Funding Support Initiative
5. Intellectual Property Facilitation
6. Facilitating Public Procurement
7. Mission Programs to Boost Innovation and Startups
8. BiotechnologySectorSpecificInitiatives

Funding Sources:

The following table summarises the various funding programs which an innovator can apply or utilise for taking an idea to market. Several government and private funds have emerged as essential drivers of the innovation ecosystem in India

Serial Number	Name of Scheme	Funding Details	Link to HomePage
1	Biotechnology Ignition Grant (BIG)	To pursue a promising technology idea, and establish and validate proof of concept (POC) for the idea.	http://www.birac.nic.in/big.php
2	Biodesign Innovation and Translation	The programme has now been renamed as School of International Biodesign (SIB) to promote development of indigenous affordable medical technologies in India	http://www.dbtindia.nic.in/stanford-india-biodesign-sib-programme/.

BASKET OF OPPORTUNITIES

3	Social Innovation Immersion Program (SIIP)	SIIP is BIRAC's social innovation fellowship/award program aimed at creating a pool of biotech "Social Innovators" who can identify needs & gaps within communities and then can help bridge the gaps either through an innovative product development or services	http://www.birac.nic.in/desc_new.php?id=395
4	Social Innovation Program for Products (SPARSH)	This programme aims to foster development of technologies/ healthcare solutions which are affordable & relevant to societal health	http://www.birac.nic.in/desc_new.php?id=110.
5	Sustainable entrepreneurship and enterprise development fund (SEED fund)	SEED Fund is to help cover the first Valley of Death for Startups and help them to become investible.	http://www.birac.nic.in/seedFund.php
6	Accelerating Entrepreneurs (ACE) Fund	Equity "Fund of Fund" exclusively for Biotech Start-ups	http://www.birac.nic.in/aceFund.php
7	Students Innovations for Advancement of Research Explorations (SITARE)	This scheme is a collaborative effort of BIRAC with Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), a non-profit organization based at Ahmedabad, Gujarat for fostering grass root level innovations at the university/college level among the students	http://www.birac.nic.in/desc_new.php?id=261
8	E-YUVA	This programme focuses on applied research and need-oriented (societal or industry) innovation among researchers and to catch them young, provide professional mentoring and support needed.	http://www.birac.nic.in/desc_new.php?id=262
9	Promoting innovations in Individuals, Start-ups and MSMEs (PRISM)	PRISM is for budding students, professionals and common citizens interested in innovation and having an implementable and commercially viable, novel innovation	http://www.dsir.gov.in/#files/12plan/prism/prism.html

10	Patent Acquisition and Collaborative Research and Technology Development (PACE)	This scheme of the DSIR provides catalytic support to industries and institutions for development and demonstration of innovative product and process technologies	http://www.dsir.gov.in/#files/12plan/pace/pace.html
11	Techno-Commercial Support for Promising Inventions / Innovations	Value additions required for the laboratory scale technologies to be acceptable by the industry	http://www.nrdcindia.com/Pages/Techno%20Commercial%20Support
12	New Generation Innovation and Entrepreneurship Development Centre (NewGen IEDC)	The programme is managed by National Science and Technology Entrepreneurship Development Board (NSTEDB), of the DST	https://www.nstedb.com/institutional/edc.htm
13	Venture Capital Funding	Risk Capital is an option where the provider reduces the burden of risk of the entrepreneur and thereby bears some part of the overall risk involved in technology translation	
14	Funding from Angel Investors	Some examples of popular Angel Investors in India are Indian Angel Network, Mumbai Angels, Hyderabad Angels	

The Way Forward:

The key challenge that industry professionals face is being prepared for the constant changes that are happening around you and thus students need to be ready for accepting and adapting to these changes. As most companies follow specific business models, termination of jobs, liquidation of entire departments can happen very quickly as a large financial component is involved. Thus, upscaling and earning additional certificates of discipline-specific skills, attending conferences and building up a strong professional network using resources such as **LinkedIn** are the needs of the hour.

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QUIZ

Uttirno Nath
Semester V

Name the Scientists

1. A Hungarian biochemist who her research work on RNAs, including mRNA, and has paved the way for development of mRNA-based COVID-19 vaccines.
2. He was an Indian-American microbiologist who developed the modified 'oil eating' strain of bacteria Pseudomonas putida. He was subsequently granted a patent in 1980, the first ever patent for genetically modified organisms.
3. In the year 1922, this leading Indian physician synthesized the medicine urea stibamine for treating the deadly disease 'kala azar' (visceral leishmaniasis).
4. She was an American born scientist who was awarded the Nobel Prize (along with Roger Guillemin and Andrew Schally) for developing the highly sensitive technique of Radioimmunoassay (RIA).
5. The first Indian woman to be elected a Fellow of Royal Society (FRS); she is known for her research studying enteric infection in children. She has also been an important figure in development of vaccine against rotavirus.
6. Popularly known as "Father of chemotherapy", he was involved in the development the first effective drug for treating syphilis, Salvarsan (containing arsenic), which led to the development of chemotherapy.
7. Using carbon-14 radioisotope as a tracer, he was instrumental in deciphering the pathway of synthesis of carbohydrates in photosynthesis. A cyclic process of 'dark reaction' of photosynthesis is named after him.
8. This German chemist devised the L- & D- nomenclature for carbohydrates and gave the lock and key hypothesis of enzymatic action.
9. She was an American marine biologist and conservationist. Based on her research on chemical pesticides, she wrote the acclaimed book "Silent Spring" which led to a nationwide ban on usage of the pesticide DDT for agriculture.
10. One of the few people to win multiple Nobel prizes, this chemist's work led to characterization of α-helices and β-pleated sheets as basic secondary structural motifs of proteins.

ANSWERS

1.Dr. Katalin Karikó 2. Prof. Ananda Mohan Chakrabarty 3. Dr. Upendranath Brahmachari 4. Rosalyn Sussman Yalow 5. Dr Gagandeep Kang 6. Paul Ehrlich 7. Melvin Calvin 8. Hermann Emil Louis Fischer (popularly known as Emil Fischer) 9. Rachel Louise Carson 10. Linus Carl Pauling

Literary Articles

Oh! What a Wonderful World

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On insistence of my colleague Dr. Priyanka De, one of the editors of Chiasma 2021, I decided to write this article. Most of my colleagues wanted me to write an article on the COVID pandemic but I decided otherwise. The reason was very simple – all of us are desperately waiting to come out of this neo-normal era.

Like many of you, I am a nature-lover and am passionate about travelling, even though I started travelling when I was around 35. I was then in USA for my post-doctoral research experience and my husband and I never used to spare a long weekend to visit new places at that time. Once we planned a two-week trip to visit the Canyon-lands of the USA which extends across a huge area covering the states of Colorado, Utah, and New Mexico. The vastness of a colourful landscape, eroded into numerous canyons, mesas, and buttes by the Colorado River, is breath-taking. My

Here I present a small example of the vastness and uniqueness of the canyon land.
Picture taken from the South Rim of the canyon.
Can you see the Colorado river meandering through the canyon?

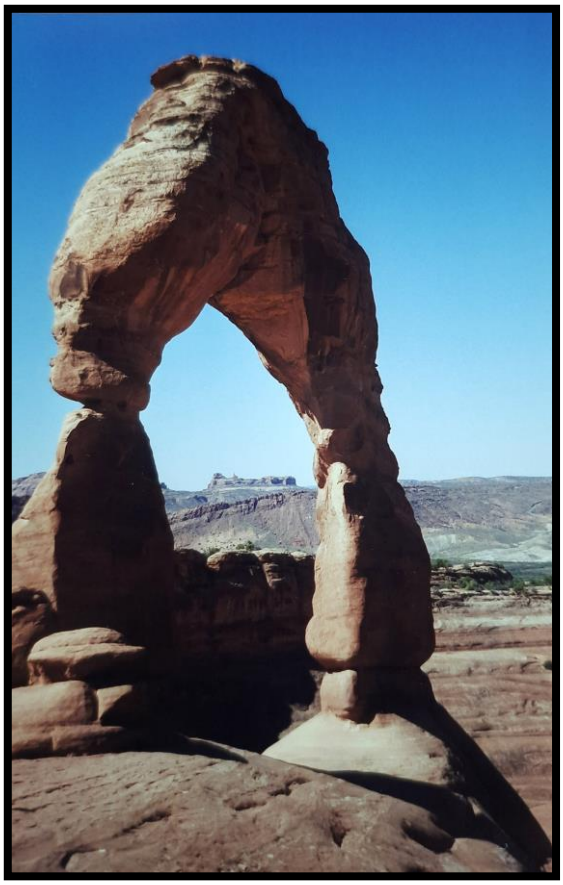
maternal cousin, who is a geologist, accompanied us on that trip. His knowledge about the different landforms and how they are created by water and wind erosion and the dependency on the nature of the soil made that trip complete and a memorable one.

The following pictures were taken from Lake Powell, a reservoir created by the Glenn Canyon Dam on Colorado river and named after the discoverer of the canyon land, John Wesley Powell.

You can see a Mesa landform on your left and a Butte on the right.
Picture Courtesy: Sankar Kumar Muhuri

This is another awesome landform, called the Rainbow Bridge.
This is considered auspicious by the native Americans.
You may go near it but are prohibited from touching it.

As I mentioned earlier, the Canyon land is huge and contains a lot of National Parks – Arches National Park, Bryce Canyon, Zion National Park, etc. Each of the park has its own spectacular landforms. I would love to share all with you but because of space constraints I am sharing this one:



This is the Delicate Arch, in Arches National Park. An iconic picture of Utah State.

We, in fact, hiked to this point, with the scorching sun dehydrating us completely but when we reached the spot, it was a total melt-down, not from the heat, but from the excitement!

When we stood at the base we looked like tiny specks!

In this trip we also visited Las Vegas, the city that never sleeps. From there we visited Death Valley National Park and in fact we were on the floor of the valley which is actually 282 feet below the sea level! This area was a part of the Pacific Ocean but due to tectonic movements it got trapped by mountains. In 2021, the world's highest temperature was recorded here, 54.4°C (130°F)! We crossed the Hoover Dam, one of the seven industrial wonders of the world, to reach the Grand Canyon. The sheer height of the dam will make you feel dizzy. John Denver's 'Rocky Mountains'

was also in our list, and I could not resist the temptation of adding this picture which was taken at the 'Continental Divide' mark in the Rocky Mountain National Park:

Mid-way through this lake runs the imaginary line called the 'Continental Drift' which signifies that the drainage system left to this line flows into the Pacific Ocean and the same to the right flows into the Atlantic Ocean.

Interesting, isn't it?

Another amazing experience while in USA was the 'Fall Foliage'. I stayed in Ohio for nearly two years and New York for nine years. Both these states experience amazing fall colour. We also travelled through the 'New England' states of Vermont, New Hampshire and Maine to enjoy Fall. Miles after miles of the Appalachian Mountain Range, covered by trees with leaves coloured yellow, orange, red and purple, created an unforgettable experience!

I would like to shed some light on this 'Fall Foliage' to make you experience that what you study in your course material today is demonstrated so nicely by nature all round you. Leaves are like seasonal workers of a 'tree' factory. As long as enough raw materials (sunlight, water, Carbon Dioxide) are brought to the factory, the workers do their job. The green pigment 'chlorophyll' is the spirit of the workers during the hay days. When the days become shorter, the sunlight reduces

and the temperature cools down which causes chemical changes to be initiated in the leaves creating the fall foliage. Carotenoids and Anthocyanins are the two chemicals that are responsible for the fall coloration of leaves. Under these circumstances, when leaves are not being able to work to their fullest capacity because of the non-replacement of the chlorophyll molecules, the management department of the tree factory engages in a cost-benefit analysis. Leaves need energy but they are no more capable of replenishing it efficiently (carotenoids and anthocyanins are not as efficient as the chlorophylls). Thus, the tree-management no longer wants to waste energy on leaves. As the night gets longer, the temperature keeps dipping and the humidity decreases which causes a corky layer of cells, the abscission layer, to be created between the tree and the individual leaves and they fall off. Sometimes before the leaves fall, they turn brown due to the formation of tannins, produced after the breakdown of the carotenoids and anthocyanins. A simple request – next time you snap a picture of copper-coloured leaves for your Instagram, take a minute to appreciate the intricate chemical interactions going on.

So, what is the connection between your curriculum and fall foliage? The perfect timing and precise dependence on sunlight-intensity, temperature and humidity, of the burst of fall colours, can be best understood through the lens of epigenetics – one of the important players in the crosstalk between the environment and our bodies. Without any change to the DNA sequence, epigenetic modification can drastically alter the characteristics of a cell or even an entire organism. Try your luck in planting a maple tree, a major contributor of fall foliage, in Kolkata and see whether you can observe any colour change?

My best Fall-shot taken in Upstate New York:

In eleven long years, I have seen much more than what I have shared here but I need to put a period here because it will be a sheer injustice if I do not describe a little about my travel experience in my country, India. From the time I relocated to India, nearly every puja and/or winter vacation, I was on the move with my family and friends. Even the neo-normal days couldn't stop me from travelling. Before I started travelling here, Grand Canyon topped the list of the places I have visited but, now it has slipped down a few places.

