CLASSIFICATION OF LIVING THINGS

All **living things** are organized into groups by scientists as they are identified. ... Different scientists use various systems of **classification** to organize all **living things** into groups. Overall, the reason scientists **classify living things** is to understand the relationships between different organisms.

Classification is **important** because it allows scientists to better identify, group, and properly name organisms via a standardized system (Linnaeus Taxonomy); based on similarities found in the organisms DNA/RNA (genetics), Adaptations (Evolution), and Embryonic development (Embryology) to other known organisms. **Classification** is needed for convenient study of living organisms. It is necessary for knowing the different varieties of organisms. It helps in the correct identification of various organisms. It helps to know the origin and evolution of organisms.

In 1735, Linnaeus published an influential book entitled *Systema Naturae* in which he outlined his scheme for classifying all known and yet to be discovered organisms according to the greater or lesser extent of their similarities. This Linnaean system of classification was widely accepted by the early 19th century and is still the basic framework for all taxonomy in the biological sciences today.

The Linnaean system uses two Latin name categories, **genus** and **species**, to designate each type of organism. A genus is a higher level category that includes one or more species under it. Such a dual level designation is referred to as a binomial nomenclature or **binomen** (literally "two names" in Latin). For example, Linnaeus described modern humans in his system as ***Homo sapiens***. *Homo* is our genus and *sapiens* is our species.

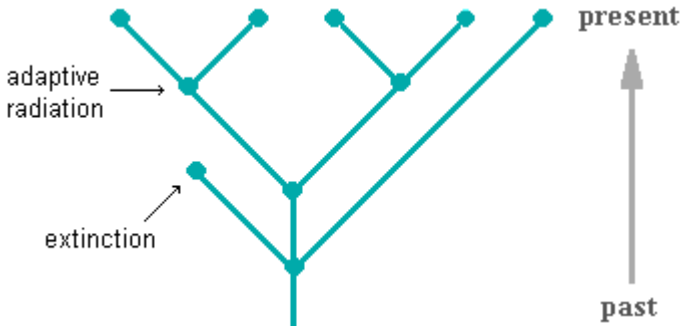
Linnaeus also created higher, more inclusive classification categories. For instance, he placed all monkeys and apes along with humans into the order ***Primates***. His use of the word Primates (from the Latin *primus* meaning "first") reflects the human centered world view. It implied that humans were "created" first. However, it also indicated that humans are animals.

For Linnaeus and his contemporaries, taxonomy served to rationally demonstrate the unchanging order inherent in Biblical creation and was an end in itself. From this perspective, spending a life dedicated to precisely describing and naming organisms was a religious act because it was revealing the great complexity of life created by God.

This static view of nature was overturned in science by the middle of the 19th century by a small number of radical naturalists, most notably **Charles Darwin**. He provided conclusive evidence that evolution of life forms has occurred. In addition, he proposed natural selection as the mechanism responsible for these changes.

Since Darwin's time, biological classification has come to be understood as reflecting evolutionary distances and relationships between organisms. The creatures of our time have had common ancestors in the past. In a very real sense, they are members of the same family tree.

The great diversity of life is largely a result of branching evolution or **adaptive radiation**. This is the diversification of a species into different lines as they adapt to new ecological niches and ultimately evolve into distinct species. Natural selection is the principal mechanism driving adaptive radiation.



Binomial nomenclature (also called binominal nomenclature or binary nomenclature) is a formal **system** of naming species of living things by giving each a name composed of two parts, both of which use Latin grammatical forms, although they can be based on words from other languages.
Every recognized species on earth (at least in theory) is given a two-part **scientific name**. This system is called "binomial nomenclature." These **names** are **important** because they allow people throughout the world to communicate unambiguously about any species.

How do scientists classify organisms in the Linnaean system?
Carolus **Linnaeus** is the father of taxonomy, which is the system of **classifying** and naming **organisms**. One of his contributions was the development of a hierarchical system of **classification** of nature. Today, this system includes eight taxa: domain, kingdom, phylum, class, order, family, genus, and species.

