

Lecture 1: Basic Biology: A Brief Introduction

Introduction: Science (or literally mean “knowledge”) is the systematic organized knowledge on a particular subject. These topics are ranging from spirituality to cutting edge open heart surgery and human’s have realized the importance to study and document them for future generations. Study of these aspects and applying the guided rules has influenced the human life and as result several branches of science have been evolved to focus on specific aspects. There are two main branches:

(A) Social Sciences: Human behavior and its relationship with other humans (in society) is complex and studied within the big umbrella of social sciences. Within the social sciences, it has several sub-branches to study specific aspects. These are as follows:

1. Anthropology: it is the field of science which study the past and present of human considering the combined knowledge feedback from social sciences, biology, human behavior etc.

2. Economics: The field of science which understand the production, distribution and consumption of wealth.

3. Education: The field of science which understand the learning ability of an individual through systematic experimentation and develop novel teaching and learning rules as per age or ethnic background.

4. Geography: The field of science which study the several aspects of earth including soil types, spatial location of rivers, mountains, environment etc.

5. History: The field of science which study the past of the human culture and experiences in different time frames. It study the cultural differences between different human races etc.

6. Linguistics: The field of science which study the human language.

7. Political Sciences: The field of science the theory and practice of politics and political behavior.

8. Psychology: The field of science study the human behavior in context to the mental processes.

9. Public administration: The field of science which study the management of human work force in an organization to achieve maximum efficiency.

10. Sociology: The field of science study the human behavior and its relationship within the society.

(B) Natural Sciences: The various fields which deals with understanding natural phenomena are grouped within the natural sciences. These fields are as follows:

1. Physical Sciences: The branches within the physical sciences study processes operating with the non-living system. The two main branches falls within physical sciences are physics and chemistry.

2. Earth Sciences: The branches within the earth sciences study planet earth. The topics within these branches are atmosphere, hydrosphere, oceans, biosphere as well as solid earth. The main branches falls within earth sciences are ecology, oceanography, geology and meteorology.

3. Life Sciences: The branches within the life sciences study living organisms such as plants, animals and human etc. The main branches falls within life sciences are zoology, biology, botany etc. many of the life sciences branches are interdisciplinary and interact with subjects to understand better understanding of living organism.

But big question at this moment is “What Defines living object”? To answer this question, we can perform comparative analysis of living system with non-living system (diesel engine) as given in the Table 1.1.

TABLE 1.1 COMPARASION OF LIVING WITH NON-LIVING SYSTEM (DIESEL ENGINE).		
Feature	Living System	Non-living System (Diesel engine)
Energy Source	Food	Diesel
Machinery	Metabolic Reactions	Combustion
Mechanism to utilize energy	Anabolic Reactions	Torque
Dispose waste material	Present	Exhaust in the form of smoke.

Based on this comparative analysis, number of charterstics observed in a living organism can be define. These properties are as follows:

- Self Growth or Self Renewal
- Endogenous ability to produce energy
- Movement with an exception in the case of Plants as they don’t Move
- Ability to self replicate.

But human has developed “robots” which can perform several of these tasks but still it does not considered as “living organism”. In addition, with the advancement in technology, the criteria for living organism is redefined. These re-defined criterias are as follows:

- **Complex organization-Composed of different types of cells**
- **Metabolism- To produce energy and utilize preformed food material.**
- **Responsiveness- To respond to the extreme environmental conditions. Such as Temp, wind, starvation.**
- **Growth- Endogenous Growth**
- **Reproduction- ability to give off springs**
- **Evolution- To better suits to the changed environment or metabolism.**

Diversity and complexity in biological system: Biological system has vast variety of organism. A large number of species you can see around you, whether it is insects, butterflies, different types of birds and other pet animals. Different types of plant species available in north-eastern india is given in the Figure 1.1.