I am sure all of you will agree with me that in India, whether you go down from North to South or travel across East to West, there is some wonder waiting for you to discover in nearly every nook and cranny. Our mighty Himalayas single-handedly compensates for all the beauty that nature has to offer in the entirety of the USA. Barring a few small trips, I actually started my travel experience in India by visiting God's abodes, starting with Pashupatinath temple in Nepal to Kedarnath, Badrinath and Tunganath temples in Uttarakhand. Tell me something, why has God chosen such remote but picturesque places for building their abodes? My answer is, 'God is Nature and Nature is God'. Now a paradoxical question – then why do we fight over religion and commit such heinous crimes in the name of God? Only if people seriously took the lyrics of John Lennon's 'Imagine' -

"… Imagine there's no countries

It isn't hard to do

Nothing to kill or die for

And no religion, too …."

But I don't want to deviate from what I want to share with you. If I am a huge chunk of magnetic material then, beyond any doubt, the Himalayan Range is the strongest magnet on the surface of our Mother Earth. Everything about the mountains, starting with their various shapes, shades imparted by the mineral content of the rocks, wide-variety of vegetation and their fading density with increasing altitude, waterfalls resembling the veil of a bride, the deep gorges with mountain-rivers meandering through them, never fail to fascinate me. I do not believe in life after death but if it was real, I would have requested Nature God to make sure that I take birth in midst of the Himalayas! I have seen Kanchendzonga quite a lot of times, from Darjeeling- Tiger Hill, Upper Pehling, Chhota Mangwa, Kaffer Gaon and finally from Chatakpur in December 2020. And every single time, the range has mesmerised me and made me want to go back to visit 'Prabhu

Kanchendzonga' innumerable times. Here I display the best picture taken last December from Chatakpur:

December 27th, 2020, in the shivering cold, we were standing on the balcony outside the room of the Humro Home Stay, waiting patiently for the Sun to rise …. and there it goes! We were all awe-stricken with the golden-red hue on the snow-clad Mt. Kanchendzonga. I felt so happy, so satisfied.

Picture Coutesy: Anirban Siddhanta

Do you see what I see? Do you agree with me that this part of the Kanchendzonga Range, looks like the side-profile of Lord Shiva? I feel that way and hence I say "Prabhu Kanchendzonga"! Prabhu has therefore bagged Rank 1.

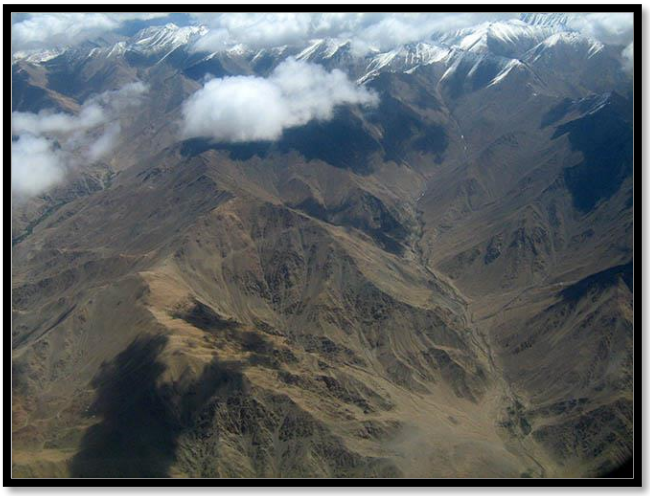
I have made several trips to Sikkim, and I can say, beyond any doubt, it is the most wonderful state I have ever visited. There are breath-taking sceneries, strewn all over the state, for you to appreciate. I credit Gurudongmar Lake, with Rank 2. You have to travel to Lachen in North Sikkim to reach this lake which is at a height of 17,800 ft. We started at 3.30 a.m. from Lachen to reach the lake. It was pitch dark outside. There was hardly any traffic visible in the front or back of our car. But what was waiting for us was this:

While returning, I saw the horrible road condition. My salute to Manoj bhai whose efficient driving through those horrible curves, with steep slopes on one side and deep gorges on the other, with rocks and boulders strewn all over from fresh landslides, helped us achieve this gorgeous sighting!

Next on my Rank List is Ladakh, a Union Territory with Leh as its main city. Before I stepped on to Ladakh I had no idea that even a harsh terrain can be so soothing to your eyes. Because of time constraint, we flew from Delhi to the Kushok Bakula Rinpoche Airport, Leh. We flew over the distinctly visible windward side of the Himalayan Range to the leeward side; it was an amazing experience. I hope you remember your Geography lessons!

Windward-side

Leeward-side



Because Ladakh is on the leeward-side, it is very dry and you can literally visit a cold desert, Nobra, with all the desert characteristics – sand dunes, thorny bushes and double-humped Bactrin Camels, which are found only in the Steppes of Central Asia.

The landing strip was not only narrow but surrounded by mountains and every time the aeroplane was taking a turn, I felt as if the wings were going to touch the mountains! There is so much to talk about Ladakh and so many pictures to share but, that space constraint will restrict me to sharing just a few:

These are iconic pictures of beautiful Ladakh!

The mountains are made up of soil turned into rock and hence are very loose. In 2010 there was a devastating flash flood caused from a rare cloud burst leading to a huge loss of life and property. The vegetation here is entirely artificial plantation which helps check soil erosion. This region is unbelievably mineral rich and hence you can see different shades of colour on the mountain slopes – just a mind-blowing experience! Buddhism is one of the major religions of the local people and hence you can see a lot of Stupas and Monasteries. Generally, the monasteries are constructed on hillocks, made of hard rock, to ensure a strong foundation.

One moment of intense excitement was when I touched the water of Indus River!
Indus river takes birth in Tibetan Himalayas and flow through Ladakh and Batalik before entering Pakistan. Just the thought that one of the very ancient but advanced civilization (Mohenjodaro-Harappa) developed on the banks of this same river gave me goosebumps!

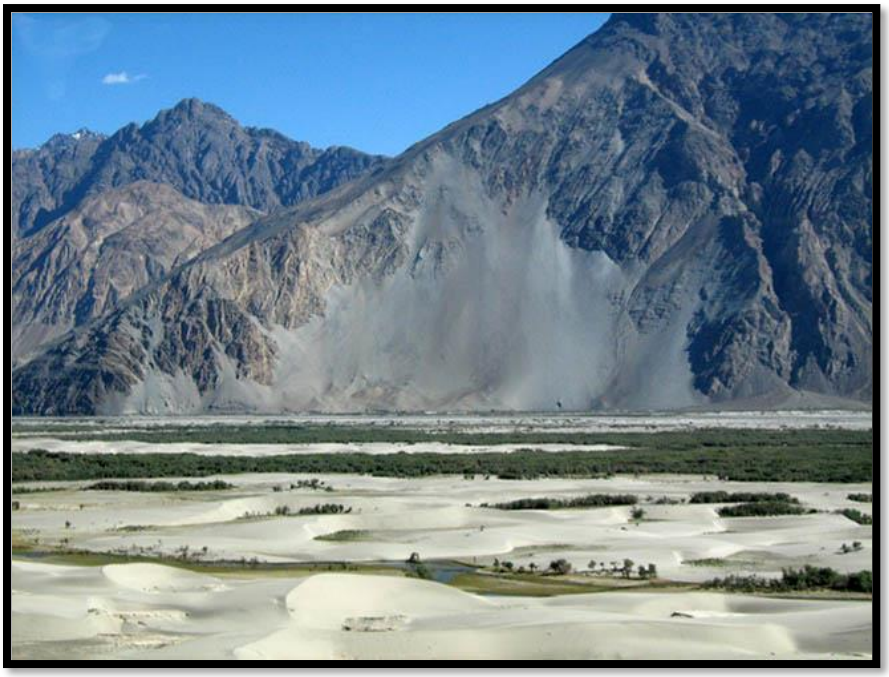
In this Ladakh trip we achieved new heights – world's highest motorable road at Khardung La, on our way to Nubra Valley and world's highest cafeteria at Chang La which we had to cross to visit Panggong Tso!

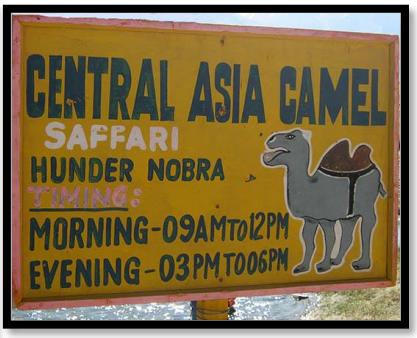
We witnessed the spectacular Karakoram Range!

Just a reminder:

La means pass and Tso means Lake

I still wonder why I found it so difficult to digest the existence of a desert at such a high altitude and having very low annual temperature! May be because, the word desert rings the bell of Thar Desert in my mind.





Even though every sight-seeing spot was just picture-perfect in Ladakh, we were all spell-bound when we reached Pangong Tso. Overall Ladakh and particularly Pangong Tso have bagged the 3rd position!

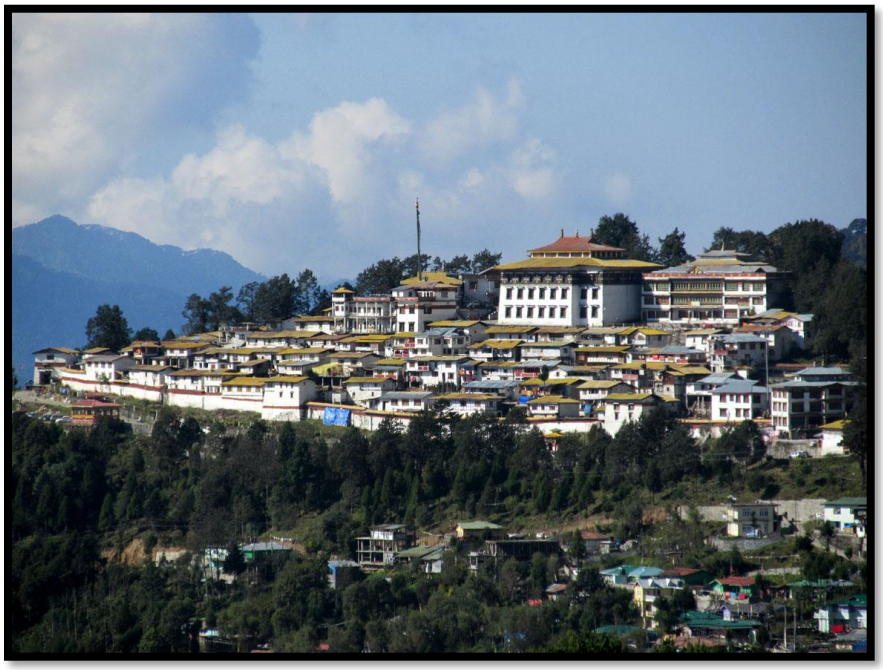
Pangong Tso, is situated at an elevation of 13,862 ft. Local people said that the surrounding mountains are made of garnet! We were lucky to get a sight of the migratory Brahmini ducks at the lake.

It is beyond my imagination why this heavenly place should become a disputed territory. Unfortunately, the Line of Actual Control passes through the lake. A section of the lake, approximately 20 km east from the LAC is controlled by China but claimed by India and results in frequent political skirmishes. The most recent one was in 2020 and turned out to be really violent. The Almighty had created such wonders for us and we, human beings are just trying to destroy the peace and sanctity of these places. What a tragedy!

Next in the Rank List is Chitkul – the last village in India bordering Tibet.

We took an elaborate trip in October 2012 to Himachal Pradesh covering quite a few picturesque places in the South and Southeast region of HP. Lofty mountains, deep gorges, dangerous roads, reservoirs from dams constructed on River Sutlej with emerald-green water, fall foliage, wild flowers, snow-clad mountains including Kinnaur-Kailash peaks, and many more beautiful attributes of Nature just kept us intoxicated for 6-8 hours everyday when we were on the road. But the best was that little hamlet, Chitkul!

I know what my reader is thinking about me, 'she is very partial, only talking about the Himalayas, but there is so much more to see in this world'. You are absolutely right. I am a little partial to the Himalayan Range because of its uniqueness, majesty and diversity. Every time you look up to the mountains, depending on whether the range belongs to the Greater Himalayas (Himadri), or the Lesser Himalayas (Himachal), or the Shivalik hills, you will discover new dimensions. I apologise for being so nagging and promise you that after sharing just one more picture I will move away from the mountains of the north!



Tawang, situated in the extreme northwest of Arunachal Pradesh, belong to the Shivalik Range. Here you can see the iconic picture of the Tawang Monastery! Rank 5)

Before I completely leave the mountains, let me share with you a very different mountainous region, situated in the South; yes, you have guessed it right, Munnar with huge areas of tea plantation, situated in midst of the Western Ghat Mountains. These volcanic mountains are distinctly different from the young-fold mountains of the Himalayan range. I visited the highest altitude organic tea estate called Kolukkumalai Tea Estate and observed the entire procedure of processing freshly plucked tea leaves. I also visited spice gardens experienced the exotic flower of 'Elaichi' plant for the first time. This trip was dedicated to my mother and her friend!

Now let me move onto a very different aspect of nature – the seas/the oceans. To tell you frankly I am not very eager to visit sea/ocean-sides, probably due to the fact that I am not a good swimmer and am a little scared of water bodies. There is another reason – I find seas or oceans a little monotonous. I feel they lack the diversity of the mountains. This notion, to an appreciable extent, was changed when I visited Andaman. Before visiting Andaman, I had visited many sea-side destinations in the coastal areas of Bay of Bengal, Arabian Sea, Atlantic Ocean, Pacific Ocean, but I was never that impressed.

