CUBE Kishore Bharati Assistantship Report January 2025 (First half)

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During the first half of January 2025, I joined 2 out of 15 days. Although I had the opportunity to moderate discussions alongside Theertha M.D., Enas Shirin, and Kiran Yadav, I struggled to coordinate effectively with my fellow interns. Despite the challenges, I still had some key highlights during my time there.

A) Developing Context to Curriculum by addressing Simple questions

1. Understanding ATP Production and Energy Metabolism - The discussion centered on the process of energy generation in the human body, particularly focusing on ATP (Adenosine Triphosphate), which is known as the primary energy currency of cells. ATP is produced through several key metabolic pathways, including glycolysis, the citric acid cycle, and oxidative phosphorylation, where glucose and fatty acids are broken down to generate ATP. Interestingly, while ATP is the high energy molecule, ADP (Adenosine Diphosphate) has less energy due to fewer phosphate groups. A crucial point raised was why ATP is the chosen energy currency, as it is synthesized abundantly, is recognized by most enzymes, and is efficient in supporting multiple metabolic pathways. The process of ATP generation from food, like rice, involves converting glucose into ATP through cellular respiration. Furthermore, other molecules such as GTP, CTP, and UTP serve specific roles in protein synthesis, lipid biosynthesis, and carbohydrate metabolism. A final interesting question was raised about entropy during the glucose to ATP cycle and why the body uses a multi step process instead of directly converting glucose to energy, which may have evolutionary advantages.

2. Understanding Butterfly Host Plant Selection and Life Cycle Differences - The discussion revolved around the fascinating behaviors of butterflies, particularly focusing on the host plant selection for oviposition and the differences between Common Mormon and Blue Mormon butterflies. The citrus swallowtail butterfly, Papilio xuthus, utilizes a gustatory receptor, PxutGr1, to detect specific chemicals like synephrine on potential host plants, a process essential for its reproductive cycle. The Common Mormon butterfly has a similar pattern, with females using chemical cues to select host plants. Amritha raised a

question about the difference in the life cycle duration between the Blue Mormon and Common Mormon butterflies, where it was noted that the Blue Mormon's life cycle may indeed take longer. This prompted further discussions on how to verify or falsify this claim. Additionally, the differences between male and female Common Mormon butterflies were explored, as well as methods for identifying the larvae of Blue Mormon butterflies. One key point that emerged was the identification of host plants, where the Blue Mormon and Common Mormon have distinct preferences.

3. Understanding Fruit Fly Larvae Behavior and Media Preparation - The discussion focused on the behavior of fruit fly larvae, specifically their attraction to different concentrations of banana solution. Batul shared observations from a single line culture of fruit flies, including larvae of varying sizes and a surprising result where larvae were more attracted to a 1X banana solution than a 2X solution, despite the latter containing more of the attractant. This led to further questioning about whether larvae prefer lower concentrations due to their ability to absorb it more easily. Batul also noted that larvae were less likely to move towards higher concentrations, possibly due to ethanol production in fermenting bananas at higher concentrations. Several rounds of experiments confirmed the preference for the more diluted solution, prompting a discussion on control setups and replicates to validate the results. The preparation of different media for culturing fruit flies was also discussed, such as BSRV and TRSV media, with details on the ingredients and process. The role of proper control in experimental design was highlighted as crucial for accurate interpretation.

4. Understanding Plant and Animal Cell Dedifferentiation and Regeneration - The discussion revolved around the intriguing ability of plant cells to dedifferentiate and regenerate new plants, a process that is not commonly observed in animals. Theertha shared that callus formation in plants involves totipotent cells capable of regenerating the entire plant body, with some cells also engaging in somatic embryogenesis. Batul raised a question about why animal cells, unlike plant cells, cannot dedifferentiate into embryo cells to regenerate a whole organism. She hypothesized that this could be linked to the absence of a nervous system in plants, which may facilitate their ability to undergo dedifferentiation and regeneration. While some animals, like hydra, can regenerate parts of their bodies, most cannot regenerate entire organisms.