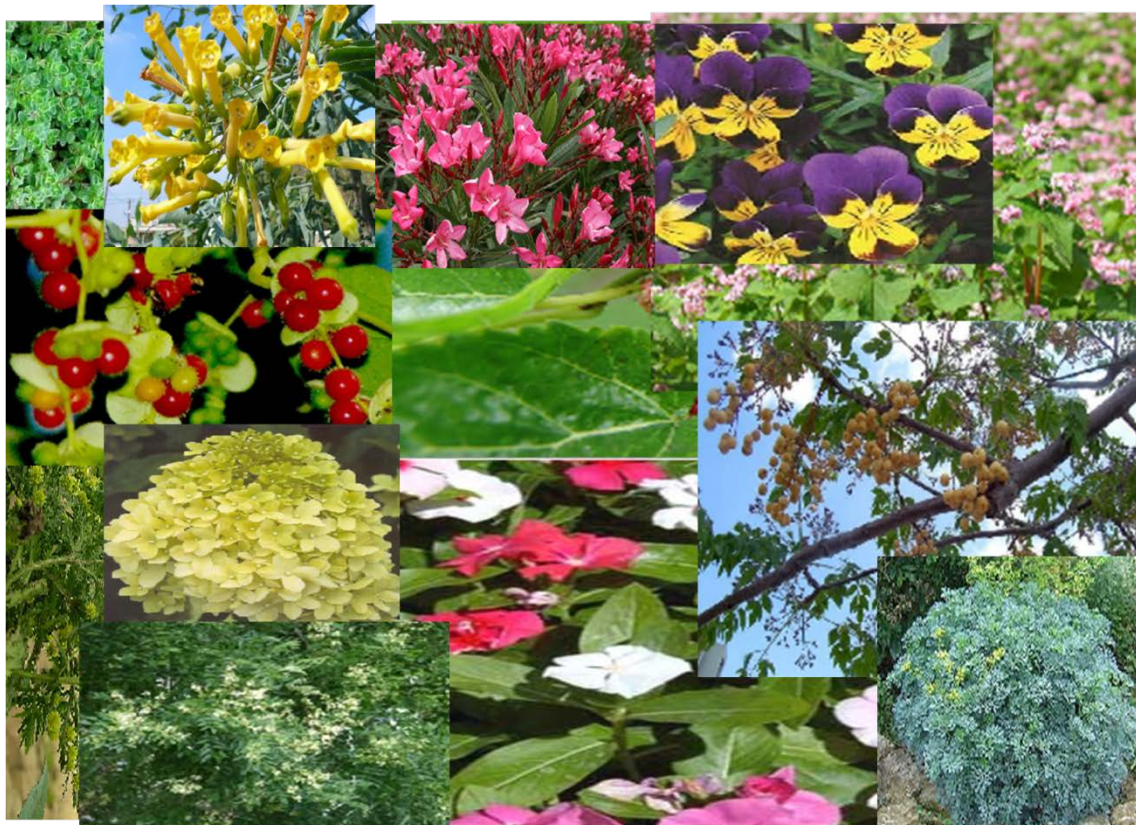


Figure 1.1 : Different types of plant species found in northeastern india.

As per rough estimate, a total number of species present on planet earth are 8.7 million. These species are widely distributed, both on the terrestrial earth and inside the ocean. A rough distribution of these species is given in the Table 1.2.

TABLE 1.2 Distribution of organisms on earth

Species	Earth			Ocean		
	Catalogued	Predicted	±SE	Catalogued	Predicted	±SE
Eukaryotes						
Animalla	953,434	7,770,000	958,000	171,082	2,150,000	145,0000
Chromista	13,033	27,500	30,500	4,859	7,400	9,640
Fungi	43,271	611,000	297,000	1,097	5,320	11,100
Plantae	215,644	298,000	8,200	8,600	16,600	9,130
Total	1,233,500	8,740,000	1,300,000	193,756	2,210,000	182,000
Prokaryotes						
Archaea	502	455	160	1	1	0
Bacteria	10,358	9,680	3,470	652	1,320	436
Total	10,860	10,100	3,630	653	1,320	436
Grand Total	1,244,360	8,750,000	1,300,000	194,409	2,210,000	182,000

As given in the Table 1.2, the distribution of different species gives salient feature of biodiversity. These features are as follows:

1. Shape: The shape of different species present varied a lot. Within the prokaryotes, bacteria of different shapes such as bacilli, cocci etc are found. In eukaryotes, plants are found with different shapes.