We flew from Kolkata to Savarkar Airport at Port Blair in Andaman. We stayed in Port Blair and went for a day-visit or one/two-night stays to different islands of which I must say Havelock Island, Neil Island and the twin Islands of Ross and Smith connected by sand-bridge, visible at low tide need special mention. Beautiful blue colours of the ocean, glass-bottom boat-rides to see a wide variety of corals and school of fish of different kinds, walking on beaches literally made of dead corals, witnessing spectacular sunsets, etc. made that trip a spectacular and memorable one. Another attraction was the Cellular Jail – while watching the light and sound show, we really felt emotional, learning and thinking of the intense sacrifices of our freedom-fighters! I am sharing a few pictures from my Andaman album (collectively Rank 6):

I can go on sharing my travelling experience with you, but I could only share this much, only because we are having an online edition of chiasma 2021 due to the neo-normal time!

I did not stop travelling even during these new normal days. Travelling to new places, not necessarily exotic ones (even the countryside is fine), has become a part and parcel of my life. I have learned a lot of new things about nature, about people, through keen observation during travelling. It really gives me a deep sense of joy and happiness. And when I have free time at home, I keep looking out of the window and standing on the balcony, to enjoy nature, frequently capturing the blue skies, white and grey clouds, rainbows, sunrise, sunset, full moon, etc. on my mobile.

This reminds me of the famous song of Louis Armstrong, and I am just quoting a stanza from it:
"… I see skies of blue
And clouds of white
The bright blessed day
The dark sacred night
And I think to myself
What a wonderful world ….".

Metanoia

Shreyasi Mitra

Semester IX

Me.

I am ombre silence,

Ricocheting off the walls of untainted dawn

I am a mirage,

Your hope of salvation behind rose-tinted glasses

I am splinters of red, white and blue

Emanating from the fires within you.

I am the embrace of wild flowers

Delusional and intoxicating to the lone traveller who seeks my love

I am shades of grey and the taste of ash on your tongue

Like the sombre skies before a storm.

I am ebony and amber,

Quietly framed in your monocolour photographs

I am purple and silver thunder

Message of the tempest, otherworldly beautiful

I am the song of the unknown,

Healing to the parched soul.

I am ephemeral,

A tiny fleeting moment lost forever in the chaos of universe

I am ombre silence

Waiting for you to speak.

Warmth of Love

Leena Bhadra

Semester VII

"Do you know what warmth is?", I asked, and he answered,

"It's when my cold hands touch yours and our fingers entwine,

It's when your sigh and my sigh mingle into a soft breath,

Warmth is when loneliness meets loneliness and becomes a silent comfort,

It's when sadness meets itself and turns into happiness.

When a cool breeze collides against another and becomes soft snow,

That's what warmth is.

When the ice-cold heart melts with the steady approach of a comfortable love,

Warmth ensues.

Just like a single leaf settles on the shoulder without making a sound,

And the cosmos lays its tender hands on me very softly,

Warmth spreads silently and peacefully just like

You, in front of my eyes, fill me up with your fond love."

Let Newton's Wheel be Stilled

Anushree Sadhu

Semester III

There are days when you're left confused at the dolorous show of life
You wonder, if ever you could, truly see its charming side
Ages through, sages have praised her beauty and light
But in all this, you only see a plain, blank, mournful white.

Colourless can look the hours of life; All senseless, sombre, dry
In earnest, you search for a hue or dye, in the seamless, afternoon skies
The less you find, the more you search, for what does not seem to be there
Your vision goes, whiter grows the world in that quick motion of yours.

What we don't understand, what we refuse to realise
Life asks of us not ceaseless motion, but a quiet, silent, stillness
Spin not so much, that the colours blur. Let Newton's wheel stand thus.
And you shall see that the same old white breaks into a vibrant spectrum.

Pause in this race that never ends, enough of worlds have been built
Move not so fast, in this ever-spinning world that all your days go blurry
Complain not then, of colourless ways, of the lonely isolating white
For colours are there, always around. It's you who needs to open your eyes.

Strings

Mitika Shireen Mundle

Semester I

We were the strings of an old guitar
And whenever we were plucked;
We did shine like a star.
We both had different pitches
But when we did play together,
We never created hitches.
Whenever you broke,
My music began to croak
Our symphony would only blend
When someone would grant you amend;
Without you being fixed,
I would rather not exist.
You had a role in creating a beautiful melody
And without you,
My chords would lose their serenity-
We were tied together in this wooden dreadnought
With a circle of life in the centre,
So that our music keeps tying together people in its knots.
We were the strings of an old guitar
Without each other, we are just an open scar.

প্রকৃত ক্ষুধা

ডঃ প্রিয়াংকা দে
সহ অধ্যাপক
বায়োটেকনোলজি বিভাগ
সেন্ট জেভিয়ার্স কলেজ (স্বশাসিত), কলকাতা

কর্মকাণ্ডময় ব্যস্ত জীবনে বাড়ির লোকের জন্য 'সময়' দেওয়া যেন এক প্রকারের পরীক্ষার মতো। সদ্য সদ্য পদোন্নতির ফলে কাজের জটিলতাও বেড়েছে। মনের সুকোমল অনুভূতি গুলো কোথায় যেন চাপা পড়ে গেছে। আজকে অফিসে কাজের চাপটা একটু বেশি ছিল। খুব ক্লান্ত লাগছে আজ। সারাদিন বাড়িতে একবারও ফোন করা হয়ে ওঠেনি চঞ্চলের। বাড়ি ফিরতেই স্ত্রী ছুটে এসে অভিমানের বন্যা বইয়ে দিলো। বার বার মুখে একটাই কথা, "সারাদিনে কতবার আমায় মনে পড়েছে গুনে গুনে বল; আমার মান না ভাঙ্গালে আমি কথাই বলবো না।" নাছোড়বান্দা স্ত্রীকে যুক্তিপূর্ণ ব্যাখ্যা দেওয়ার বৃথা প্রচেষ্টার আগেই হস্তক্ষেপ পড়ল পাশের ঘর থেকে অসুস্থ বৃদ্ধা মার আগমন। মা এসে জিজ্ঞাসা করলো, "কি রে বাবান, সারাদিন কিছু খেয়েছিস তো?" চঞ্চল যেন নতুন ভাবে সম্পর্কের গভীরতা বুঝল, মনের খিদের চেয়েও পেটের খিদে বলীয়ান। সারাদিন খাওয়া হয় নি; সেটা মা কত সহজে বুঝে গেল!

ভাত কাপড়ের দায়িত্ব

ডঃ প্রিয়াংকা দে
সহ অধ্যাপক
বায়োটেকনোলজি বিভাগ
সেন্ট জেভিয়ার্স কলেজ (স্বশাসিত), কলকাতা

সামাজিক বিধি মেনে 'ভাত কাপড়ের দায়িত্ব নিলাম' কথা সহযোগে বিবাহ বন্ধনে আবদ্ধ হয় অনিকেত ও তৃষা। রীতিমতো দেখেশুনে কাগজে বিজ্ঞাপন দিয়ে নতুন ফ্ল্যাটে আনা হয় সুগৃহিনী ও গৃহকর্মনিপুণা পাত্রী তৃষাকে । বেসরকারি অফিসের উচ্চপদস্থ কর্মচারী অনিকেত সারাদিন অফিসের কাজের ব্যস্ততায় বুঝতেই পারেনি সংসারে তৃষার অবদানের পরিমাপ। তৃষাও কোনদিন কোনরকম বাড়তি চাহিদা নিয়ে আসেনি অনিকেতের কাছে। যে কপালের জোড়ে তৃষার মতো স্ত্রী জুটলো, সেই কপালের দোষেই বিয়ের একবছরের মধ্যেই অনিকেত তৃষাকে হারালো। মাত্র একদিনের জ্বরে চিকিৎসার কোনও সুযোগ না দিয়ে হাসিমুখে বিদায় নিল তৃষা। মৃত্যুর আগের দিন অবধি স্ত্রী রান্নাঘরের দায়িত্বে ছিল। জলখাবার থেকে শুরু করে রাতের খাবার -সব দায়িত্ব সুনিপুণ ভাবে পালন করত তৃষা তার স্বতোবৃত্ত ভালোবাসায়। স্ত্রীর মৃত্যুর পরদিন জীবনে প্রথম রান্নাঘরের দর্শন করল অনিকেত। সামান্য ভাত করতে গিয়ে হিমশিম সে। দায়িত্বজ্ঞানসম্পন্ন অনিকেত অফিসে শত কঠিন সমস্যা মেটালেও আজ রান্নাঘরের বাতাবরণে রীতিমতো পীড়িত অনুভব করল। আজ হঠাৎই মনে হল, ভাত কাপড়ের দায়িত্ব কি অনিকেত আদৌ নিয়েছিল! এতদিন অনিকেতের খাওয়ার যত্ন, অনিকেতের কাপড় গুছিয়ে রাখা সব তো তৃষাই করেছে সাবলীল ভাবে। আজ তৃষা নেই; অনিকেত বুঝতে পারল যে এতদিন তৃষাই তার ভাত কাপড়ের দায়িত্ব নিয়ে এসেছে। তাই বিয়ের সময় 'ভাত কাপড়ের দায়িত্ব নিলাম' কথাটা তৃষারই বলা উচিত ছিল।

বৃত্তের বাইরে- রবিকিরণে

ডঃ সৌভিক রায়
সহ অধ্যাপক
বায়োটেকনোলজি বিভাগ
সেন্ট জেভিয়ার্স কলেজ (স্বশাসিত), কলকাতা

শুনেছি চাঁদ নাকি বৃত্তাকারে পৃথিবী প্রদক্ষিণ করে -
আর পৃথিবী করে সূর্যকে।
বৃত্তের মধ্যে থাকাটাই সব
সেই সবের জন্য মানুষ কতো পাপ করে।
আর যারা পাপী নয়
তাদের বৃত্তের বাইরে থাকতে হয়।
বৃত্তের বাইরেও তবে আর এক বৃত্ত আছে
বৃহত্তর বৃত্ত - ভালোবাসার গোলক।
যার ব্যাসার্ধ মনের সংকীর্ণতার চেয়ে ঢের বড়ো
ঢের বড়ো সস্তা রাজনীতির চেয়ে
ঢের বড়ো কেতাবী বুলির চেয়ে।
তাইতো আজও আমরা বেঁচে থাকি
সেই অতিক্ষুদ্র বৃত্তের বাইরে
ছিটকে যাওয়া তারাদের দলে নয়
গনগনে আঁচে জ্বলতে থাকা রবিকিরণে -
' তুমি নির্মল কর, মঙ্গল করে, মলিন মর্ম মুছায়ে'।।

নতুন বায়োস্কোপ

ড: সায়ক গাঙ্গুলী
সহ অধ্যাপক
বায়োটেকনোলজি বিভাগ
সেন্ট জেভিয়ার্স কলেজ (স্বশাসিত), কলকাতা

ছোটকু পাসোয়ান পারেনি আর হাঁটতে
১০০ মাইলের পথটা, পারলোনা হতে পার....
হাজার মাইল দূরে - কাবুল-কান্দাহারেতে,
জীবন কাড়ছে গুলি আর কাঁটাতার।

বিশ্বজুড়ে জ্বলছে মোমের বাতি,
খুঁজছে কত হারিয়ে যাওয়া মুখ
পৃথকীকরণে আটকে থাকা জাতি,
মানবজাতির সিক্ত হওয়া চোখ।

তাকিয়ে দেখো বন্ধ আজি দ্বার
তিরুপতি আর হজরত নিজামুদ্দিনে;
ঈশ্বর আজ নিছকই দর্শক
অতিমারী সব ক্ষমতা নিয়েছে কিনে,

সামনে দাঁড়িয়ে লড়ছে ওরা কারা?
হাতে পিপেট গলায় স্টেথোস্কোপ;
চিনে নাও তোমায় বাঁচিয়েছিল যারা
দেখিয়েছিলো নতুন বায়োস্কোপ।

পিঁদাড়ে দলমা

শ্রমণা কর

সেমিস্টার-৯

দলমা পাহাড় তার অদ্‌ভুত সুন্দর নামটি পেয়েছে পাহাড়ের একেবারে মাথায় অধিষ্ঠিত 'দলমা মাই'- এর থেকে আর এই পাহাড়কেই আষ্টেপৃষ্টে জড়িয়ে রেখেছে নৈসর্গিক সৌন্দর্যের এক অরণ্য। ঘন জঙ্গলে ঘেরা দলমা পাহাড় বহু বহু জীব-জন্তুর স্থায়ী বসতি, তদের 'অভয়' দিয়ে আগলে রাখে 'দলমা অভয়ারণ্য'।