5. Understanding Hypoxia and Regeneration in Chlorohydra - The discussion revolved around Sakshi's study on the regeneration abilities of Chlorohydra and how hypoxia, induced by cobalt chloride, impacts this process. The focus was on understanding how hypoxia inducible factors (HIFs) can be stabilized under normoxic conditions through cobalt chloride, a common method used in hypoxia models. When hydras were treated with higher concentrations of cobalt chloride, regeneration did not occur as expected, signaling potential cytotoxic effects. This indicates that cobalt chloride concentration may need to be optimized for further experimentation.

   Additionally, the Cubists discussed the culturing techniques for hydra and moina. Hydras are cultured using simple equipment: a transparent plastic bottle, dechlorinated water (which is made by letting tap water sit for 24 hours), and hydra specimens. Moina, the primary food source for hydra, is also cultured using dechlorinated water and a small amount of milk to feed the bacteria that moina consume. The importance of dechlorinated water for both organisms was emphasized since chlorine can negatively affect their survival.

6. Understanding Stem Cells and Brain Disorders - The Chatshaala discussion focused on various aspects of stem cell research, particularly the generation of Induced Pluripotent Stem Cells (iPSCs). These cells, created by reprogramming differentiated somatic cells using the Yamanaka factors (Oct3/4, Sox2, Klf4, and c-Myc), hold immense potential for regenerative medicine, including treatments for neurological disorders. A major highlight was the use of Lymphoblastoid Cell Lines (LCLs), which are created by infecting B lymphocytes with the Epstein-Barr Virus (EBV), enabling continuous cell division and eliminating the need for repeated blood sampling. These LCLs are valuable in genetic and cellular research due to their ability to maintain the characteristics of the original cells.

   The discussion also covered bipolar disorder, highlighting the role of lithium as a mood stabilizer. Interestingly, the potential connection between lithium and stem cell research opens new possibilities for treating brain related conditions. Shivani, a Cubist, shared her experience in researching iPSCs for addressing neurological disorders. Her journey, from introducing earthworm regeneration studies to working at NCBS Bangalore in collaboration with NIMHANS.

B) Citizen Science Projects

1. Understanding the Biology and Behaviour of Mosquitoes - The discussion covered various aspects of mosquitoes, including their anatomy and behavior. Male mosquitoes have shorter, less flexible proboscises, while females have longer, more flexible ones for blood feeding. Only female mosquitoes bite humans and animals, as they need blood for egg development, while males feed on nectar. Mosquitoes are attracted to hosts by body heat, CO_2, and chemicals like lactic acid. We also explored how Drosophila use halteres for balancing during flight, though their movement may differ. Using the clap/slap trap method, we can distinguish male and female mosquitoes and identify different species. Cold temperatures slow mosquitoes down, but they don't become fully anesthetized.

2. Understanding Mango Tree Flowering Patterns - The ongoing research on mango tree flowering patterns has been focused on documenting the flowering, fruiting, and non-flowering statuses of mango trees across different locations. Data was collected from multiple regions including Pamgarh, Erattakulam, and New Delhi, between January 4th to 15th, 2025. Initial observations revealed that many mango trees, especially in Pamgarh, showed no flowering or fruiting, with a significant percentage of trees remaining non-flowering. For example, out of 41 trees surveyed in Erattakulam, only 25% were flowering. Similarly, in New Delhi, mango trees showed no flowering at all. A noteworthy observation came from Mumbai, where 90% of mango trees were flowering in the second week of January. This contrast across locations prompted a deeper inquiry into the factors influencing flowering patterns.

D) Homelab updates

Further plans - Culturing and Maintaining Chlorohydra and Moina in Homelab

E) Future Plans for Enhancing CUBE Program Operations

1. Resolving issues on Documentation of Context to Curriculum Chat on STEM Games.

2. Joining through the microphone mode - Participants find it difficult to join through microphone mode.

Possible solution - We can have a screen recording of how to change the setting of the browsers so that Cubists find it easy to join through microphone mode.

3. Activation of CUBE groups - With the help of reliable Cubists, simple discussion can be carried out in small CUBE groups so that new Cubists find it easier to join the discussion.

4. Making celebration of Goof ups more streamline.

5. Resolving issues of BBB server.