2. Size: The shape of different organisms varies from very tiny virus to giant blue whale.

3. Spatial distribution: Living organisms are distributed from extreme cold weather to very hot region of the planet. They are also distributed on land, water and in the air as well.

4. Biological Activity: Due to their wide distribution of species to the extreme condition, species have devised the metabolic activities to adopt to these conditions.

Outline of the course content: With such a brief introduction, you might have realized the complexity and diversity of the different organisms found on the earth. Within the diversity, most of the organism follows similar basic steps to complete their life-cycle. In addition, interaction of these species give appearance of newer species or original species with extra features. The understanding basic features of living system and different steps involved to run their life-cycle as well as the known mechanism of appearance of newer species are being covered in this course with a discussion of their future impact at the

end. By the end of this course, student will be able to understand following aspects of biology:

1. Origin of life on earth and associated different hypothetical models to explain the process.
2. Evolution
3. Cellular organization of living organism.
4. Basic physiology of living organism.
5. Structure-function of building blocks of living organism.
6. Environment and Ecosystem.

Lecture 2: Classification of Living Organisms

Introduction: As discussed in previous lecture, a large number of species exist on the earth. Human and its constant efforts to identify newer species and their potentials for food, cloth and shelter. In addition, human's are also interest to explore the relationship between different species so that techniques developed for one species canbe used for distantly related species without much efforts. For examples, experiments performed on monkeys and the results of these experiments can be applied to the human without much optimization. Since, it is difficult to draw the relationship between different species without comparing their properties and group them accordingly. This process of classification is known as taxonomy.

Classification of Living Organism: In earlier day when number of species were limited, Aristotle has used morphological differences as a criteria to group into plant and animals. But as number goesup this kind of classification didn't hold and the organism were classified into two kingdom; plantae and animalia. This type of classification was easy to do but several organism are difficult to classify of either of these kingdoms. Later, R.H. Whittaker have grouped the organisms using five kingdom classification. The properties used to distinguish different kingdoms are given in Table 2.1. The basis of classification includes cellular structure, body organization, mode of nutrition, reproduction etc.

TABLE 2.1: PROPERTIES OF THE FIVE KINGDOMS

	FIVE KINGDOMS				
Property	Monera	Protista	Fungi	Plantae	Animalia
Cell Type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell Wall	Non-Cellulosic	Present	Present	Non-Cellulosic	Absent
Nuclear Membrane	Absent	Present	Present	Present	Present
Organization	Unicellular	Unicellular	Multicellular	Tissue/Organ	Tissue/Organ/ Organ System
Mode of Nutrition	Autotrophic and	Autotrophic	Heterotrophic	Autotrophic	Heterotrophic

	heterotrophic				
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KINGDOM MONERA: Bacteria belong to kingdom monera. They are further divided into different categories based on shapes; Coccus (spherical), bacillus (rod), vibrium (comma shape) and spirillum (spiral). They can be able to grow from soil to extreme conditions such as hot springs, snow and deep ocean. The selected examples of bacterial species belonging to different groups in kingdom monera are as follows:

1. Archaeobacteria: The bacteria belonging to this group has distinct cell wall structure to allow their survival into extreme conditions. These bacterial species live in harsh habitats such as extreme salty areas (halophiles), hot springs (thermoacidophiles) and marshy areas (methanogens). The presence of these bacterial species in the cow dung is responsible for the production of methane (bio-gas).

2. Eubacteria: These are the true bacteria due to presence of rigid cell wall and a well defined flagellum for motility. Several species belonging to this group contain chlorophyll a and are photosynthetic autotrophs. In addition, few of the chemosynthetic autotrophs oxidize various inorganic substances such as nitrates, nitrites and ammonia to generate ATP. This property is exploited in industrial setting as well as in environment to recycle nutrients like nitrogen, phosphorous, iron and sulfur.