সমতলের থেকে প্রায় ৩০০০ ফুট উচ্চতায়, জামশেদপুর-এর উপকণ্ঠে ঝাড়খন্ডের দলমা পাহাড়, যার মূল আকর্ষণ বলাই বাহুল্য, দলমা অভয়ারণ্য। দলমার উদ্দেশ্যে আমরা রওনা হয়েছিলাম ঘাটশিলা থেকে, একটি ছোট গাড়িতে। রেলপথও অবলম্বন করা চলে, তবে সে বেশ ঝক্কির ব্যাপার। সড়কপথে ৩৩ নং জাতীয় সড়ক হয়ে ঘাটশিলা থেকে দলমা অভয়ারণ্যে পৌঁছতে সময় লাগে প্রায় ২ ঘন্টা। আমাদের গন্তব্য ছিল মাকুলা কোচা ইকো হাট্। এই প্রসঙ্গে বলে রাখা ভালো, প্রায় ১৯৫ বর্গ কিলোমিটার জায়গা জুড়ে অবস্থিত দলমা অভয়ারণ্যের মধ্যেই বনবিভাগের দু'টি রেষ্ট হাউস রয়েছে, মাকুলা কোচা এবং পিন্দরাবেড়া। মাকুলা কোচা পাহাড়ের পাদদেশে এবং পিন্দরাবেড়া বেশ অনেকখানি উপরে পাহাড়ের ঢালে। রেষ্ট হাউসের প্রি-বুকিং করা যায় সরাসরি দায়িত্বে থাকা ফরেস্ট অফিসারের সাথে টেলিফোন মারফত কথা বলে, তবে তা সারতে হয় অনেকদিন আগেই। মাকুলা কোচায় দাঁড়িয়ে যেমন মনে হয় গোটা পাহাড়টাই যেনো চারিদিক থেকে ঘিরে রয়েছে ছোট্ট দ্বীপের মতো রেষ্ট হাউসটাকে তেমনি একেবারে মূল জঙ্গলের ভেতরে পিন্দরাবেড়ার ঢালে দাঁড়িয়ে মনে হয় গোটা জামশেদপুরটাকেই যেনো ছবির মতো দেখতে পাওয়া যাচ্ছে।

আমরা যখন মাকুলা কোচায় পৌঁছলাম তখন প্রায় বেলা ১০ টা। দলমার প্রবেশপথে স্বাগত জানাবে তিনটি হাতি ও আরও কিছু জীব-জন্তুর অবয়বের আদলে তৈরী মূর্তি দিয়ে সাজানো একটি ফটক। "Dalma Wildlife Santuary – Home of Asiatic Elephant Welcomes You", এভাবেই তার পর্যটকদের অভ্যর্থনা জানায় দলমা। দু'পাশে শাল, আসান, আবলুস, বহেড়ার জঙ্গলের মধ্যে দিয়ে লালমাটির রুক্ষ পথে ধুলো উড়িয়ে হাজির হলাম রেষ্ট হাউসে। খাওয়া-দাওয়ার বন্দোবস্ত রেষ্ট হাউসের কর্মচারীরাই করে রাখেন, তবে বেশ কয়েক ঘন্টা আগেই তাদের জানিয়ে দেওয়া প্রয়োজন কারণ রেশন জোগাড় করে আনতে হয় অনেক দূর থেকে। সেই দিনটা মাকুলা কোচাতেই কেটে গেলো। বিকেলের দিকে যাওয়া হল 'Deer Park'-এ। মাকুলা কোচা রেষ্ট হাউসের পেছন দিকটায় একেবারে গায়ে লাগোয়া হরিণদের বিচরণক্ষেত্র। রেষ্ট হাউসের জানলা দিয়েই অনায়াসে তাদের গতিবিধি পর্যবেক্ষণ করা যায়। জালের

দলমা অভয়ারণ্যে প্রবেশের মূল ফটক

মাকুলা কোচা 'Deer Park'-এর চিতল ও সম্বর হরিণেরা

বেড়া দিয়ে ঘেরা Deer Park-এর মধ্যে চড়ে বেড়ায় চিতল ও সম্বর হরিণের পাল। এমনিতে তারা পর্যটক বিমুখ। তবে কখনো ইচ্ছে হলে ঘুরতে ঘুরতে চলে আসে বেড়ার ধারে, পর্যটকদের হাত থেকে পাতা খায় মহানন্দে। যেকোনো পাতা তাদের না-পসন্দ, একমাত্র কচি শালপাতাই তাদের মেনুতে জায়গা করে নিতে পেরেছে বলা চলে। রেষ্ট হাউসের মধ্যেও দু'টি হরিণের অবাধ বিচরণ, তবে তাদের দেখা পাওয়া ভার। মাঝেমধ্যে 'Bamboo Hut'- এর পেছন থেকে তাদের উঁকি-ঝুঁকি মারতে দেখা যায়।

দীর্ঘ শাল-আবলুসের পেছনে আস্তে আস্তে ঢাকা পড়ে সূর্য। আমরাও ফিরে যাই নিজেদের অস্থায়ী বাসায়। চারিদিকের নিকষ কালো অন্ধকারে মাকুলা কোচা ফরেস্ট রেষ্ট হাউসকে সত্যিই মনে হয় কোনো বিচ্ছিন্ন দ্বীপ। বাইরের এত কোলাহল, যান্ত্রিক পৃথিবীর ব্যস্ততা কোনকিছুই যেনো স্পর্শ করতে পারেনি এই পাহাড়ি রেষ্ট হাউসটিকে। এটাই হয়তো জঙ্গলের নিয়ম!

পরেরদিন খুব ভোরে বেড়িয়ে পড়া হল দলমার জঙ্গল ভ্রমণে। বাইরে তখন আধো-আলো আধো-অন্ধকার, পাহাড়ি জঙ্গলের বুক চিরে শোনা যাচ্ছে ময়ূরের ডাক। ড্রাইভার দাদা দৃঢ় প্রতিজ্ঞ, হাতি তিনি আমাদের দেখাবেনই। আমরাও আশায় বুক বেঁধে বেড়িয়ে পড়েছি। পথে যেতে যেতে চোখে পড়ল বেশ কিছু রঙ-বেরঙের পাখি, তবে যার ডাক শুনতে শুনতে এলাম, সেই ময়ূরের দেখা মিলল না। যেহেতু আমরা কিছুটা 'অফ-সিজন'-এ (মার্চের শেষ-এপ্রিলের শুরু) গিয়েছিলাম, তাই রাস্তায় আমাদের ছাড়া আর একটিও গাড়ি চোখে পড়ল না। আধঘন্টার পথ পেরিয়ে উপস্থিত হলাম পিন্দরাবেড়ায়। রেষ্ট হাউসটি যেমন ছবির মতো সুন্দর তেমনি নিচের দিকে তাকালেও চোখ জুড়িয়ে যায়। সারি সারি কাগজ ফুলের গাছে ফুটে রয়েছে শত সহস্র থোকা থোকা ফুল। আরও ঘন হয়ে উঠেছে শাল-বহেড়া-আবলুসের জঙ্গল। এখানেই চোখে পড়ল 'Indian giant squirrel', 'Rhesus monkey'-র মতো কিছু প্রাণী। পিন্দরাবেড়া ওয়াচ টাওয়ার থেকেও চারপাশের দৃশ্য দেখতে বেশ ভালো লাগে।

Indian Giant Squirrel


Rhesus monkey

এবারে ড্রাইভার দাদা বললেন তিনি এমন রাস্তা দিয়ে গাড়ি নিয়ে যেতে চান, যেখানে সচরাচর অন্য গাড়ি যায় না, যদি হাতির দেখা মেলে! দেখতে পেলাম বেশ কিছু 'elephant corridor',

এক পাল বুনো মহিষ আর এক-দু'টি হাতির জল খাওয়ার স্থান। কেমন করে এমনই এক 'corridor' দিয়ে বেড়িয়ে এসে ড্রাইভার দাদার গাড়িকে তাড়া করেছিল এক হাতি সে গল্পও শুনলাম। পূর্বরাত্রে বিসর্জিত তাদের বর্জ্যবস্তুও দৃষ্টি এড়ালো না। তবু সেই মাহেন্দ্রক্ষণ আর এলো না। বিশ্বকর্মা দেবের বাহন গাড়ির সামনে এসে শুঁড় তুলে অভ্যর্থনা জানানো তো দূরের কথা, দয়া পরবশ হয়ে তাঁর পুচ্ছাগ্রও প্রদর্শন করলেন না!

হাতির জল খাওয়ার স্থান

পথে বেশ কিছু যায়গায় এক চিলতে করে জঙ্গল দেখা গেল পুড়ে ছাই হয়ে আছে। মনে পড়ল কিছুদিন আগেই দলমা ছিল বিদ্ধংসী আগুনের কবলে। কাদের কাজ বলবো এগুলোকে? মানুষ না অমানুষ? আর ঠিক কতবার পৃথিবীর সবচেয়ে উন্নত(?), সবচেয়ে বুদ্ধিমান প্রাণীর সীমাহীন লোভের আগুনে দগ্ধে মরবে শত শত নিষ্পাপ প্রাণ? হারিয়ে যাবে প্রকৃতির পরম যত্নে তিল তিল করে গড়ে তোলা সবুজের সাম্রাজ্য?

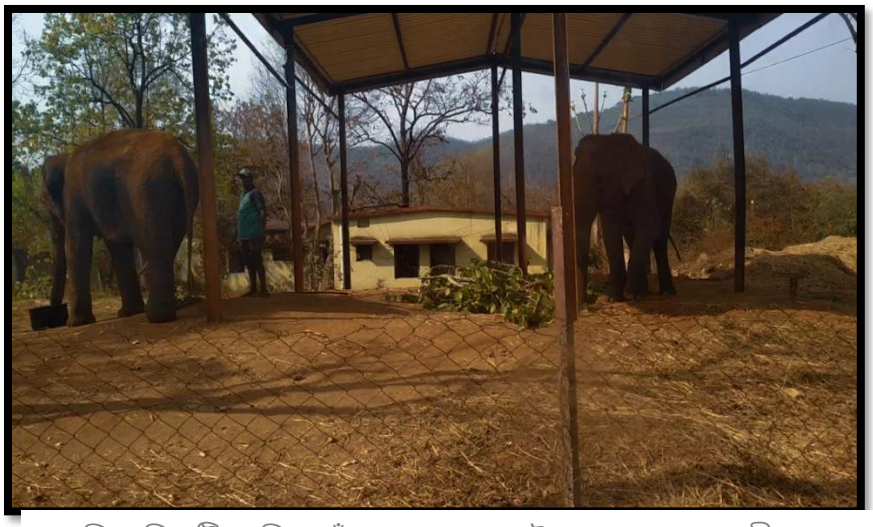
দলমা পাহাড়ের মাথায় অর্থাৎ 'Dalma Top'-এ যখন পৌঁছলাম তখন প্রায় সকাল ৭:৩০। দলমা মাই-এর দর্শন সেরে উঠলাম দলমা ওয়াচ টাওয়ারে। অসময়ে যাওয়ার কারণেই ওয়াচ টাওয়ারে উঠে আবিষ্কার করলাম সেখানে আমি ছাড়া একটিও জনপ্রাণী নেই। নিচের দিকে তাকালে মনে হবে যেনো স্বর্গ থেকে মেঘে ঢাকা মর্ত্য দর্শন করছি। হাতি দেখতে না পাওয়ার দুঃখ, শতাধিক সিঁড়ি চড়ার ক্লান্তি সব নিমেষে দূর করে দেয় সে দৃশ্য। যেদিকেই তাকানো যাক না কেনো শুধু সবুজ আর সবুজ, যেনো এই আশঙ্কায় দিন গুনছে আবার কবে সভ্যতার লেলিহান শিখা গ্রাস করবে তাদের!

Dalma Top-এ Santuary-র একটি মানচিত্র

এবার ফেরার পালা সবুজদ্বীপ ছেড়ে কংক্রিটের জঙ্গলে। আবার সেই থোড়-বড়ি-খাড়ার জীবন শুরু করার পালা। ফেরার পথে একটি বোর্ড চোখে পড়ল, তাতে লেখা, "No one in the world needs an elephant tusk but an elephant"। সত্যিই তো! এত সহজ একটা সমীকরণ বোঝা কি এতই দুস্কর? তার দাঁতের মূল্য তো অনেক কাল আগেই বুঝে নিয়েছি আমরা, তার মূল্য বুঝবো কবে? তার বসতি কেড়ে তাকেই কোণঠাসা করেছি, আর তারপর সে এক পা বাড়ালেই সব দোষ তার! মেতে উঠেছি পৈশাচিক মারণ খেলায়।

দলমা ওয়াচ টাওয়াররের উপর দাঁড়ালে যে দৃশ্যে চোখ জুড়িয়ে যায়

মূল ফটক পেরোনোর সময় ডান দিকে চোখ পড়ল, দু'জন তখন আরাম করে শুঁড় দুলিয়ে খাদ্যে মনোনিবেশ করেছে। এই কুনকি হাতি দু'টি ছাউনিতেই বাঁধা থাকে, তবে দিনের বেশীরভাগ সময়টাই তারা জঙ্গলে ঘুরে ঘুরে কাটায়। সেই কারণেই যাওয়ার দিন তাদের দেখা মেলেনি। দুধের সাধ ঘোলে মিটিয়েই বিদায় জানালাম দলমা রাণীকে। আর কারোর দেখা মিলুক বা নাই মিলুক শুধু এই জঙ্গলের গন্ধ গায়ে মেখে নিতে, ভোরের শান্ত স্নিগ্ধতাটুকু উপভোগ করতেই বারবার ছুটে যাওয়া যায় দলমার ডাকে।



কুনকি হাতি দুটি (গাড়ির কাঁচের ভেতর থেকেই তাদের ক্যামেরাবন্দী করার চেষ্টা)

~সমাপ্ত~

সায়ন কুমার ভৌমিক

সেমিস্টার–৯

প্রভাতী

শুরু হয়েছে ধ্বংসলীলা,
সাবধান করি শোনো এবেলা।

পৃথিবী আজও করছে ধারণ,
ঘরবাড়ি আর কত লোকজন;
বেড়ে চলেছে গাড়িঘোড়া,
গ্রাম থেকে শহর ইমারতে মোড়া।

কেটে ফেলা ওই সেগুনের খাটে -
শুয়ে আছি মোরা কত আহ্লাদে !
এসি ঘরে বসে করি আবদার -
বড্ড গরম! বৃষ্টি দরকার।

আমাজনে দেখো জ্বলছে আগুন,
গ্রীষ্ম আসে আজ,আসেনা ফাগুন!