Scientific names follow a specific set of rules. **Scientists use** a two-**name** system called a Binomial **Naming** System. **Scientists name** animals and plants **using** the system that describes the genus and species of the **organism**. The first word is the genus and the second is the species.

The taxa in hierarchical order:

- Domain - Archea, Eubacteria, Eukaryote.
- Kingdom - Plantae, Animalia, Fungi, Protists, Eubacteria (Monera), Archaebacteria.
- Phylum.
- Class.
- Order.
- Family.
- Genus.
- Species - smallest classification.

These specialized groups are collectively called the **classification of living things**. The **classification of living things** includes 7 levels: kingdom, phylum, classes, order, families, genus, and species. The most basic **classification of living things** is kingdoms. Currently there are six kingdoms.

Taxonomy and binomial nomenclature are both specific methods of classifying an organism. They help to eliminate problems, such as mistaken identity and false assumptions, caused by common names. An example is the comparison between crayfish and catfish, where one might believe that they both are fish when in fact, they are quite different.

Nomenclature is concerned with the assignment of names to taxonomic groups in agreement with published rules. The words unicellular, multi- cellular, bilateral symmetry, radial symmetry, chlorophyll, photosynthesis, respiration, reproduction, vertebrates, endoskeleton, exoskeleton, consumers, decomposers, heterotroph, autotroph, vascular, non-vascular are all part of classifying things.

The Three Domains

The three domains are organized based on the difference between eukaryotes and prokaryotes. Today's living prokaryotes are extremely diverse and different from eukaryotes. This fact has been proven by molecular biological studies (e.g. of RNA structure) with modern technology. The three domains are as follows:

Archea (Archeabacteria) consists of archeabacteria, bacteria which live in extreme environments. The kingdom Archaea belongs to this domain.

Eubacteria consists of more typical bacteria found in everyday life. The kingdom Eubacteria belongs to this domain.

Eukaryote encompasses most of the world's visible living things. The kingdoms Protists, Fungi, Plantae, and Animalia fall under this category.

Under the three domains are the six kingdoms in taxonomy [Plantae, Animalia, Protists, Fungi, Eubacteria (Monera), Archaebacteria].

Protists, the third kingdom, was introduced by the German biologist Ernst Haeckel in 1866 to classify micro-organisms which are neither animals nor plants. Since protists are quite irregular, this kingdom is the least understood and the genetic similarities between organisms in this kingdom are largely unknown. For example, some protists can exhibit properties of both animals and plants.

Fungi are organisms which obtain food by absorbing materials in their bodies. Mushrooms and moulds belong in this kingdom. Originally, they were part of the plant kingdom but were recategorised when they were discovered not to photosynthesise.

Eubacteria are bacteria, made up of small cells, which differ in appearance from the organisms in the above kingdoms. They lack a nucleus and cell organelles. They have cell walls made of peptidoglycan.

Archae (or Archaebacteria) are bacteria which live in extreme environments, such as salt lakes or hot, acidic springs. These bacteria are in their own category as detailed studies have shown that they have unique properties and features (ex. unusual lipids that are not found in any other organism)which differ them from other bacteria and which allow them to live where they live. Their cell walls lack peptidoglycan.

Origins of Diversity

The diversity in our planet is attributed to diversity within a species. As the world changed in climate and in geography as time passed, the characteristics of species diverged so much that new species were formed. This process, by which new species evolve, was first described by British naturalist Charles Darwin as **natural selection**.

For an organism to change, genetic mutations must occur. At times, genetic mutations are accidental, as in the case of prokaryotes when they undergo asexual reproduction. For most eukaryotes, genetic mutations occur through sexual reproduction, where meiosis produces haploid gametes from the original parent cells. The fusion of these haploid gametes into a diploid zygote results in genetic variation in each generation. Over time, with enough arrangement of genes and traits, new species are produced. Sexual reproduction creates an immense potential of genetic variety.

One goal of taxonomy is to determine the evolutionary history of organisms. This can be achieved by comparing species living today with species in the past. The comparison in anatomy and structure is based on data from development, physical anatomy,

biochemistry, DNA, behaviour, and ecological preferences. The following are examples of how such data is used:

- Anatomy:

Although a horse and a human may look different, there is evidence that their arm structures are quite similar. Their arms' sizes and proportions may be different, but the anatomical structures are quite similar. Such evidence reveals that animals in different taxa may not be that different. Biological features from a common evolutionary origin are known as **homologous**.