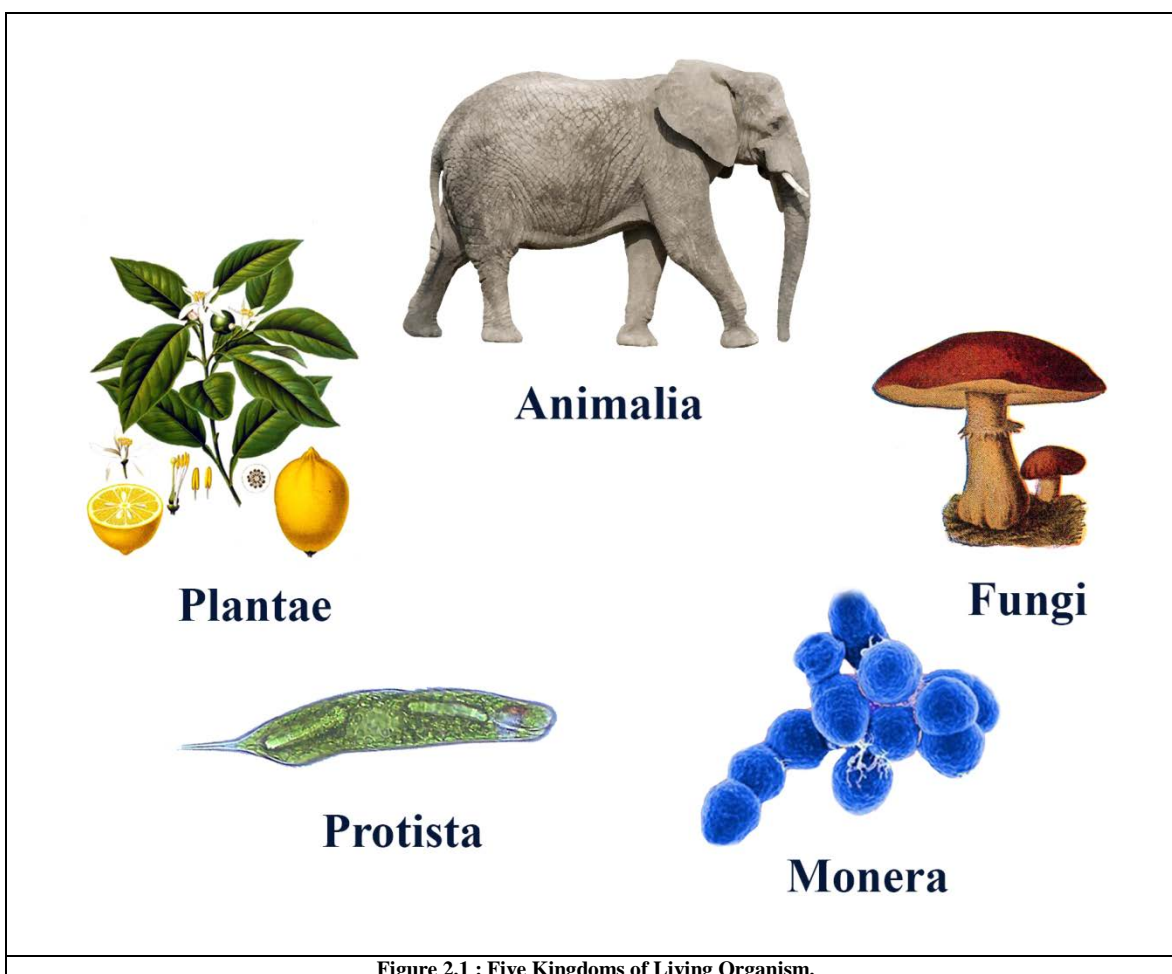
KINGDOM PROTISTA: All unicellular eukaryotes belong to kingdom protista. The organisms in this group have well defined nucleus and other membrane bound organelles. These organisms have mixed properties of plant, fungi, animals and considered to be responsible for linking organisms in other kingdoms. Protista reproduce mostly asexually and sexually with cell fusion and zygote formation. The selected examples of few of the group from this kingdom are as follows:

1. Chrysophytes: Diatoms and golden-brown algae belong to this group. These organisms are present in water and float passively. Diatoms have silica cell wall and they accumulate in the ocean to give diatomaceous earth. This soil is used in polishing, filtration of oils and syrups.

2. Dinoflagellates: These are photosynthetic marine organisms of different colors depending upon the pigment present in their cell wall. The cell wall has cellulose on its outer surface. Most of the dinoflagellates have two flagella attached to their cell body. Red dinoflagellates multiplication in ocean and gives red color.