ধরিত্রী পালন করে চলেছে তার ধর্ম,
শিশুপালের শত পাপ,হয়েছে পূর্ণ।
শতবর্ষ পর দেখা দিয়েছে মহামারী !
শত শত প্রাণ নিয়ে-তবেনা দুনিয়া ছাড়ি।

তাইতো বলি এসো সবাই করি বৃক্ষরোপণ,
'একটি গাছ একটি প্রাণ' জানে সবাই, করে কয়জন?
মাঠ-ঘাট উঠবে আবার শস্য-শ্যামলে ভরে !
চলো সবাই করি প্রার্থনা,সেই প্রভাতের তরে ।

~সমাপ্ত~

অভিরূপ চক্রবর্তী
সেমিস্টার-৭

আস্থা টুকু রেখো

চারিদিকে আজ আলো নিমজ্জমান,
বেঁচে থাকা বড় কঠিন,
তবু বলি বন্ধু, ভেঙে পড়োনা এমন,
পথ চলা এখনও অনেক বাকী।

যদি মনে হয়,
আর পারা না যায়,
ভারটা বড্ড বেশি,
হাল ছাড়তে তবু দেবোনা বন্ধু,
আর কিছু নাই বা করতে পারি।

তোমার লড়াইটা আজ তোমারই,
চাইলেও ভাগ বসাতে পারব না,
দূর থেকে তাই,
আর কিছুই উপায় নাই,
করজোড়ে শুধু প্রার্থনা করে যাই।

জানি আজ সময় বিপক্ষে,
নিশ্চয়তা নেই কিছুরই,
ভালো থাকার তবু চেষ্টা করো,
নিজেকে শক্ত করে ধরো,
বিজয়ী তুমি হবেই, এই আস্থা টুকু রেখো।

~সমাপ্ত~

ইচ্ছেপূরণ

দেবাশ্রিতা মজুমদার

সেমিস্টার-৭

এতক্ষণ চোখ বুজে ঘাপটি মেরে পড়ে ছিল ইচ্ছে; মা, বাবা ঘুমোচ্ছে, এই সুযোগে পা টিপে টিপে বাইরে বেরিয়ে আসে ইচ্ছে। আজ প্রায় মাস আষ্টেক পরে ঠাম আর দাদাই এর কাছে এসেছে ও। এই স্বরূপনগরের ব্যাপারটাই আলাদা, বাড়ির পিছনে মস্ত বাগান, সামনে গাড়ি-বারান্দা, পুবদিকে নিজস্ব পুকুর, সব মিলিয়ে এক্কেবারে এলাহি ব্যাপার। এখানে এসে ঘুমোতে ভালো লাগে নাকি! ঠাম, দাদাই-এর ঘরের দরজাটা ফাঁক করে একটু উঁকি মারে ইচ্ছে। ও ভেবেছিল এঘরে এসে একটু গল্প শুনবে ওদের থেকে কিন্তু ওরাও যে ঘুমোচ্ছে! কী করবে ও এখন? ডাকবে ওদের? সেই সকাল থেকে অনেক খাটাখাটনি গেছে ওদের, তাই ক্লান্তি কাটাতে শুয়েছে একটু এখন। কিছুতেই ওদের ডাকা যাবেনা। কি করবে! কি করবে! কিছুই তো ভেবে পাচ্ছে না ইচ্ছে।

আরে, কিসের আওয়াজ ওটা? ঐ পিছনের বাগান থেকে আসছে কি? খানিকক্ষণ মন দিয়ে শোনার পর ইচ্ছে নিশ্চিত হল ঐ শব্দের আগমনস্থল সম্বন্ধে। বাগান থেকেই আসছে ঐ স্বর। খিড়কি দরজা খুলে বাগানে যায় ও। আহ্! কি আরাম! এত সবুজ, এত আলো, এত হাওয়া, এত আকাশ, শহরের ঐ তিনকামরা ফ্ল্যাটে কেন যে এসব নেই! ব্যালকনিতে দাঁড়িয়ে এতটুকু নীল বা সবুজ দেখতে পায়না ইচ্ছে। কতো চেষ্টা করে একটা কাঠবেড়ালি কিংবা চড়াই দেখার কিন্তু কোথায় কি! ক্লাস ওয়ান অবধি তো ও পরী কিংবা ব্যঙ্গমা-ব্যঙ্গমীদেরও খুঁজত, কিন্তু টু-এর বইতে ঐ পরিবেশ দূষণ চ্যাপ্টারটা পড়ে ও বুঝেছে শহরে ওরা থাকতেই পারে না, তাই এখন খোঁজা ছেড়ে দিয়েছে। আসলে বইতে লেখা ছিল শহরে দূষণের মাত্রা অনেক বেশী আর দাদাই-এর মুখে শুনেছিল পরী, ব্যঙ্গমা-ব্যঙ্গমী, ওরা বিশুদ্ধ পরিবেশে ছাড়া থাকতেই পারে না, তাই...

আরে আরে ওটা কি! এগিয়ে গিয়ে ইচ্ছে দেখে, গাছের গুঁড়িতে একটা গর্ত আর ঐ যে, ঐ কাঠবেড়ালিটা ইচ্ছেকেই তো ডাকছে মনে হচ্ছে। একটু কাছে যেতেই, ওর হাতটা ধরে, ওকে টেনে নেয় ঐ ফোকরে, তারপর কয়েকমুহূর্তের জন্য সবকিছু অন্ধকার; আর তারপর? তারপর সে যে এক আশ্চর্য দুনিয়া। চারিদিকে রঙবেরঙের ফুল, শয়ে শয়ে প্রজাপতি উড়ে বেড়াচ্ছে, গাছের ডালে

বসে মিষ্টি সুরে গান গাইছে পাখিরা। ওরা কারা গল্প করছে ওখানে? ওরা কি ব্যঙ্গমা-ব্যঙ্গমী? একটু যেন হকচকিয়ে যায় ইচ্ছে। কেমন যেন ধাঁধা লেগে যায় ওর।

আরও কারা যেন এগিয়ে আসছে ওর দিকেই। ভীষণ চেনা, অথচ এখন ঠিক মনে করতে পারছে না।

- ইচ্ছে, ইচ্ছেপূরণ মিত্র!

- হ্যাঁ, হ্যাঁ। তোমরা কারা?

- বলোতো আমরা কারা?

- পরী?

- ঠিক বলেছ। তুমি প্রায়ই আমাদের ডাকো তোমাদের কলকাতার ফ্ল্যাটের বারান্দা থেকে, কিন্তু আমরা তো ওখানে যেতে পারিনা। তাই তোমাকে নিয়ে এলাম আমাদের জগতে।

- ওখানে গেলে তোমাদের খুব কষ্ট হয়, তাই না?

- হ্যাঁ, মানুষেরা যে বিষিয়ে দিয়েছে শহরটাকে। ওখানে গেলে আমাদের চোখ জ্বালা করে, শ্বাসরোধ হয়ে আসে, শরীর নিস্তেজ হয়ে যায়, তারপর আস্তে আস্তে আমরা মারা যাই। তাই তো যেতে পারিনা ওখানে। কিন্তু তোমার মতো মিষ্টি, ফুলের মতো কেউ যখন ডাকে তখন খুব মনখারাপ হয় যে।

- মনখারাপ কোরো না তোমরা, তোমাদের মনখারাপ হলে আমারও তো কষ্ট হয় বলো।

- আচ্ছা, ঠিক আছে। চলো তোমাকে ঘুরে দেখাই আমাদের দেশ।

সবকিছু দেখেশুনে তো ইচ্ছে অবাক। এদেশের নাম স্বপ্নপুরী। এখানের ঝর্ণাতে হাসি ঝরে, এদেশের আকাশজুড়ে খেলে বেড়ায় রামধনুরা। স্বপ্নপুরীর হাওয়ায় ভেসে বেড়ায় আনন্দের ছন্দ। এখানের কাঁচা-মিঠে রোদে লেগে থাকে সুখের ছোঁয়া। এত স্নিগ্ধতা, এত শান্তি, এত আদর, এত ওম- সব দেখে, গায়ে মেখে, খেলে বেড়িয়ে, এখন ইচ্ছের মনে যেন একসাথে হাজারে হাজারে

বুদ্‌বুদ্‌ দাপাদাপি করে বেড়াচ্ছে। এই সময়ে নিজেকে যেন এই রূপকথার জগতের রাজকন্যা মনে হচ্ছে ইচ্ছের।

- ইচ্ছে! ইচ্ছে!

- তুমি কে?

আশ-পাশ থেকে পরীরা বলে ওঠে, "উনি আমাদের রাণী, মায়াবতী"।

মায়াবতী বলেন,

-বলো, তুমি কি চাও? যা চাইবে তাই পাবে।

- যা চাইব তাই পাব?

- হ্যাঁ। বলো, কি চাই তোমার?

- আমি মাঝে মাঝে তোমাদের এখানে আসতে চাই। তোমাদের সাথে খেলতে, সময় কাটাতে চাই।

- বেশ, এটা ধরো।

- এটা তো একটা নকশা-কাটা বল। কি হবে এটা দিয়ে? আমি তো বল খেলি না।

- উমম্‌-হুমম্‌ এটা যে-সে বল নয়। তোমার নামের মতোই এটা একটা ইচ্ছেপূরণ বল। এখন এত বড়ো দেখছ তো, যেই তুমি ওটাকে কোথাও ঢুকিয়ে রাখতে যাবে ওমনি ওটা ছোটো হয়ে সেই জায়গারই আকার নেবে। তারপর তোমার ইচ্ছে মতো ওটা বের করে তুমি স্বপ্নপুরীর কথা মনে করলেই চলে আসবে এখানে।

- কিন্তু আমি একা আসব কি করে? আমার তো তোমাদের মতো ডানা নেই। আর কলকাতা যে এখান থেকে অনেক দূর।

- তুমি শুধু এখানের কথা মনে করলেই হবে। এই বলই নিয়ে আসবে তোমায় স্বপ্নপুরীতে।

- সত্যি বলছো?

- সত্যি, সত্যি, সত্যি।

"ইচ্ছে, এই ইচ্ছে, ওঠ মা, সন্ধ্যে হয়ে গেল যে, ঠাম ভাপা পিঠে বানিয়েছে, খেতে ডাকছে, ওঠ মা"- মায়ের ডাকে ঘুম ভেঙে যায় ইচ্ছের। একি! ও যে বিছানায়! তাহলে চোখ বুজে শুয়ে থাকতে গিয়ে কি ও ঘুমিয়ে পড়েছিল? কিন্তু তাহলে এই যে ও স্বপ্নপুরীতে গেল! তাহলে ওটা কি স্বপ্ন? স্বপ্নই হবে বোধহয়। মনে মনে ইচ্ছে ভাবে -"যদি স্বপ্ন হয়, স্বপ্নই হোক, স্বপ্নে হলেও পরীদের সাথে, ব্যঙ্গমা-ব্যঙ্গমীদের সাথে দেখা তো হল, এই ঢের"।

- এই পাতলা সোয়েটারটা খুলে মোটা জ্যাকেটটা পরে নে তো মা, এখানে সন্ধ্যের পর থেকে খুব ঠান্ডা।

জ্যাকেটটা পরার জন্য সোয়েটারটা খুলতে গিয়ে হাতে কি যেন একটা কঠিন টের পেল কি? ঐ পকেটের কাছটায়? হাত ঢুকিয়ে ইচ্ছে দেখে একটা ছোট্ট বল, এটা তো হুবহু সেই নকশা কাটা বড়ো বলটার মতো দেখতে। তার মানে, তার মানে স্বপ্ন নয়, সত্যি!