- Biochemistry:

Biochemical analysis of animals similar in appearance has yielded surprising results. For example, although guinea pigs were once considered to be rodents, like mice, biochemistry led them to be in a taxon of their own.

On the basis of 18 protein sequences, it is suggested that the guinea pigs and the myomorphs (rat-like rodents) are not monophyletic. Rather, the evolutionary lineage leading to the guinea pig (long classified under the order Rodentia) seems to have branched off before the divergence of myomorphs, lagomorphs, primates, chiropterans, artiodactyls, and carnivores. It is suggested therefore that the Caviomorpha (guinea pig-like rodents) and possibly the Hystricomorpha (porcupine-like rodents) should be elevated in taxonomic rank distinct from the Rodentia.

INTERRELATIONSHIPS BETWEEN LIVING ORGANISMS (ECOSYSTEMS AND BIOMES)

Definition of Concepts

Ecology: The study of the interrelationships between living organisms and the living and non-living components and processes in an environment

Biome: A major ecological region within which plant and animal communities are similar in general characteristics and in their relationships to the physical environment. E.g. vegetation zones such as the Desert & Rainforests.

Ecosystem: The collection of all living organisms in a geographic area, together with all the living and non-living things with which they interact; a community and its physical environment.

- Aquatic Ecosystems (water-based) ecosystems
- Terrestrial Ecosystems (land-based) ecosystems.

Population: A group of organisms of the same kind living in a given area

Natural Community: Populations of different plant and animal species interacting among themselves in an area.

Habitat: The specific physical location where a particular organism lives or is adapted to live in a community. The habitat of a species describes the environment over which a species is known to occur and the type of community that is formed as a result.

THE NATURAL BIOMES

Biomes are larger units of organization that categorize regions of the Earth's ecosystems, mainly according to the structure and composition of vegetation. Biomes are dominated by different functional types of vegetative communities that are limited in distribution by climate, precipitation, weather and other environmental variables. Biomes include tropical rainforest, temperate broadleaf and mixed forest, temperate deciduous forest, tundra, and desert.

1. Equatorial and Tropical Rain Forest

   a) Evergreen broadleaf forest

2. Tropical Seasonal Forest and Scrub

   a) Tropical monsoon forest

   b) Tropical deciduous forest

3. Tropical Savanna

   a) Derived savanna b) Savanna woodland

4. Desert and Semi-Desert

   Subtropical desert and scrubland

5. Arctic and Alpine a) Tundra

STRUCTURE OF ECOSYSTEMS

Biotic and Abiotic

Every ecosystem is composed of two basic units:

a) **Biota:** the living organisms - all plant & animal species

b) **Abiotic:** the non-living physical and chemical component consisting of wind, temperature, water, soil, precipitation etc.

The single **abiotic** factor most lacking in a particular environment is termed a **Limiting Factor**. e.g. water – in a **desert** and temperature - Tundra.

The variation in physical factors that a population can withstand and continue to thrive in an environment is termed **Range of Tolerance**.

CATEGORIES OF ORGANISMS

1. PRODUCERS:

Green plants that carry on photosynthesis. Producers are termed ***auto-trophs*** because they are self-nourished **–** they do not depend on other species to feed.

During **photosynthesis**, plants capture light energy with their chlorophyll and use it to convert carbon dioxide and moisture (absorbed from air) into sugar (chemical energy). **Oxygen** is released as a by-product

Every major ecosystem has its particular green plants that carry on photosynthesis and release chemical energy (carbohydrates, protein etc.) on which non-producers feed (e.g. algae & plankton in aquatic systems, plants in terrestrial systems)

2. CONSUMERS:

a) Consumers are heterotrophs for they rely on chlorophyll-containing plants or the products of such plants for nourishment.

b) Consumers are subdivided into groups according to their food source.