3. Euglenoids: Euglena is the representative organism belonging to this group. These are photosynthetic organism and they perform photosynthesis in the presence of sun light. In the absence of sunlight, it catches tiny preys and behave like heterotrophs. The cell body has a protein rich layer pellicle and it gives flexibility to the organism.

4. Slime Moulds: Slime molds are saprophytic protists. They feed on organic matter from decaying twigs and leaves. During unfavorable condition, they forms spores which are resistant and survive in extreme conditions. Spores of these organisms can survive for several years and be dispersed by air.



KINGDOM FUNGI: Fungi are heterotypic organisms and constitute a unique kingdom. They exhibit great diversity in morphology, living type and habitat. They are unicellular (yeast) to multicellular (penicillium) organism. They are universally present in air, water, soil, plant and on animal body. These organisms are infectious (candida) and non-infectious (yeast). In addition, they live as symbiont; lichens (algae with fungi) and mycorrhiza (plant and fungi). These organisms are commercially being used in fermentation to produce alcohol, antibiotics, vitamin and other products. Mushroom is used as edible fungi. The cell wall of fungi is composed of chitin and polysaccharides. Reproduction in fungi is mostly by vegetative method such as fragmentation, fission, budding and asexual reproduction by spores.

KINGDOM PLANTAE: All multicellular green plants are part of kingdom plantae. Their cell wall is made up of cellulose. Mostly these organisms are photosynthetic but few insect eater plants are parasitic in nature. Plants reproduce through asexual vegetative propagation and sexual method. Plants are either bisexual or unisexual with separate male and female. Algae, bryophytes, pteridophytes, gymnosperm and angiosperm are the main groups present in kingdom plant.

KINGDOM ANIMALIA: These organisms are heterotrophic multicellular eukaryotic without thick cell wall. They depend on plants for nutrition. They have digestive system, circulatory system and well defined sensory and neuromotor mechanism. These organisms have a definitive development pattern to acquire defined shape and size in adults. Reproduction in these organism is mostly by sexual mechanism with separate male and female.

OTHER ORGANISMS: There are organisms which don't fall into five kingdoms due to their unique features. These organisms are not placed and placed into their own group separately. These organisms are as follows:

1. Virus: These are non-nucleated and acellular organisms. Virus can be stored for year as particle and they are considered to be false living organism. They depend on host organisms to provide cellular machinery for multiplication. They contain genetic material either as DNA or RNA and protein coat. Post infection, they integrate their

genetic material into the host genome to control the cellular machinery of host. Virus can use bacteria, plant or animal cells as host. They are mostly pathogenic and be responsible for disease in bacteria, plant and animals.

2. Viroids: T.O. Diener discovered these organisms which contains only free RNA. They are smaller than virus. It doesn't contain protein coat as found in virus.

3. Lichens: As discussed previously, algae and fungus are associated to give organism known as lichen. In this organism, algae is phycobiont and be responsible for preparing food whereas fungi are absorbing mineral nutrient and water. The association between both counterpart help each other and this kind of association is known as “symbiont”. Lichen are very sensitive to pollution as they don't grow in high polluted area.

Taxonomic Categories: Each kingdom is a group of similar organism but these organism are further divided into different taxonomic categories. Different taxonomic categories are given in Figure 2.2. These categories are as follows:

Kingdom: This is the highest taxonomic categories and all organisms are placed in a particular kingdom based on the gross properties as discussed earlier. There are five different kingdoms and few organism as separately kept.

Phylum: Different organisms with similar properties are placed in phylum. For example, phylum chordata comprises animals containing central notochord for examples: fishes, amphibians, reptiles, bird etc.

Class: Different classes are present within single phylum. For examples within phylum chordata, we have individual class for fishes, amphibians, reptiles etc.

Order: Each class is divided into different order based on the aggregate of character. Each class contains different families. For examples, order carnivore includes families like felidae and canidae.

Family: Individual order is divided into different families basis of related genera. For examples, plants are placed in different families basis of reproductive features of the plants.