ইচ্ছের হাতে এখন স্বপ্নপুরীর চাবিকাঠি। জ্যাকেটটা পরে বাইরে যাওয়ার আগে কাচের বলটা ও সযত্নে ভরে রাখে ওর পেন্সিল বক্সের ভিতরে। এখন থেকে খুব সাবধানে রাখতে হবে এটাকে, এটা যে ইচ্ছেপূরণ মিত্র-র এতোবড়ো একটা ইচ্ছেপূরণের সাক্ষী।

~সমাপ্ত~

সিকিমের হাতছানি

শ্রাবন্তী মুখার্জী

সেমিস্টার-৫

"থাকব নাকো বদ্ধ ঘরে,

দেখব এবার জগৎটাকে"--

এই চিন্তাধারা প্রায় প্রত্যেকটি মানুষের মনের কাঙ্খিত বাসনা। তাই পৃথিবীর প্রায় প্রত্যেকটি মানুষের চরিত্রের সাথে 'ভ্রমণ' শব্দটি জড়িয়ে আছে। কে না ভ্রমণ করতে ভালোবাসে? একঘেয়ে কর্ম জীবনে মনের শ্রান্তি, ক্লান্তি দূর করে মনকে সতেজ শান্তিময় করে কর্মদ্যোগী করে তোলার জন্য ভ্রমণ এক অনন্য সঙ্গী। তাই বারে বারে ভ্রমণপিপাসু মানুষ প্রকৃতির টানে বেড়িয়ে পড়ে সমুদ্রতটে, পাহাড়-পর্বতে, বনাঞ্চলে, রুক্ষ মরু অঞ্চলে কিংবা ইতিহাস বিজড়িত নানা স্থানে।

আমিও ভারত প্রকৃতির রূপ-রস-সৌন্দর্য্যে আকৃষ্ট হয়ে মাঝে মাঝেই বেড়িয়ে পড়ি ভ্রমণের পথে। পাহাড়-পর্বতমালা যেন আমায় হাতছানি দিয়ে ডাকে। সেই ডাকে সাড়া দিয়ে এবার গিয়েছিলাম পর্বতমালা বেষ্টিত সুন্দরী প্রদেশ সিকিম সফরে। মার্চ মাসের স্নিগ্ধ বায়ু প্রবাহিত এক সন্ধ্যায় বাবা-মাকে সঙ্গে নিয়ে বেরিয়ে পড়লাম সিকিমের উদ্দেশ্যে। ভোর বেলায় গাড়ি পৌঁছল শিলিগুড়ি। সেখান থেকে আবার গ্যাংটকের পথে গাড়ি ছুটল। শিলিগুড়ি ছাড়িয়ে ঘন্টা খানেক যাওয়ার পর শুরু হয়ে গেল পর্বত প্রকৃতির অপরূপ শোভা। খাড়াই-উৎরাই পথ এঁকে বেঁকে চলেছে।

যে দিকে তাকাই শুধু পর্বত আর পর্বত। সেই পর্বতমালার বুক চিরে বয়ে গেছে কত খরস্রোতা নদী। তারই বুকে গড়ে উঠেছে কত নগর-শহর-গ্রাম, কত জনপদ। চলতে চলতে দেখি -- কিছুক্ষণ আগে আমাদের গাড়ি যেখানে ছিল, কিছুক্ষণ পর সে জায়গাটা আমাদের থেকে কত নীচে, আবার

এতক্ষণ উপরে যে জায়গাটা দেখছিলাম এখন সে জায়গায় আমরা। এই ভাবে চলতে চলতে ঘন্টা পাঁচেক সময় কখন যে কেটে গেল বুঝতেও পারলাম না। বুঝতে পারলাম না নিদ্রাহীন ক্লান্ত শরীরটাকেও। দু'চোখ ভরে প্রকৃতির রূপ শোভা অবলোকন করতে করতে পৌঁছে গেলাম সিকিমের রাজধানী গ্যাংটক শহরের এক মনোরম হোটেলে। স্নান, খাওয়া-দাওয়া সেরে একটু বিশ্রাম নিয়ে বেরিয়ে পড়লাম গ্যাংটকের ম্যালের বিখ্যাত এম.জি. মার্কেট দেখতে। সাজানো গোছানো একটা ঝা চকচকে মার্কেট এতো উপরে! দেখলেও অবাক হতে হয়।

রাতের শহর গ্যাংটক

রোপওয়ে থেকে গ্যাংটক শহর

পরদিন সকালে প্রাতঃরাশ সেরে বেড়িয়ে পড়লাম সেই বহু আকাঙ্খিত ছাঙ্গু লেক, বাবা মন্দির, নাথুলা পাস দর্শনে। চড়াই উৎরাই, আঁকা বাঁকা পথ বেয়ে গাড়ি ছুটল। মন ছুটে চলেছে হংস বলাকার ন্যায়। চারিদিকে শুধু পর্বত আর পর্বত, খাদ আর খাদ, নদী আর নদী। কোথাও বা পর্বতারণ্য, কোথাও বা বরফাচ্ছাদিত পর্বতমালা। কোথাও বা মাথার উপরে যেমন মেঘাচ্ছাদিত আকাশ, নীচেও তেমনি মেঘাচ্ছাদিত আকাশ। কোথাও বা পর্বতের গায়ে বরফের উপর সূর্য রশ্মি এসে ঠিকরে পড়ে কাঁচা সোনার চাদরে ঢেকে দিয়েছে।এ কি প্রকৃতির আশ্চর্য রূপ! পার্বত্য প্রকৃতির এই অপরূপ রূপ শোভা অবলোকন করতে করতে পৌঁছে গেলাম বহু কাঙ্খিত মন মুগ্ধ করা ছাঙ্গু

লেকে। চারিদিকে বরফাচ্ছাদিত সুউচ্চ পর্বত আর পর্বত। তারই মাঝে বিস্তৃত এলাকা জুড়ে নীল স্বচ্ছ স্রোতহীন জলাভূমি -- ছাঙ্গু লেক, রূপের ডালি নিয়ে বসে আছে।

ছাঙ্গু লেক

বাবা মান্দির থেকে ছাঙ্গু লেক

এখানে প্রকৃতি যেন হাতছানি দিয়ে আমাদের ডাকছে,আমাদের দাঁড় করিয়ে দিচ্ছে তার রূপের গরিমা দেখানোর জন্য। একদিকে আমরা পেঁজা তুলোর মতো বরফের উপর দাঁড়িয়ে, অপর প্রান্তে সূর্যালোকিত বরফাচ্ছাদিত সু-উচ্চ পর্বতমালা। মাঝে শান্ত স্নিগ্ধ ছাঙ্গু লেক। কি মনোরম, কি অনির্বচনীয় মাধুর্য এ জায়গার। ঘন্টা খানেক কাটিয়ে চলে গেলাম আরো উপরে বাবা মন্দিরে।

বীর সৈনিক বাবা হরভজন সিং-এর স্মরণে তাঁর নামাঙ্কিত এ মন্দির গড়ে উঠেছে পর্বত চূড়ায় এক সুন্দর শান্ত পরিবেশে। সেখানে কিছুক্ষণ কাটাবার পর আরো ওপরে ভারত-চীন সীমান্তে নাথুলার উদ্দেশ্যে ছুটল আমাদের গাড়ি।

নাথুলা পাস ভারত ও চীনের মধ্যে একমাত্র স্থল সীমান্ত। এটি হিমালয়ের প্রায় ১৪৪২৫ ফুট উঁচুতে অবস্থিত। এখানে ভারতের সিকিম রাজ্যের সীমান্তের সঙ্গে চীনের তিব্বতের সীমান্ত মিলেছে। চীন ভারত যুদ্ধের সময় এই বাণিজ্য পথটি বন্ধ হয়ে যায়। তারপর দীর্ঘ ৪০ বছর পর ২০০৬ সালে এ জায়গা আবার খুলে দেওয়া হয়। আর তারপর থেকেই এটি একটি পর্যটন কেন্দ্রে পর্যবসিত হয়। শুনেছি সিকিমে গিয়ে, এ জায়গাটিতে না গেলে সিকিম ভ্রমণ পূর্ণ হয় না। ওখানে পৌঁছে বুঝলাম

সত্যিই তাই। এ যেন এক অন্য জগতে এসেছি। এক অজানা উন্মাদনায়, রোমাঞ্চে শরীর মন ডুবে যায়। হারিয়ে যায় পার্থিব চিন্তা ভাবনা। সেখানে ঘন্টা খানেক অতিবাহিত করে হোটেল অভিমুখে যাত্রা। নাথুলা থেকে হোটেলে আসার ফিরতি পথে আবার দাঁড়িয়ে পড়লাম ছাঙ্গু লেকের ধারে। আবার কিছুক্ষণ ছাঙ্গুর রূপ শোভা উপভোগ করে হোটেল অভিমুখে রওনা দিলাম।

পরের দিন আবার গাড়ি ছুটল সিকিমের আরও নানান দর্শনীয় স্থান পরিদর্শনের জন্য। অভাবনীয় প্রকৃতির শোভা, স্থাপত্যের নিদর্শন, বিগ্রহ, মন্দির দু চোখ ভরে দর্শন করে ফিরে এলাম হোটেলে।

পরদিন বাড়ি ফেরার পালা। সকাল সকাল স্নান খাওয়া-দাওয়া সরে সিকিমকে বিদায় জানিয়ে যেখান থেকে যাত্রা শুরু হয়েছিল সেইখানে অর্থাৎ শিলিগুড়ির পথে চললাম ভারাক্রান্ত মনে। পর্বতের বুকে মেঘ-বৃষ্টি-রৌদ্র-ছায়ার খেলা দেখতে দেখতে সন্ধ্যার প্রাক্ মুহূর্তে এসে পৌঁছলাম শিলিগুড়ির বাস স্ট্যান্ডে। ক্লান্ত, অবসন্ন মনে বাসে চেপে বসলাম। বাস ছুটে চলল আমাদের স্বস্থানে পৌঁছে দেওয়ার জন্য। সিকিমের সুখ-স্মৃতি নিয়ে অবশেষে ভোর বেলায় নিজ গৃহে এসে উপনীত হলাম। পর্বতমালার অপরূপ শোভা-লাবণ্য চিরস্মরণীয় হয়ে রয়ে গেল মনের মণিকোঠায়।

~সমাপ্ত~

মর্ত্যবাসীর স্বর্গ দর্শন

সহেলী মজুমদার

সেমিস্টার-৫

স্বর্গ, মর্ত্য, পাতাল একটা কাল্পনিক ধারণা, তবে স্বর্গ সর্বাপেক্ষা উৎকৃষ্ট বোঝাতেই যে ব্যবহৃত হয় সেটি নিশ্চিত । করোনার দ্বিতীয় ঢেউয়ে আক্রান্ত হয়ে নরক –যন্ত্রনা ভোগতোহলোই – এ রকম একটা নিকৃষ্ট অভিজ্ঞতার ঠিক পরেই কাশ্মীর ঘোরার সুযোগ আমার মতো মর্ত্যবাসীর কাছে স্বর্গ-স্বাদের চেয়ে কোনো অংশে কম ছিল না। কলকাতা থেকে কাশ্মীরে যাত্রায় আনন্দ- উত্তেজনার সাথে একটা চাপা আতঙ্ক থাকলেও শ্রীনগর এয়ারপোর্টে নামার সাথে সাথেই তা কর্পূরের মতো উবে গেল, গোটা ট্যুরে তার আর দেখা মিললো না।

পহেলগাঁও দিয়েই আমাদের যাত্রা শুরু হয়েছিল।ডানদিক, বাঁদিক না সামনের দিক, কোন দিকটা দেখবো? সবটাই যেন একটা সাজানো গোছানো ছবির মতো সুন্দর জায়গা।খানিকটা পথ এগোতেই দুগ্ধ ফেনিল স্রোতের 'লিডারনদী', সুন্দরী, উচ্ছল যুবতীর মতো চলল আমাদের সাথে সাথে। দুদিকে পাইন আর জুনিপারের ব্যক্তিত্বময় চেহারার সাথে পাহাড়ের খাঁজে- ভাঁজে তুলো তুলো মেঘ যেন জেগে স্বপ্ন দেখার মতো।দু'দিন পহেলগাঁওতে থেকে বেতাবভ্যালী, আরুভ্যালী,চন্দনওয়াড়ি এবং পথে নানারকম ঝর্নার দৃশ্য সবটাই মনোমুগ্ধকর, সবুজের সমারোহে ভরপুর, যৌবনের প্রাচুর্যে ঢলঢল যা অবর্ণনীয়।

বেতাব ভ্যালী

পরের দিনে পহেলগাঁও থেকে গুলমার্গের যাত্রা পথে দুদিকের সবুজ গালিচার মাঝখান দিয়ে সরু কালো রাস্তাটা যেন ঘন চুলের এয়োস্ত্রীরসিঁথি।গুলমার্গের অপরূপ প্রাকৃতিক সবুজ – সৌন্দর্যের সাথে সাথে দেখা মিলল নানা রঙের ফুলের। নাম না জানা সেসব রং বেরঙের ফুলেরা আপন খেয়ালে হাওয়ায় দুলছে ,একে অপরের গায়ে ঢলে ঢলে পড়ছে।

"গন্ডোলারাইড" , পৃথিবীর সর্বোচ্চরোপওয়ে- যেটি প্রায় 13450 ft. উচ্চতায় অবস্থিত,যা

গুলমার্গের অন্যতম একটি আকর্ষণ। কুয়াশা-বৃষ্টি আমাদের সাময়িক মন খারাপের কারণ হলেও প্রকৃতি নিজের রূপবদলে সুযোগ করেদিল আমাদের মুখে হাসি ফোটানোর কারণ কুয়াশা থাকলে গন্ডোলারাই ডের দ্বিতীয় ফেজ অর্থাৎ শেষ অব্দি আমরা যেতে পারতামনা। একজন গাইড এর সাহায্যে আমরা গন্ডোলা রাইড এ গেলাম।বেশ উঁচু রোপওয়ে। নীচের থেকে উপরে ওঠার সময় সে কী যে অসাধারণ দৃশ্য , যেন পুরো ক্লোরোফিলের সমুদ্র দিয়ে ভেসে ভেসে চলেছি।

