

CUBE Kishore Bharati Assistantship Report September 2024 (First half)

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Throughout September 2024, I attended ChatShaala for 07 out of the 15 days. During this time, I moderated discussions alongside Theertha M.D., Enas Shirin, and Kiran Yadav. However, due to health issues, I struggled to coordinate effectively with my fellow interns. This impacted my ability to fully engage in ChatShaala and support the team as intended.

Here are some of the key highlights from this period:

A) Developing Context to Curriculum by addressing Simple questions

1. Understanding Butterfly Metamorphosis and Plant Interactions - The discussion focused on the process of butterfly metamorphosis and the interactions between butterflies and their host plants. We reviewed observations from posts sent by Cubists, including the transformation of the Tailed Jay (*Graphium agamemnon*) and the Common Mormon butterfly. The timeline of metamorphosis was highlighted by Cubists, with specific dates for caterpillar collection, pupation, and emergence.

We discussed the fascinating pupal color variations in the Common Mormon, referencing research on the genetic regulation of these colors. Theertha explained that the brown pupal color is influenced by melanin synthesis genes, particularly tyrosine hydroxylase (TH) and laccase 2, while the green color is attributed to multiple bilin binding protein (BBP) related genes and juvenile hormone binding protein (JHBP) related genes. This led to a conversation about environmental factors that may affect color expression during pupation.

The discussion also covered the variability in emergence times among pupae. Prithviraj noted the differing durations for three pupae, comparing it to human pregnancy to illustrate biological variability influenced by various factors.

We then explored the emergence of a female Common Mormon butterfly, with Sneha documenting the color changes from green caterpillar to black pupae, leading to the butterfly's emergence.

Further, we examined the attraction of butterflies to the *Crotalaria* plant. Cubists speculated on the role of chemical signals emitted by fresh and dry twigs in attracting butterflies, with Batul noting the plant's production of pyrrolizidine alkaloids, which can deter predators and possibly attract butterflies.

We concluded by discussing the role of gustatory receptors in butterflies, particularly how they use these receptors to detect plant chemicals when selecting suitable host plants for oviposition. Theertha referenced a study on *Papilio xuthus*, which employs specific gustatory receptors to identify host plants, prompting questions about the diversity of these receptors across different butterfly species and their evolutionary aspects.

2. Understanding the Insights from TIFR Open Day - The discussion focused on Sneha Maurya's recent visit to the TIFR Open Day program, where she explored the practical applications of scientific study through various model organisms. Sneha highlighted three primary model systems: *C. elegans*, *Drosophila* (fruit fly), and Zebrafish.

In the *C. elegans* segment, researchers examined neuronal signal transmission and neural network formation after injury using fluorescent markers. They conducted laser axotomy and introduced genes of interest (GOIs) to study escape responses and movement differences among specimens.

In the *Drosophila* segment, the focus was on the relationship between food and aggression. Researchers observed male fruit flies competing for yeast based food in a chamber, where various aggressive behaviors emerged. They also studied the connection between sleep and food intake, finding that starved flies exhibited disrupted sleep patterns.

The Zebrafish portion involved investigating epithelial cell polarity in six day old larvae using Cas9 technology to induce GOIs. Differences in cell structure and color were observed between normal and mutant larvae. The advantages of zebrafish, including their short lifespan and high reproductive capacity, were noted for studying developmental processes.

Sneha's experience at TIFR prompted further questions about aggression triggers in *Drosophila* and the implications of sleep deprivation on behavior, as well as the relevance of these model organisms in biological research.

3. Understanding Slug Observations - The discussion focused on ongoing observations of slugs, particularly in relation to their feeding habits and differences from snails. Prithviraj shared his experience of providing a slug with leaves, flowers, and a banana piece, and noted about its behavior and feeding habits.

Arunan raised questions about the differences between snails and slugs, highlighting that snails have coiled bodies and protective shells, while slugs possess straight bodies without shells. He referenced articles explaining the biological distinctions and the significance of the marine snail *Aplysia* in neuroscience research.

Sneha shared her finding of a slug in the NES Ratnam College garden, while Enas provided context on Eric Kandel's Nobel Prize winning research on *Aplysia*, which advanced the understanding of learning and memory. We discussed several questions regarding slugs, including their diet, the functions of their tentacles, and the sensory roles of different body parts.

4. Understanding the "From Homelab to Research Lab: Be a Collaborator of CUBE" Program - The program held at SN College Varkala on 5th of September 2024 provided valuable insights into collaboration within the CUBE community. Theertha from CUBE Kozhikode and Lakshmi from CUBE Thrissur served as resource persons, with Babita organizing the session.

Arunan had a causerie with first year students about their ambitions and the importance of observation. The formal session highlighted various engaging discussions, including the significance of slugs in research. Attendees explored the college garden and participated in interactive discussions about aspirations and scientific topics. Notable moments included presentations from Prithviraj and Arunan, who introduced a gully cricket model.

5. Understanding the Study of Emotions in Human Interaction - Arunan initiated a study on different emotions observed in the gathering at CUBE, SN College, Chempazhanthy, on

September 3, 2024. Dhanraj referenced a research article emphasizing the crucial role of emotion in both human experience and psychiatric illnesses. The article noted that despite the significance of emotions, the lack of objective methodologies limits our understanding, highlighting the need for innovative approaches, such as using animal models like *Drosophila* to study emotional behavior.

Arunan proposed an engaging activity: naming and categorizing the emotions expressed in the faces captured in a group photo. He suggested that even a basic labeling of emotions could provide understanding into the emotional landscape of the gathering. We tried to develop context on emotions as part of human interaction.