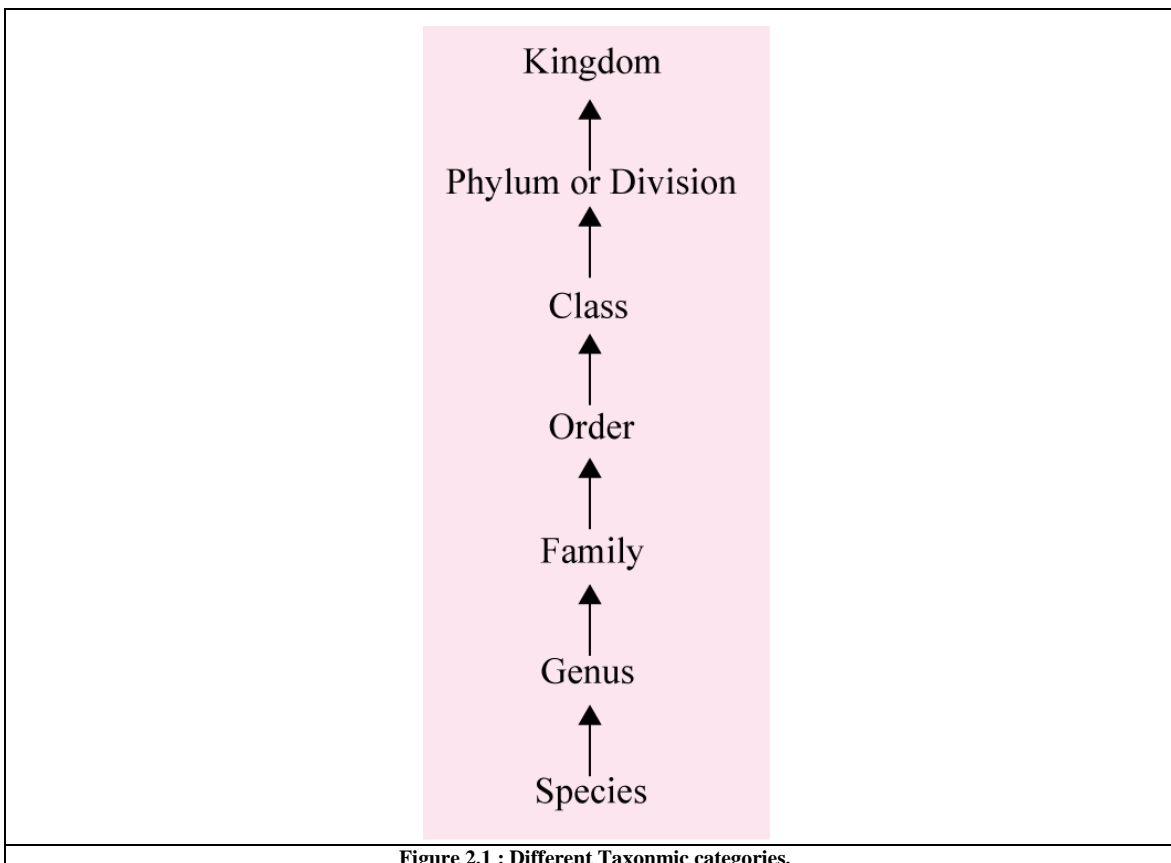


Figure 2.1 : Different Taxonomic categories.

Genus: It comprises similar species which has common features. For examples, lion, leopard and together are placed within the genus panther.

Species: These are group of organisms with fundamental similarities. Species is the smallest unit in the taxonomic classification. For examples human belongs to species sapiens.

Nomenclature of Living Organism: The taxonomic classification is used to nomenclature of the organism. The most popular method of naming organism is known as binomial system which involves the information of genus and species to name each organism. This system is proposed by carolus Linnaeus where genus and species as first letter and second letter to give the nomenclature of individual organism. For examples, the scientific name of human is *Homo sapiens*. Here, Homo is the genus and the sapiens

is the species. In case the two organism has similar species but they belongs to different sub-species. In these cases, along with species, name of the sub-species is also included. In addition, name of the author appears at the end of biological name, for ex. Scientific name of mango is *Mangifera indica* Linn. It indicates that mango was first discovered by Linnaeus.