

CUBE Kishore Bharati Assistantship Report October 2024 (Second half)

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During the second half of October 2024, I was scheduled to attend ChatShaala but was unable to participate due to health issues. 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. This impacted my ability to fully engage in ChatShaala and support the team as intended. Despite these challenges, I still had some key highlights during my time there:

A) Developing Context to Curriculum by addressing Simple questions

1. Understanding Insect Behavior and Phototaxis - Cubists discussed observations made by Deekshith in the homelab, Warangal, where larvae showed movement under sunlight. This behavior was hypothesized to be related to phototaxis or possibly linked to mechanisms similar to melatonin in humans, which could trigger the larvae to seek food. The larvae exhibited preference for certain plants, with three moving onto spinach leaves and two remaining on hibiscus leaves.
2. Understanding Moth vs. Butterfly Distinction - Cubists debated the distinguishing features of moths and butterflies, particularly focusing on the shape of antennae. It was noted that butterflies have club shaped antennae, while moths have straight edged antennae.
3. Understanding Host Plant Selection Mechanisms in Butterflies - The discussion focused into the mechanisms by which butterflies select their host plants, with specific mention of *Papilio xuthus* and its use of gustatory receptors to detect synephrine, a chemical involved in host selection. Female butterflies use their foreleg chemosensilla to detect specific chemicals while drumming on the leaf surface to find suitable plants for laying eggs. It was noted that swallowtail butterflies from the Papilionidae family often specialize in a limited number of plant species.
4. Understanding Plant Preferences in Swallowtail Butterflies - Further discussion focused on the selective plant preferences of swallowtail butterflies, particularly the species within

the *Papilio* genus. Swallowtails were observed to utilize only a few plant families, and females lay eggs only on those plants that they can detect through chemical cues. This led to a deeper inquiry into the sensory organs involved in plant recognition. The discussion referred to research indicating that most butterfly species are specialists, feeding on specific plant families, while generalists feed on closely related plants from different families.

5. Understanding Tumor Suppression, Hypoxia, and Reproductive Mechanisms in Hydra - The discussion focused on tumor suppression in multicellular organisms, particularly in *Hydra*, and the potential for tumor formation under hypoxic conditions. Arunan MC raised questions about the presence of tumor suppressor genes across different species, noting that while tumor formation is well studied in vertebrates, it was previously not observed in simpler organisms like sponges and cnidarians. Sakshi shared her ongoing experiment where hypoxic conditions were induced in hydra using sodium sulfite, hypothesizing that this could lead to tumor formation through the activation of the hypoxia inducible factor (HIF), which drives cell division. We also explored the genetic, epigenetic, and metagenetic aspects of changes in *Moina*'s color when exposed to increased food. Additionally, budding in hydra was compared to similar asexual reproduction processes in plants, highlighting the genetic continuity between mother and offspring in both cases.
6. Understanding Autophagy, Survival Strategies, and Regeneration in Chlorohydra - The discussion focused on the remarkable survival mechanisms of *Hydra*, particularly its ability to endure long periods of starvation through autophagy, a process where cells break down and recycle damaged components to maintain essential functions during stress. *Hydra* can survive for weeks without food by activating autophagy, which helps it sustain itself during food deprivation. We also explored the concept of autophagy, which was further clarified through references to Nobel Prize winning work by Yoshinori Ohsumi on the mechanisms of autophagy in yeast and its relevance to human cells. In relation to *Chlorohydra*, the group discussed its survival strategies, including resistance to starvation and potential regeneration capabilities. The conversation also touched on the transfer of *Chlorohydra* from Mumbai to Bageshwar, Uttarakhand.

7. Understanding Starvation Effects, Symbiosis, and Feeding in Hydra - The discussion focused on various aspects of Hydra biology, including its response to starvation, symbiotic relationships, and feeding behavior. It was highlighted that when Hydra is starved for six days, it does not initiate new buds, and its mitotic index drops to just 10% of that seen in well fed animals, indicating a decrease in cell division under starvation conditions. We also explored the symbiosis between Hydra viridis and Chlorella algae, noting that under standard feeding conditions, polyps with and without symbionts proliferated similarly. However, under low or moderate feeding conditions, polyps lacking algae showed reduced asexual growth, suggesting that the symbionts play a role in providing essential nutrients to their host. Additionally, the symbionts were found to influence sexual differentiation in Hydra viridis, as female gonads typically developed only when the algae were present.
8. Understanding Intraspecific Variation and Species Identification in Drosophila - The discussion focused on the morphological variation in Drosophila species, particularly the sex comb and thoracic outgrowths, which are key features used in species identification. Batul shared observations from their homelab in Kolkata, noting that male flies from a particular generation exhibited sex combs with eight teeth, a characteristic used by males to hold females during mating. Batul also mentioned a thoracic outgrowth, characteristic of Drosophila bipectinata, though Rahul Kushwaha pointed out that the number of teeth on the sex comb can vary within species, leading to intraspecific variation. Rahul suggested capturing better images of the thorax to clarify the presence of lateral outgrowths, and he questioned whether rapid evolutionary changes could be occurring between generations. Batul proposed screening more males and comparing generations to determine whether intraspecific evolution or random polygenic variation, similar to human skin color, might be influencing the traits observed.
9. Understanding Osmosis and Its Implications in Biological Systems - The discussion focused on the process of osmosis, its mechanisms, and its impact on living organisms, particularly in the context of earthworms and plant cells. Participants examined what happens when an earthworm is exposed to saltwater, with the main point being that saltwater creates a hypertonic environment for the earthworm. This leads to the movement of water from inside the earthworm's cells to the external environment by osmosis, causing the cells to shrink and potentially resulting in dehydration or death.

The discussion also highlighted how osmosis functions in plant cells when exposed to different solutions. In distilled water (hypotonic solution), water moves into the plant cells, causing them to swell but not burst due to the rigid cell wall. Conversely, when exposed to saltwater (hypertonic solution), water moves out of the cells, leading to plasmolysis where the cell membrane shrinks away from the cell wall. It was noted that some plants, particularly those in saline environments like coastal areas, have developed specialized adaptations to cope with excess salt, such as the ability to excrete salt or maintain osmotic balance.

10. Understanding the Reproductive Strategies of Freshwater Zooplankton Daphnia - The discussion focused on the reproductive strategies of the freshwater zooplankton Daphnia, which adopts two distinct methods to ensure survival in varying environmental conditions: asexual (parthenogenetic) reproduction and sexual reproduction. In favorable environments, Daphnia reproduces asexually, rapidly producing many offspring. However, when environmental conditions become unfavorable, such as during cold weather, shorter daylight, food scarcity, crowded populations, or the presence of toxins like pesticides and pharmaceuticals, Daphnia switches to sexual reproduction. This process results in the production of resting eggs that are encased in a tough, protective shell called the ephippium.

These resting eggs can remain dormant for extended periods, allowing Daphnia to survive harsh conditions and resume development when the environment becomes more favorable. This strategy ensures that Daphnia can maintain its population over time, even through periods of environmental stress, acting as a seed bank for future generations. The ability to switch between these reproductive modes highlights the evolutionary adaptability of Daphnia in response to changing environmental factors, ensuring the continuity of the species.

B) Citizen Science Projects

1. 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.

2. Understanding Mango Mapping through Observations - The discussion focused on the seasonal flowering and fruiting patterns of mango trees, based on data collected from a survey conducted by Cubists.

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.