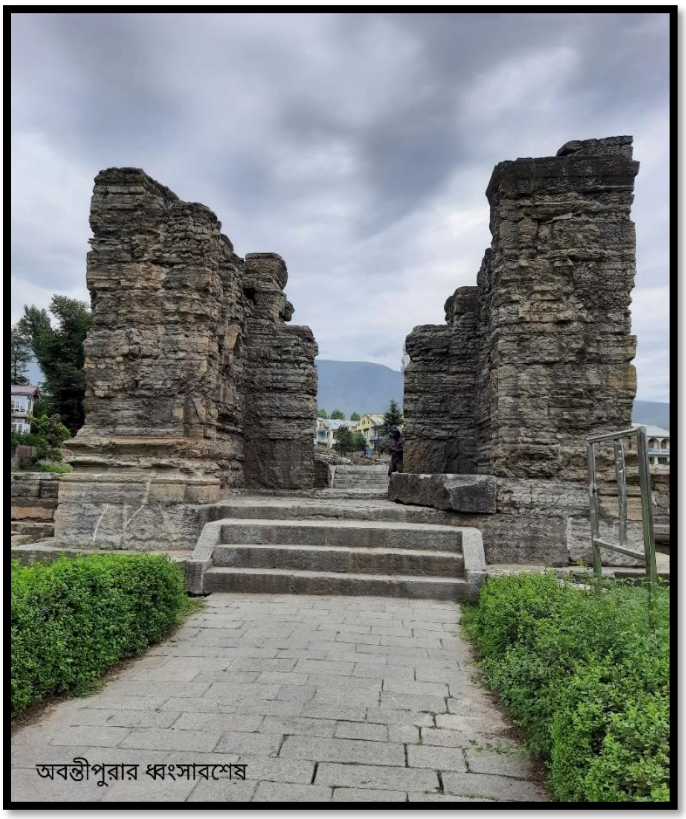
পর পর দুটি ফেজ,অর্থাৎ একটা উচ্চতা অবধি উঠে যখন আবার দ্বিতীয় স্তরে উঠছি বাড়তে লাগল ঠান্ডা । সামনেই বরফ রাজ্যকারন এর খুব কাছেই 'ডাগু' হিমবাহ । ওখানে পর্বত শিখরে পৌঁছনো বেশ এক রোমাঞ্চকর অনুভূতি। কিন্তুঘন কুয়াশা, বৃষ্টি, কনকনে হাওয়ায়,ভেজা পিচ্ছিল পাথরে বেশিক্ষণ থাকতে পারিনি।কিছু মানুষ জন ওখানে 'স্কি' করছিলেন, বরফ নিয়ে খেলাও করছিলেন । আমরা ফেরার পথ ধরলাম।

গুলমার্গের পথে

গুলমার্গ থেকে আমরা চললাম শ্রীনগরের দিকে । ভাগ্য করে পেয়েছিলাম সাথে বিলাল কাকুকে, যিনি আমাদের সঙ্গে টানা গাড়ি নিয়ে থেকে শুধু সহযোগিতা নয় অভিভাবকত্বও করেছিলেন। সে পরিষেবা ভোলার নয় । সারা পথে, ফলন্ত আখরোট গাছ, নতুন পাতা গজানো চিনার গাছের 'শ্রী' দেখতে দেখতে চললাম শ্রীনগরের দিকে। পথে দেখলাম দুটি প্রত্নতাত্ত্বিক সাইট ।একটি পুলওয়ামা জেলারঅন্তর্গত 'অবন্তীপুরার' ধ্বংসাবশেষ।এইস্থানটি ঐতিহাসিক ভাবে খুবই গুরুত্বপূর্ণ।কথিত আছে উৎপল রাজবংশ এখানে 854-883 AD রাজত্ব করেছিল।যদিও শুধুই ধ্বংসাবশেষ, তবু নিজের গৌরব নিয়ে দাঁড়িয়ে রয়েছে প্রাচীন স্থাপত্যের আর ইতিহাসের এক প্রবীন সাক্ষী। খুব ভালো

লেগেছিলো কাশ্মীরের প্রাচীন ঐতিহ্যমন্ডিত এই অঞ্চল।অপর স্থানটি ছিল'মার্তণ্ড' টেম্পল। এটিও অতি প্রাচীনএকটি হিন্দু মন্দির। চিনার গাছে ঘেরা অতি মনোরম এক স্থান।

শ্রীনগর কাশ্মীরের রাজধানী ও জন বহুল শহর । প্রসারিত 'ডাল লেক' এখানকার মূল আকর্ষণ।এত বড়ো লেক ,যেন শেষই হয়না। আমরা প্রথম পৌঁছলাম – 'নিষাদ মুঘল গার্ডেন' এ। আয়েস, আরাম, শিল্পবোধ আর প্রকৃতির উজাড় করা মুঘল আমলের এক ফুলের বাগান।ধাপে ধাপে সিঁড়ি, বাগান, ফোয়ারা,হরেক রকম গাছ , নানা প্রকার ফুলের সমাবেশ 'স্বর্গোদ্যানের' সাথেইতুলনীয়।ঠিক এরকমই আরও দুটি গার্ডেন দেখা হলো-শালিমার বাগ আর চাসমেশাহী।প্রতিটি গার্ডেন সুন্দরএবংস্বকীয়।


অবন্তীপুরার ধ্বংসাবশেষ

শ্রীনগরে থেকে দ্বিতীয় দিন সকালে 'সোনমার্গের' যাওয়ার পথে দেখা মিলল সিন্ধুনদ এর। পুরো পাহাড় ভেঙে জলেরস্রোত ঘুরপাক খাচ্ছে।উদ্দাম ,উত্তাল সিন্ধুনদ এর সেদৃশ্য 'ভয়ঙ্করসুন্দর'।

সমগ্র পথেই শুধুইসবুজ পাহাড় আর মাঝে বর্ষারখরস্রোতা নদী, মেঘেদের 'এইআছি-এইনেই' আহ্লাদি আনাগোনা,সব মিলিয়ে মনে হচ্ছিল 'সার্থক জনম মাগো, জন্মেছি এই দেশে'।


সোনমার্গ

সোনমার্গে নেমে প্ল্যান বদলে গেল। ঠিক হলো ঘোড়া চড়ে না ঘুরে, গাড়ি বুক করে 'জোজিলাপাস' যাওয়ার। 'জোজিলাপাস' পৃথিবীর একটি অতি দুর্গম পাহাড়ি পথ।অনেকে এই রুট ধরেই কাশ্মীর হয়ে লাদাখ যান।

গাড়ির রাস্তাটা বেশ খারাপ হলেও সেপথেরদু-ধারছিল অপরূপ। যতসময় যাচ্ছিল বাড়ছিল শীতের প্রকোপও।পাহাড়ের মাথায় বরফের আচ্ছাদন, কোলে সাদা সুতোরমত ঝরনা। দেখতে দেখতে পৌঁছেগেলাম 'জিরোপয়েন্ট'এর বরফের ঢালে।এখানে ঠাণ্ডা আরও বেশি। আমাদের আগেই বহুলোক সে জায়গায় স্কেটিং করা, স্লেজ গাড়িচড়া, বরফ নিয়ে খেলা এস বেদারুণ মেতে উঠেছিলেন।আমরাও তড়িঘড়ি ঢাউস শীতের জ্যাকেট আর গাম্বুট ভাড়া নিয়ে নেমে পড়লাম।ষোলো-কলা পূর্ণ করে আনন্দ উপভোগ করার সময় জানতাম না যে আমাদের জন্য অপেক্ষা করছে এইট্যুরের সব চেয়ে বড়'অ্যাডভেঞ্চার'।

ইতি মধ্যে ঝিরঝিরে বৃষ্টিও শুরুহ য়েছে। সাথে ঠাণ্ডা হাওয়ার ঝাপ্টা। ফেরার পথে কিছুদূর আসার পরেই টের পেলাম সামনের রাস্তাবন্ধ কারণ গাড়িগুলো উল্টোদিকে ফিরে যাচ্ছে।জানা গেল সামনেই ধ্বস নেমেছে ।বেশ ভালো রকম বিপদ এর মধ্যে যে পড়েছি তা টের পেলাম। চোখের সামনে গাড়ি থেকে বসে দেখলাম সামনের পাহাড়গুলো থেকে ঝুরঝুর করে গড়িয়ে পড়ছে পাথর,সাথে পাহাড় থেকে স্রোতের মতো রাস্তার উপর নেমে আসছে কাদা-পাথরমিশ্রিত জলেরধারা।উঁকি মেরে দেখ্লাম রাস্তাজুড়ে ছোটবড়ো পাথরেরচাঁই। সার দিয়ে দাঁড়িয়ে পড়েছে সব গাড়ি। এসব জায়গায় যিনি গাড়ির দায়িত্বে থাকেন তার উপর ভরসা করা ছাড়া আর কোনো উপায় থাকেনা।পাহাড়িঅঞ্চলের ড্রাইভারদাদারা যে শুধু গাড়ি চালানোতেই দক্ষহন তা না তাদের নিজেদের মধ্যে বোঝাপড়া, ঐক্যবদ্ধতা এবং যেকোনো বিপদে দুঃসাহসিকভাবে এগিয়ে যাওয়া সবেতেই অনন্য।এটি সত্যিই শিক্ষণীয়।রক্ষাকারীদল আসার আগেই ড্রাইভারদাদাদের দল রাস্তা পরিষ্কারের কাজে নেমে পড়েছিল, এভাবে কেটে গেছিলো ঘন্টা পাঁচেক, প্রায় দমবন্ধ পরিস্থিতিতে,কারণ বাঁদিকে খাঁদ, ডানদিকে ধ্স এবং সামনে বৃষ্টির প্রকোপ।শ্রীনগরে ফেরাটা অতিরিক্ত ক্লান্তিতে আধো-আধো ঘুমেইকেটে গেল।


জোজিলা পাস

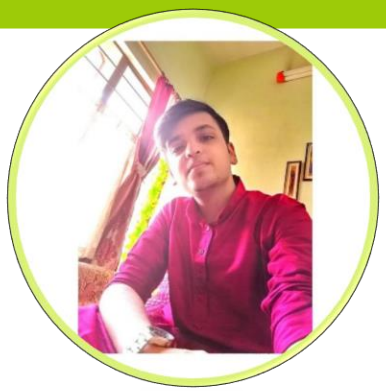
শ্রীনগরের শেষ দিন আমরা গেছিলাম 1000 ft. উচ্চতায় অবস্থিত'শঙ্করাচার্যমন্দির' এ । 243টি পাথরের অতি খাঁড়া সিঁড়ি বেয়ে প্রাচীন ঐতিহ্যময় এই মন্দিরে ওঠাখুব সহজ কথা নয় কিন্তু, কথায় বলে 'কষ্ট করলে কেষ্ট মেলে' ঠিক সেরকমটাই হলো যখন হাঁপাতে-হাঁপাতে পৌঁছে এই মন্দিরের ওপর থেকে পুরো শ্রীনগরের 'Panoramic' দৃশ্য দেখতে পেলাম, সত্যিই অসাধারন সে দৃশ্য।

শ্রীনগরের অন্যতম মনোমুগ্ধ কর অভিজ্ঞতা হলো 'শিকারা' করে 'ডাললেক' ঘোরা।সেখানে হাউসবোট, ভাসমানদোকান-বাজার, রেস্টুরেন্ট এমনকি আস্ত একটা গ্রামও জলের উপর ভাসছে – যা ভাবনার অতীত। এরই মধ্যে ভাসমান পদ্মবাগান, চিড়িয়া ঘরতো ছিলই।রং-বেরঙের পাতলা পাতলা রঙিন ডিঙি নৌকোগুলো সারা'ডাললেক' জুড়ে এক ঝাঁক রঙিন প্রজাপতির মতো লাগছিলো।


ডাল লেক

কাশ্মীর এর মানুষজনদের আন্তরিক আতিথেয়তার কথা না বললে অপূর্ণ থেকে যায় ভ্রমন কথা। চলে এল এক রাশ মন খারাপ নিয়ে ফেরার মুহূর্ত। স্বপ্ন থেকে বাস্তবে প্রবেশ। এরকম সুন্দর জায়গা ছেড়ে কেই বা যেতে চায়। কিন্তু উপায় কি, স্মৃতিতেই ধরে রাখি 'ভূস্বর্গ' এর সেই অভিজ্ঞতা।

~সমাপ্ত~



২৩ শে এপ্রিল

রিতম দাস

সেমিস্টার-৫

ভোরের আড়মোড়া ভাঙার সাথে সাথে
ওই মাসের দ্বিতীয় শনিবারের খেয়ালটা হতেই
প্রত্যাশা মতো স্বস্তির রেশ যেটা অনুভব করি
কোথাও যেনো হালকা ছড়িয়ে দিয়ে গেলো মনের মধ্যে।

আজকের তারিখটা যদিও মনে পড়ছে না—
দরকার ও নেই, ক্যালেন্ডার দেখে উদ্ঘাটনের ইচ্ছাও নেই তেমন...
রোজনামচার থেকে যতটা দূরে থাকা যায় আর কি...
বাস্তবকে কিছু সরিয়ে রেখে অথবা চেপে।
সারা সপ্তাহের আওয়াজ, কোলাহল-
মেট্রোতে সেন্ট্রাল-এ নামা মহিলার সাথে ঝগড়া,
অটোওয়ালার সাথে খুচরো নিয়ে চেঁচামেচি
এবং শেষ মেষ বস এর কচকচানি -
এই সব কিছুকে কিছুটা সম্ভ্রান্ততার সাথে দুর থেকে স্মরণ করে
গরম কফির ধোঁয়াকে ছড়িয়ে দেওয়া প্রাক বসন্তের খোলা জানলায়
মাগ এর গায়ে ঠোঁট দুটোকে দুবার স্পর্শ করতেই— কলিং বেল এর আওয়াজ

