

## **CUBE Kishore Bharati Assistantship Report December 2024 (Second half)**

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During the Second half of December 2024, I was scheduled to attend ChatShaala but was unable to participate. 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. Effective Learning in Science: Connecting Music, Experimentation, and Imagination** - The discussion centered on enhancing science learning through active involvement rather than simply performing experiments for the sake of completion. The topic of isolating curd bacteria at home was used as an example to demonstrate how one can engage in scientific practices without sophisticated equipment. Inspired by John Lennon's song "Imagine," participants discussed using alternative methods, such as potatoes, as a medium for isolating bacteria and fungi in a home lab. This idea emphasized creativity in science and how seemingly simple materials could be used effectively for experiments.
- 2. Understanding the Size Variation in Drosophila** - The discussion focused on the observed size variation in male *Drosophila* fruit flies, particularly in single line cultures across different generations (6th and 7th). Some male flies were noted to be smaller than others, with one possible explanation being genetic variation. Additionally, environmental factors, such as temperature, were considered to influence the size of fruit flies, with warmer temperatures potentially leading to smaller body sizes. The transfer of flies between generations might also introduce stress or genetic changes that could affect their growth. These observations highlight the complex interplay of genetics and environmental conditions in determining the size and development of *Drosophila*.
- 3. Understanding Leaf Development and Hormonal Regulation in Plants** - The discussion focused on leaf development in plants, specifically in species with compound leaves like *Cardamine hirsuta*, *Pisum sativum*, *Medicago truncatula*, and

*Solanum lycopersicum*. It highlighted that variations in compound leaf forms are influenced by the flexible regulation of developmental factors. The role of xylem in water and nutrient transport was also discussed. Cytokinins were emphasized for their role in promoting cell division and expansion during leaf growth, and in leaf senescence, where they regulate sugar accumulation, chlorophyll synthesis, and prolong photosynthesis. The conversation also covered the formation of simple and compound leaves, comparing this to human growth stages. Additionally, the synthesis of plant hormones like auxin from tryptophan was discussed, highlighting the importance of biochemical pathways in plant and human development.

4. **Understanding Reflex Action and Nerve Signal Transmission** - The discussion focused on the process of reflex action and the role of nerve cells (neurons) and nerves in transmitting signals. The reflex arc, which is the simplest pathway for reflex actions, was explained as involving sensory neurons, interneurons, and motor neurons. When a stimulus, such as touching a hot object, is detected, sensory neurons (afferent neurons) carry the signal to the spinal cord, which processes the information and sends an immediate response through motor neurons (efferent neurons) to muscles, causing them to contract and withdraw the hand. This process occurs rapidly and is involuntary.

Key concepts such as resting potential, action potential, depolarization, and synaptic transmission were explored. Neurons generate electrical signals via the movement of ions ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ) across their membranes, which is essential for signal propagation. The energy required for these processes comes from ATP, specifically via the sodium-potassium pump ( $\text{Na}^+/\text{K}^+$  ATPase), which maintains ion gradients necessary for neuron function.

The discussion also touched on the distinction between neurons and nerves. A nerve is a bundle of neurons, while a neuron is a single cell responsible for transmitting electrical signals. The difference in electrical behavior between living nerve cells and conductors like copper wires was also addressed. In contrast to wires, neurons rely on chemical and electrical changes within the cell to transmit signals.

Additionally, reflex actions were described as involving both electrical and chemical signaling. The electrical signals are the result of ion movement, while neurotransmitters mediate the chemical communication between neurons across synapses. The conversation highlighted the complexity of reflex actions, the types of

neurons involved, and the role of muscle contractions in removing the hand during reflex responses.

- 5. Understanding Organic and Organometallic Compounds, Protein Structure, and Microbial Observation** - The discussion focused on several important concepts related to organic chemistry, biochemistry, and microbiology. First, the definition of an organic compound was clarified, noting that organic compounds are characterized by the presence of carbon atoms covalently bonded to hydrogen, oxygen, or nitrogen atoms. However, certain carbon containing compounds such as carbides, carbonates, and cyanides are exceptions and are not classified as organic.

A key question was raised about organometallic compounds, which involve bonds between carbon and metal atoms. This was followed by a query about the structure of hemoglobin, a protein in red blood cells responsible for oxygen transport. The structure of hemoglobin was discussed, particularly the presence of the pyrrole ring within its composition and how the alpha and beta chains are connected to form its quaternary structure.

The conversation also touched on practical observations in microbiology, with moina (a type of water flea) being identified in a college pond. The distinction between moina and other water fleas was briefly mentioned, alongside the question of whether bacteria can be seen under 100x magnification, which is typically insufficient for observing such small microorganisms. Lastly, the structure of proteins was introduced, covering the basic aspects of protein structure at different levels primary, secondary, tertiary, and quaternary and its relevance to their biological functions.

- 6. Understanding Floral Dip Method and Seed Germination** - The discussion in the Chatshaala focused on the floral dip method in plant genetic engineering, particularly its application in the transformation of Cardamine. The method involves using an unopened floral bud and introducing an Agrobacterium containing a kanamycin resistant gene. This technique was examined in terms of its effectiveness and whether it could potentially replace traditional plant tissue culture in genetic engineering applications.

Further exploration into seed germination rates led to a comparison between fresh and old seeds of Cardamine. Cubists thought about whether older seeds have a higher germination rate compared to fresh seeds. This was expanded to other seeds,

such as Green Gram, and members discussed if the age of seeds influences their ability to germinate.

- 7. Understanding Hypoxia-Inducible Factors (HIF) and Cellular Responses in Different Organisms** - The recent Chatshaala discussion focused on the role of Hypoxia-Inducible Factors (HIFs) in cellular adaptation to low oxygen conditions, highlighting their involvement in cancer, anemia, and organismal responses like those of *Moina* and *Chlorohydra*. HIFs regulate processes such as angiogenesis and metabolism under hypoxia, helping organisms survive in low oxygen environments. Cubists also explored how *Moina* produces more hemoglobin and turns red in hypoxic conditions and how the body converts food, particularly boiled rice, into energy through glucose metabolism. Additionally, we discussed the regenerative capabilities of *Chlorohydra* and the culturing of *Moina* in experimental setups to further understand these processes.

## **B) Citizen Science Projects**

- 1. Understanding Mango Flowering and Regional Variations** - The discussion centered on factors affecting mango flowering across India, focusing on the role of the florigenic promoter (FP), synthesized in leaves and transported to buds to induce flowering. Observations from various regions showed different flowering and fruiting patterns, with mature mangoes already in markets like Punnamoodu, while data from NITK Campus, Surathkal, showed mixed statuses. In contrast, no flowering was observed in Gumani near Malda, West Bengal, raising questions about the impact of sunlight and geographical location on flowering, suggesting regional variations influenced by climatic conditions.
- 2. Understanding Street Dogs' Midday Sleep Behavior** - The discussion focused on the behavior of street dogs observed in Cherunniyoor, Thiruvananthapuram, Kerala, on 23 December 2024. The topic explored the midday sleep pattern of street dogs, which is a common phenomenon in urban areas. It was noted that during the hot midday hours, street dogs often seek cool and shaded spots to rest, as this behavior helps them conserve energy and avoid heat stress. This rest period is crucial for their survival, as it provides them with the energy they need to remain active during cooler times of the day, such as early morning and evening. Understanding this behavior gives insight into the adaptations of animals to their environment. The rest also serves as a form of thermoregulation, helping the dogs to maintain an appropriate

body temperature in the tropical climate of Kerala.

#### **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.