Primary consumers: Species that feed directly on producers (plant-eating species). They are also called **Herbivores.** E.g. elephants, goats, cattle

Secondary Consumers: Species that feed on primary consumers. Secondary and higher order consumers are called **Carnivores**. E.g. cat.

Tertiary and higher level Consumers: Species that obtain their nourishment by eating other meat-eating species. E.g. tiger, lion

Multiple level Consumers: Species that obtain their nourishment from eating both plants and animal species. Also called **Omnivores**

3. DECOMPOSERS:

They are the final link in the food chain. Comprise of organisms that feed on dead matter and break it down to release chemical energy back into the soil for plants to re-use them. E.g. fungi, bacteria, insects, worms and others.

Detritivores: feed on detritus matter (dead plants and animals) e.g. crab, vulture, termites, wood beetle and crayfish. Also called **scavengers.**

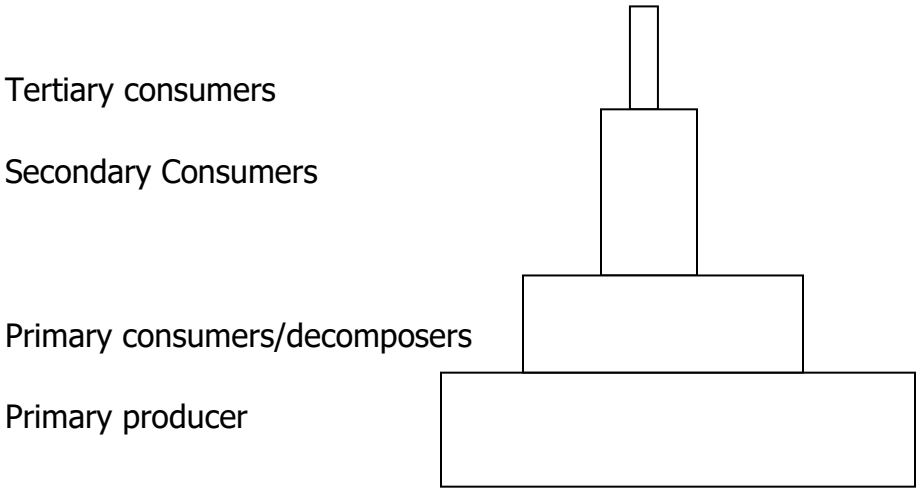
FEEDING RELATIONSHIPS AMONG SPECIES

The Food Chain.

A food chain or food web comprises a sequence of organisms through which energy and nutrients are taken in and used up e.g. Grass--> Grasshopper--> Lizard--> Snake.

Food chains begin from producers to consumers and the major feeding levels are called **Trophic Levels**.

Producers belong to the **First Trophic Level.** Primary consumers, whether feeding on living or dead producers feed from the **Second Trophic Level**. Organisms that feed on other consumers belong to the **Third Trophic Level.** Only about **20%** of the calories in plant matter survive from First to the Second trophic level.



NON-FEEDING RELATIONSHIPS

1. Mutual relationships:

Relations between organisms can be

(a) **mutually beneficial** to both species, For example, relationship between flowers and insects is a mutually supportive relationship, or …

(b) **Parasitic,** in that such a relationship benefits only one party. Examples include ticks, fleas, mosquitoes, mistletoe plants and fungi.

Mutually beneficial relationships are also termed **Symbiotic** (sym = together, bio = living) and can be described as

a) **Commensalism** is a mutual interaction between two different species in which one organism benefits but the other is neither harmed nor helped in any way, or… (E.g. The relationship between cattle egrets and cattle).

b) **Mutualism** is a type of species interaction in which both participating species benefit. Bees and flowers have a mutualistic relationship. Bees get the nectar they need to make honey from flowers. The bee brings pollen from other plants, resulting in cross pollination.

2. **Competitive Relationships:**

Plant and animal species compete over food, water, territorial space and mating with the opposite sex.

Five Types of Ecological Relationships

Organisms occupy what are called niches. A niche includes the physical space in which they live, how they use the resources that are in that space, and how they interact with other organisms in that space. The interaction among organisms within or between overlapping niches can be characterized into five types of relationships: competition, predation, commensalism, mutualism and parasitism.