জীবনকে নিয়ে যতটা নিরুৎসাহী, তার থেকে কিছুটা কম উৎসাহ নিয়ে দরজা খুলে দেখি কেউ নেই।
খানিকটা- ফেলা আশা কোনো দিনের দমকা গন্ধের ঝাপটায় পরিচয়হীন কাগজে মোরা একটা বাক্স দেখলাম দরজার সামনে রাখা।
বাক্সটা চেনা লাগলো আমার
খুবই সতেজ যেনো তার স্মৃতি আমার অনুভবে
নিজের অজান্তেই ফুঁপিয়ে কাদতে ইচ্ছা করলো— তখন ও বুঝতে চাইছি না কেনো।
মনের গর্ভগৃহ যেনো কিছুতেই স্মৃতির কোনো এক অংশকে ভাসমান হতে দিতে চায় না।
ভয় পায় হয়তো যদি আবার তলিয়ে যাই আমি সেই স্মৃতির ভারে।

ফোঁপানির মাঝে মাঝে কিছু দৃশ্য বার বার উঁকি দিছে যা দেখতে চাই নি আমি—
রোববারের বিকেলে ছোট সেই মেয়েটার আঙ্গুল ধরে গঙ্গার ধারে ঘুরতে নিয়ে যাওয়া,
মা মরা মেয়েটাকে প্রতিদিন আলতো অপটু হাতে বিনুনি করে দেওয়া,
নিজের সব ইচ্ছা কে জলাঞ্জলি দিয়ে আমার কোনো আবদার মুখে ফুটতে অব্দি না দেওয়া
নিজেকে আমার ক্ষুদ্র পৃথিবীর উৎস করে রাখা...

হায় রে সেই অক্লান্ত ভালোবাসা—
যেই ভালোবাসার শুন্যতা থেকে পালিয়ে বেড়িয়েছি আমি
প্রত্যেকটা দিক, প্রত্যেকটা মুহূর্ত...
অপূর্ণ রেখে যাওয়া— যেই বই টাকে পুড়িয়ে ফেলতে ছেয়েছি আমি- নিজের জীবন থেকে,
প্রত্যেকটা দিন, প্রত্যেকটা মুহূর্ত...
হারিয়ে ফেলতে চেয়েছি- যেই আমি কে, যার রন্ধ্রে রন্ধ্রে ছিল তার বাবার ভালোবাসা...
মায়ের অভাব কোনোদিন না বুঝতে দেওয়া- যেই বাবার অভাব কে অস্বীকার করতে চেয়েছি আমি
প্রত্যেকটা দিন...
এই সব কটা আমিকে আবার জীবন্ত হয়ে উঠতে দেখলাম চোখের সামনে।

২৩ শে এপ্রিল...
মাথায় আসতেই এই তারিখটা কিরকম যেনো শরীরটা গুলিয়ে উঠলো
গ্রাস করতে থাকা- ভুলে যাওয়া সেই অপূর্ণতা যেনো কয়েক মাত্রা বেড়ে গেল।
২৩ শে এপ্রিল বাবার জীবনের শেষ জন্মদিনে ওই বাক্সটা গিফট করেছিলাম
সেগুন কাঠের মধ্যে কাশ্মীরি শিল্পের কাজ
খুব পছন্দ হয়েছিলো বাবার... কাঠের কাজে ঝোঁক ছিল খুব।

উফ্... উফ্... অসহ্যকর!
মনে করতে চাই না আমি এইসব
পালাতে চাই অনেক দূরে...
তাই তো করে আসছি আমি এতদিন... তালে আবার কেনো।
কোথায় ভুল ছিল আমার
চাইনি তো আমি ওই ২৩ শে এপ্রিল বাবাকে হারাতে
নিজেকে হারাতে—
চাইনি তো আবার সেই পলিথিনে মরা, রক্তের স্যাঁত স্যাঁতে গন্ধে জড়ানো দেহ তার দৃশ্য চোখের
সামনে ফুটিয়ে ফুটিয়ে তুলতে...

হারিয়ে দিয়েছিলাম তো এই বাক্স রূপের কলঙ্কটাকে।
পুড়িয়ে ফেলেছিলাম জীবন থেকে
তালে আবার কেনো
কে আনলো এটা।
কে টেনে আনলো আমাকে ফের জীবনের সেই স্তব্ধ হওয়া মুহূর্তটায়
হন্য হয়ে ভাবছি তখন,
হঠাৎ... হঠাৎ কি যেনো খেয়ালে দৌড়ে গেলাম ক্যালেন্ডার এর সামনে।
দেখলাম
[স্তব্ধতা]
আজ ২৩ শে এপ্রিল।

~সমাপ্ত~

অন্য মিছিল

রিতম দাস

সেমিস্টার-৫

ভোরের আড়মোড়া ভাঙেনি তখনও
হাইওইয়ের পূর্ব কোণায় ভোরের আলো
কিছুটা সতেজ হলেও
তাতে খুব একটা কিছু এসে যায় না রুরকির।
মাইলের হিসাব না বুঝলেও
ভিড়ের গতি দেখে বুঝতে পারছে
'দেশ এখনো অনেক দূরে'
কিংবা বলা ভালো পেটের টান এখনো অনেক দূরে।

তার আট বছরের মেয়ে সুধা; কিছু না বুঝলেও
ক্ষুধার টানে সেই অকাল বিস্তৃত কালো যাত্রায়
কোথাও যেন মিশিয়ে নিয়েছে নিজেকে।
আগের ভোরের এক তৃতীয়াংশ রুটির জোর
যে এতটা টেনে আনতে পারবে সুধাকে
— ভাবতে পারে নি রুরকি।
হয়ত গোটা রুটির খিদে – বল দিয়েছে তাকে।

ভর্তি না হোক আধভরা পেটের আর্তিই যেন ক্লান্তি ভোলাচ্ছে পুরো মিছিলের।

কোলের বীরাকে নিয়ে যদিও খুব একটা চিন্তা নেই
রক্ত চুয়ে পরে না তার ক্ষুদ্র পা দুটোর থেকে।
কান্নার আওয়াজ না পৌঁছালেও
মায়ের দুধের স্বাদ পেলেই সে খুশী।

তপ্ত পিচের ছেঁকা যেন ধুলিধুসর জনপ্লাবনের ভিতকে নাড়িয়ে দিতে পারে না
টিকে থাকার লড়াই যে কতো বড়ো প্রতিযোগীতা হতে পারে প্রকৃতির —
তা হয়তো বোঝা যায় প্রতিটি পায়ের চিহ্নে যা রক্ত দিয়ে লিখে যাচ্ছে তাদের পরিচিতি।

জীর্ণ হাড়ের আওয়াজে প্রতি পদক্ষেপ যেন
গমগম করে অভুক্ত প্রতিটা পেটের হাহাকারে
যা হয়ত শোনা যায় না
কিন্তু তা ব্যক্ত হয় ক্ষুধা যাত্রায় সম্মিলিত প্রতিটা
রুরকির চাহনিতে।

মানবতার এই হাহাকার যতই তুচ্ছ হোক
যতই থেমে থাকুক শিক্ষিত সমাজের টিভির পর্দায়
তা ব্যক্ত করে এই সময়কে
তুলে ধরে বাস্তবের ভারতবর্ষকে।

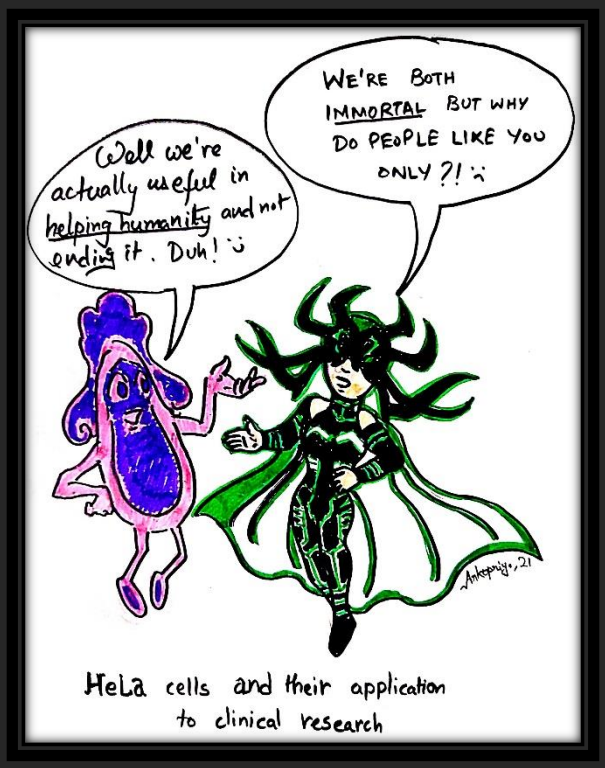
~সমাপ্ত~

Artworks, Photographs and Doodles

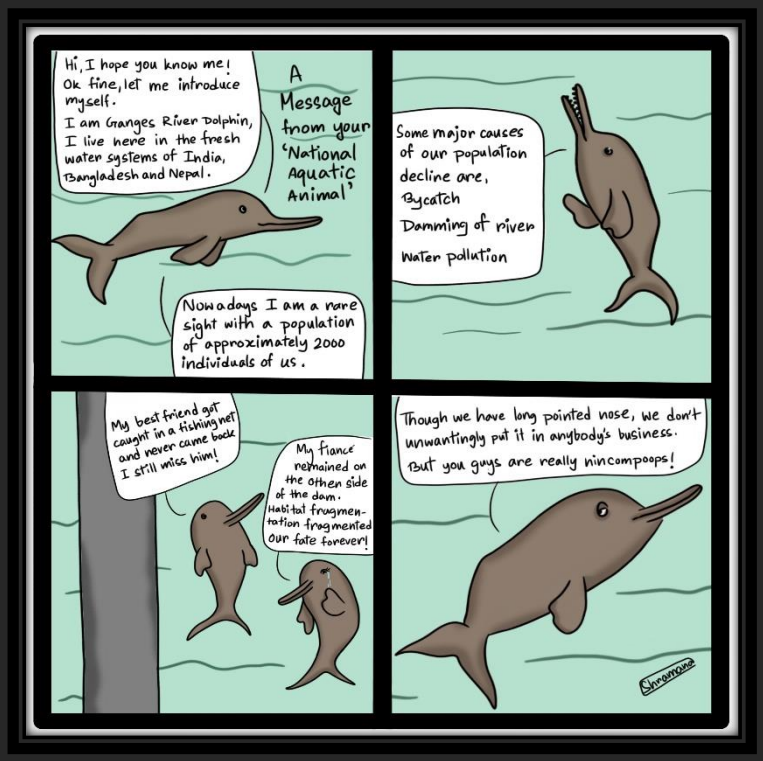
Saheli Majumder, Semester 5

Shreyasi Mitra, Semester 9

Anwesa Chattopadhyay, Semester 1



Arkopriyo Banerjee, Semester 9



Shramana Kar, Semester 9

Suravi Mukherjee, Semester 9

Amitava Chowdhury, Semester 5

Enakshi Chatterjee, Semester 1

Enakshi Chatterjee, Semester 1

Shreyasi Mitra, Semester 9

Anushka Chowdhury, Semester 5

Suravi Mukherjee, Semester 9

Department of Biotechnology

Arkopriyo Banerjee, Semester 9

Pallavi Chakraborty, Semester 9

Department of Biotechnology

Bisakha Das, Semester 1

Dibyanshu Shaw, Semester 3

Hriddi Maitra, Semester 3

Sagnik Kabiraj, Semester 3

Hriddi Maitra, Semester 3

Leena Bhadra, Semester 7

Sayantani Paul, Semester 9

Diganta Mandal, Semester 9

Nayantara Biswas, Semester 9

Dharitri Chaudhuri, Semester 9

Prajna Gupta, Semester 9

Nayantara Biswas, Semester 9

Avirup Sinha, Semester 9

Pallavi Chakraborty, Semester 9

Avirup Sinha, Semester 9

Pallavi Chakraborty, Semester 9

Avirup Sinha, Semester 9

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SERIES CREDIT: ABHINANDA ADAK AND TANNISHTHA DAS (SEMESTER 7)

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2. STREPTOCOCCUS TYPE B INFECTIVITY
3. CRISPR-CAS9 SYSTEM (PART 1)
4. CRISPR-CAS9 SYSTEM (PART 2)
5. ARTIFICIAL SWEETENERS
6. THE IMPLANTABLE PACEMAKER

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SERIES CREDIT: DIPABARNA BHATTACHARYA (DOCTORAL STUDENT, TRIMM - TRANSLATIONAL IMMUNOLOGY RESEARCH PROGRAM; UNIVERSITY OF HELSINKI AND FOUNDER “THE BLUE PATCH” AND DR. SAYAK GANGULI)

1. LOST PROTECTION - PART 1

"There is a light that never goes out and hope that never dies"

~ Inspired by the song by The Smiths