

Science Club

School of Life Sciences, University of Hyderabad

Presents

“Jawaharlal Nehru Chair Lecture Series”

on

“Understanding Biology”

(A series of 12 lectures in the year 2017)

By

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Second Lecture on

“What is a Living Organism?”

09/3/2017, Thursday, 4 to 5 pm, Seminar Hall,
School of Life Sciences

ALL ARE CORDIALLY INVITED

Host: Dean SLS and Science Club

What is a Living organism?

Biology is the science of living organisms. But what is a living organism? How does it differ from an 'inanimate' object? It sounds easy to answer but in fact it is not that easy as we will find out below. From time immemorial, man has been mystified by the phenomenon of living. There were two predominant views. One compared our body to a machine. Every machine works mechanically with coordinated moving parts. Every machine is designed by man and works according to principles of Physics. Hence our bodies are designed, probably by God, to execute physiological and behavioural processes. The idea of a designer (God?) lurking behind these mechanistic ideas is inescapable. The other believed that life is a 'force' which drives the action in the body including thinking and is variously labelled as soul, spirit, energy, *prana* etc. The location and material basis of the force within our body is not clear in the writings of those who proposed this idea. Ancient Greek, Indian and Chinese philosophers speculated on the composition of objects in this universe. The five elements (Pancha Bhuthas like fire, earth, air, water and ether) principle of Indian thought is one such theory. All these philosophies do not make us understand what exactly is 'living'.

A commonly held simple idea among uneducated men and women about living is that when you 'insult' a living organism it will react unlike a non-living entity that does not react. By this definition, a dog or a cockroach is living. In other words all animals are living but all plants are non-living! In a way this idea of what is living is tantamount to saying that living organisms move voluntarily while non-living objects are stationary. Obviously this should be a wrong notion. Anybody who has studied biology at the school level is told that living organisms exhibit growth, reproduction and ability to sense and respond to environmental cues/insults as characteristic features/properties. However one should explain that inanimate objects like a sand dune can also grow but by accretion. Living organisms grow by intussusception. Exceptions to these expected properties are found. Hence this is not a defining property of living organisms.

Centuries back, Chemists raised a simple question regarding elemental composition of living organisms and whether it differs from that of inanimate objects. Results indicated that there was no qualitative difference in elemental composition between a handful of top soil (example for non-living) and a tissue from say cockroach or plant (example of living or even recently dead). Closure examination revealed that the relative abundance of carbon, hydrogen, oxygen and some other elements is much higher in a living tissue than on a sample of inanimate rock. Further, type of compounds present in soil sample was mostly inorganic while that in living organisms was organic. In fact these compounds found in Nature (another loose term for living organisms) were called 'Natural Products'. When they raised queries about what these compounds do inside living organisms, they discovered 'metabolism'. A new definition of living organism came about and that said anything that exhibits metabolism is living! The implications of this statement are enormous.

Physicists who study the manifested properties of Natural objects/phenomena discovered the fundamental Laws which explain the patterned behaviour of Nature. One such Law is 'Universal Laws of Thermodynamics' according to which all objects in this universe

are subject to entropic doom. Living which is an ordered structure and process is improbable! Later developments in Open System Thermodynamics made them realize that living organisms are energy machines which extract energy from environment and keep themselves in a non-equilibrium steady state. Death is equilibrium where free energy change is zero! It is true that dead bodies do not perform voluntarily any work, the convertible form of internal energy. We got a new definition of what is a living organism.

Many a time we have come across 'brain-dead' patients in hospitals. The doctors declare the patient as dead but keep it alive artificially by heart-lung machine. The family of the patient of course believe that the patient is alive but only cannot recognize any relation or friend. Consciousness or more correctly self-consciousness becomes the definition of higher living organism. What is self, though? We enter the domain of Philosophy! Summary we do not have a satisfactory and universal definition of living! Man in his attempt to search for life in extra-terrestrial astral bodies cannot recognize them even, if they are not based on 'carbon'. Even those aliens cannot recognize man if they are two-dimensional and not three dimensional like us on earth!

Suggested Readings:

01. Muralidhar, K., as Chief Advisor (2005) *Biology for 11th Class*, NCERT publication, CBSE system of School Education and Exams.
02. Muralidhar, K., as Chief Advisor (2006) *Biology for 12th Class*, NCERT publication, CBSE system of School Education and Exams.
03. Muralidhar, K., (2014) *Communications in Living Organisms*, INSA Distinguished Lectures, (Ed) SK Saidapur, Indian National Science Academy, New Delhi.