Competition & Predation

Predation is when one organism eats another organism to obtain nutrients. The organism that is eaten is called the prey. Examples of predation are owls that eat mice, and snakes that eat rats. Competition is when individuals or populations compete for the same resource, and can occur within or between species. When organisms compete for a resource (such as food or building materials) it is called consumptive or exploitative competition. When they compete for territory, it is called interference competition. When they compete for new territory by arriving there first, it is called preemptive competition. An example is lions and hyenas that compete for prey.

Commensalism

Commensalism is a relationship in which one organism benefits while the other is neither helped nor harmed. Commensal is the one that receives the benefit. The host is the partner that is neither benefited nor harmed. Examples are barnacles that grow on whales and other marine animals. An example of commensalism is the relationship between a shark and a remora. Remora, a sucker fish, attaches itself to the underside of the body of the shark. As the shark feeds, the remora picks up the scraps of food which the shark leaves. Another example is an aerial plant or epiphytes growing on the branches of a tree. Orchids cling onto the branches of trees. Their presence does not affect the tree although the tree provides support and place for the orchids to grow. The orchids does not affect the tree because they can manufacture their own food through photosynthesis.

Parasitism

Parasitism is a relationship in which one organism benefits and the other organism is harmed, but not always killed. Parasites cannot live alone. They must live on a living host. The organism that benefits is called the parasite, and the one that is harmed is the host. Parasitism is different from parasitoidism, which is when the host is always killed, such as when one organism lays its egg inside another organism that is later eaten by the hatchlings. Parasites can be ectoparasites -- such as ticks, fleas, and leeches -- that live on the surface of the host. Parasites can also be endoparasites -- such as intestinal worms (hookworm, tapeworm) – that live inside the host. Endoparasites can be further categorized into intercellular parasites, that live in the space between cells, or intracellular parasites, which live inside of cells. There is also hyperparasitism, which is when a parasite is infected by another parasite, such as a microorganism living in a flea, which lives on a dog.

Example: Aphids and a rose plant show parasitism. An aphid is a louse that lives on plants and sucks their juices. Aphids are insect parasites. They are tiny white cotton-like spots underneath the leaves of roses. Other examples of parasite-host relationships are a flea and a dog and head lice on a child's hair.

Mutualism

Mutualism is a relationship in which both species living together in a common space benefit. Mutualistic interaction patterns occur in three forms. Obligate mutualism is when one species cannot survive apart from the other. Diffusive mutualism is when one organism can live with more than one partner. Facultative mutualism is when one species can survive on its own under certain conditions. Trophic mutualism is exemplified in lichens, which consist of fungi and either algae or cyanobacteria. The fungi's partners provide sugar from photosynthesis and the fungi provide nutrients from digesting rock. Defensive mutualism is when one organism provides protection from predators while the other provides food or shelter: an example is ants and aphids. Dispersive mutualism is when one species receives food in return for transporting the pollen of the other organism, which occurs between bees and flowers.

For example: the butterfly and flowers. Butterfly hovers around the flowering plants because it is attracted by the color and odor of the flowers. It also sips nectars from the flowers. The flowers on the other hand, benefit from it because as the butterfly hovers from one flower to another, it transfers pollen grains and pollinates the flowers.

BIOGEOCHEMICAL CYCLES

Processes through which elements that sustain life (water, carbon, phosphorus and nitrogen) are continuously made available to living organisms.

Well known chemical cycles include:

a) Nitrogen Cycle,

b) Hydrological cycle,

c) Carbon cycle, and …

d) Phosphorus cycle

What are the guiding questions for this lesson?

1. In what various ways do organisms interact in an ecosystem?
   Answer should include the following concepts
   - *Mutualism: relationship in which both organisms benefit*
   - *Parasitism: relationship in which one organism benefits and the other is harmed*
   - *Commensalism: relationship in which one organism benefits and the other is unaffected*

2. How does competition affect the population density of a population? *When populations become crowded, organisms compete for food, water space, sunlight and other essentials. Competition among members of the same species is a density-dependent limiting factor.*