Chapter 1

The Living World

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INTRODUCTION

The Earth, teeming with an extraordinary array of life forms, presents itself as a captivating and marvelous abode. The diversity of living entities on our planet is boundless, encompassing a myriad of habitats, habits, and behaviors. Amidst these, there exist some remarkable life forms that thrive in extreme environments such as frigid mountains, scorching deserts, hot springs, and saline lakes, posing challenges to conventional life forms.

The natural world we observe and experience is a source of profound beauty and wonder, akin to witnessing a galloping horse, the melodic chirping of birds, the blossoming of flowers, the rhythmic dance of honeybees, or the predatory prowess of sharks. Nature, in its grandeur, unveils numerous relationships—ranging from cooperation and conflict to nurturing and predation—among members of populations and communities.

Beyond the macroscopic realm, intricate relationships unfold at the micro level, within cells. Molecular interactions inside, around, and among cells unveil astonishing insights into life's complexities. Consequently, attempts to comprehend the essence of life reveal multifaceted aspects, with certain well-defined elements taking precedence.

One perspective defines life in technical terms as the inherent ability of an organism to sustain and reproduce itself on Earth. It underscores life as a distinctive, intricate organization of diverse molecules that arrange in specific patterns to form the fundamental unit—cells. Within these cells, various chemical reactions occur, ultimately yielding energy and facilitating growth, development, responsiveness, metabolism, and reproduction in living beings.

Another philosophical approach delves into the purpose of life for living organisms. Biologists, guided by a technical perspective, systematically study and elucidate various life forms. They employ classification criteria to distinguish living organisms from non-living entities and have formulated universal norms and processes that facilitate the comprehensive study of diverse life forms.

WHAT IS LIVING?

- When we try to define 'living', we conventionally look for distinctive characteristics exhibited by living organisms.
- Growth, reproduction, ability to sense environment and mount a suitable response come to our mind immediately as unique features of living organisms.
- One can add a few more features like metabolism, ability to self-replicate, self-organise, and interact and emergence to this list.
- Let us try to understand each of these.

Characteristic of living beings

Growth

- Increase in mass and increase in number of individuals are twin characteristics of growth.
- A multicellular organism grows by cell division.
- In plants, this growth by cell division occurs continuously throughout their life span (Indeterminate growth)
- In animals, this growth is seen only up to a certain age (Determinate growth). However, cell division occurs in certain tissues to replace lost cells.
- Unicellular organisms multiply by cell division. One can easily observe this in in vitro cultures by simply counting the number of cells under the microscope.
- In majority of higher animals and plants, growth and reproduction are mutually exclusive events.
- One must remember that increase in body mass is considered as growth but non-living objects also grow if we take increase in body mass as a criterion for growth. E.g. Mountains, boulders and sand mounds do grow. However, this kind of growth exhibited by non-living objects is by accumulation of material on the surface.
- In living organisms, growth is from inside. Growth, therefore, cannot be taken as a defining property of living organisms.
- Conditions under which it can be observed in all living organisms have to be explained and then we understand that it is a characteristic of living systems. A dead organism does not grow.

Reproduction

- In multicellular organisms, reproduction refers to the production of progeny possessing features more or less similar to those of parents. Invariably and implicitly, we refer to sexual reproduction.
- Organisms reproduce by asexual means also.
- Fungi multiply and spread easily due to the millions of asexual spores they produce.
- In lower organisms like yeast and hydra, we observe budding.
- In Planaria (flat worms), we observe true regeneration, i.e., a fragmented organism regenerates the lost part of its body and becomes, a new organism.
- The fungi, the filamentous algae, the protonema of mosses, all easily multiply by fragmentation.
- When it comes to unicellular organisms like bacteria, unicellular algae or Amoeba, reproduction is synonymous with growth, i.e., increase in number of cells.
- We have already defined growth as equivalent to increase in cell number or mass.
- Hence, we notice that in single-celled organisms, we are not very clear about the usage of these two terms – growth and reproduction.
- There are many organisms which do not reproduce (mules, sterile worker bees, infertile human couples, etc). Hence, reproduction also cannot be an all-inclusive defining characteristic of living organisms.
- Of course, no non-living object is capable of reproducing or replicating by itself.

Metabolism

- All living organisms are made of chemicals.
- These chemicals, small and big, belonging to various classes, sizes, functions, etc. are constantly being made and changed into some other biomolecules. These conversions are chemical reactions or metabolic reactions.
- There are thousands of metabolic reactions occurring simultaneously inside all living organisms, be they unicellular or multicellular.
- All plants, animals, fungi and microbes exhibit metabolism.
- The sum total of all the chemical reactions occurring in our body is metabolism.
- No non-living object exhibits metabolism.
- Metabolic reactions can be demonstrated outside the body in cell-free systems. An isolated metabolic reaction(s) outside the body of an organism, performed in a test tube is neither living nor non-living.
- Hence, while metabolism is a defining feature of all living organisms without exception, isolated metabolic reactions in vitro are not living things but surely living reactions.
- Hence, cellular organization of the body is the defining feature of life forms.

Consciousness

- Perhaps, the most obvious and technically complicated feature of all living organisms is this ability to sense their surroundings or environment and respond to these environmental stimuli which could be physical, chemical or biological. We sense our environment through our sense organs.
- Plants respond to external factors like light, water, temperature, other organisms, pollutants, etc. All organisms, from the prokaryotes to the most complex eukaryotes can sense and respond to environmental cues.
- Photoperiod affects reproduction in seasonal breeders, both plants and animals.
- All organisms handle chemicals entering their bodies.
- All organisms therefore, are 'aware' of their surroundings.
- Human being is the only organism who is aware of himself, i.e., has self-consciousness. Consciousness therefore, becomes the defining property of living organisms.
- When it comes to human beings, it is all the more difficult to define the living state. We observe patients lying in coma in hospitals virtually supported by machines which replace heart and lungs. The patient is otherwise brain-dead. The patient has no self-consciousness.
- Properties of tissues are not present in the constituent cells but arise as a result of interactions among the constituent cells.
- Similarly, properties of cellular organelles are not present in the molecular constituents of the organelle but arise as a result of interactions among the molecular components comprising the organelle.
- These interactions result in emergent properties at a higher level of organization.
- This phenomenon is true in the hierarchy of organizational complexity at all levels.
- Therefore, we can say that living organisms are self-replicating, evolving and self-regulating interactive systems capable of responding to external stimuli.
- Biology is the story of life on earth. Biology is the story of evolution of living organisms on earth.
- All living organisms – present, past and future, are linked to one another by the sharing of the common genetic material, but to varying degrees.