6. Understanding Sample Sending and Experimental Design in Chatshaala - The discussion focused on the logistics of sending samples, specifically Moina and Hydra, to collaborators across the country. A key discussion revolved around establishing standardized methods for transporting these organisms to ensure their viability during transit.

Cubists explored the idea of designing an experiment to investigate the interactions between Moina and Hydra. One proposed experiment involved placing 20 Hydra in a sealed flask or plastic bottle with 20 Moina, storing them in the dark for seven days. A similar setup was suggested for the Moina, adding five drops of milk as a nutrient source.

7. Understanding Seed Germination: A Collaborative Study - The discussion focused on the effects of soaking mustard seeds versus using moist tissue for germination. Collaborators from various locations actively engaged in the study, bringing observations to the forefront. This collaborative approach allowed for a rich exchange of ideas about the germination process.

A key aspect discussed was the role of water in seed germination, particularly how it affects the rehydration and metabolic activity of the seeds. The literature indicates that during germination, water uptake initiates various metabolic processes, facilitating the activation of enzymes crucial for growth (Britannica, 2024).

Cubists also explored the concept of seed dormancy, discussing how environmental conditions influence the germination rates of different seeds. Studies suggest that dormancy allows seeds to survive unfavorable conditions, thereby increasing their chances of germination at more opportune times (Oregon State University, 2024).

The discussions highlighted significant differences in germination rates and seedling development based on the medium used, prompting into the optimal conditions for seed growth. This led to further questions regarding factors affecting germination, such as temperature, oxygen availability, and seed coat permeability.

8. Understanding *Drosophila* Eye Color and Genetics - The discussion focused on the eye color of *Drosophila melanogaster*, which serves as a clear demonstration of sex-linked inheritance. The eye color gene is located on the X chromosome, with white eye color being recessive. When a red-eyed male mates with white-eyed females, their daughters exhibit red eyes, while their sons display white eyes. This genetic pattern reflects key principles of inheritance, as discussed in the research paper.

Cubists explored several questions about fruit flies, including their typical habitats, which are often decaying fruits in gardens and orchards, and their identifying features, such as their small size (3 to 5 mm), red eyes, and distinctive body shape from the family Drosophilidae. Effective traps can be created using containers with baits like vinegar or overripe fruit.

Cubists pointed out that fruit flies do exhibit sleep-like behavior at night, similar to mammals, and they typically rest in sheltered areas. In terms of differentiation, fruit flies are smaller and more attracted to fermenting fruits compared to house flies, which are drawn to decaying organic matter. The significance of studying fruit flies is their genetic similarities to humans, making them valuable for understanding genetic principles and diseases.

9. Understanding Soil Nematodes Through Experimentation - The discussion focused on soil nematodes, where Cubists collected soil samples from various locations and set up an experiment to isolate these organisms. They placed a piece of raw potato on a surface, then added soil around its periphery and a drop of milk in the center. This

method, designed, allows nematodes to be attracted to the milk while utilizing the potato as a medium. For further details on the experiment design, you can refer to the article [here](#).

Additionally, the significance of nematodes in biological research is highlighted by the work of Sydney Brenner, H. Robert Horvitz, and John E. Sulston, who were jointly awarded the Nobel Prize in Physiology or Medicine in 2002 for their discoveries related to genetic regulation of organ development and programmed cell death. More information about their contributions can be found in the Nobel Prize summary [here](#).

B) Citizen Science Projects

1. Understanding Seasonomics with Context to Biogeography - The causerie centered on ongoing observations of mango trees and their flowering patterns in various regions of India, particularly Mumbai and Kerala. Cubists engaged in hypothesis formation, emphasizing its role as a testable statement guiding scientific investigations. We highlighted the geographical context of Mumbai, noting Colaba's classification as an island surrounded by the Arabian Sea and bordered by rivers and creeks due to historical land reclamation.

The Mango data sent by Cubists revealed varying flowering percentages among mango trees, with one Cubist reporting 11.29% of 62 trees flowering, while others noted 33% and 20.97% in different areas. A key discussion focused on environmental factors during the monsoon, particularly the possibility of mango trees flowering in this season. One Cubist cited up to 30% flowering in August, pointing out the importance of sunlight despite heavy rains.

We emphasized statistical analysis, discussing sample size calculations and understanding effect sizes for reliable results. Cubists recognized that statistically significant findings suggest a low chance of occurring by random factors. We referenced a paper on recent advances in molecular genetics, focusing on florigen, a protein that triggers flowering and could enhance crop yields. Lastly, we discussed data collection methods, clarifying the need for detailed descriptions alongside photographs of mango trees to improve accuracy.

2. Understanding Mosquito Identification - The discussion focused on understanding the identification of mosquitoes as a major citizen science project aimed at spreading awareness about Aedes and Non-Aedes mosquitoes. Mainly data collected by Cubists from Swaroop nagar, Kanpur was discussed.
3. Understanding Nail Regeneration - The discussion revolved around understanding regeneration and growth and how by simply using mehndi/ ink we can track the nail growth and understand the role of hormones in nail growth.

C) Development through Discussion

1. To invite more Cubists in the ChatShaala whiteboard during the discussion along with a small summary was shared.
2. Screenshot of the whiteboard along with the summary and the leading question was shared alongside Theertha M. D; Enas Shirin to follow up the discussion.
3. Daily CUBE ChatShaala maps of participants were shared in all the CUBE groups, for acknowledging them.

D) Homelab updates

As of now I don't have any Model system in my Homelab, but I am planning to get some *Chlorohydra* and *Moina* from Sophia Resource Centre with the help of Sakshi, a collaborator from Bhandup, Mumbai.

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.