

Section 1 – Lesson 1 – Living Versus Nonliving

Characteristics of Living Things

In order to be considered living, an organism **must** possess the following Six (6) characteristics.

- a. Living things are organized systems made up of one or more cells.
 - i. Ex: Tissues (A group of cells working together for a common function)
 - ii. Ex: Organelles – small structures inside a cell that undergo functions.
 - iii. Organ systems – groups of organs working together for a common function.
- b. Living matter must maintain some type of homeostasis.
 - i. Homeostasis – The process of maintaining a stable internal environment. Homeostasis is accomplished using “feedback” mechanisms to regulate bodily function.
 1. ex: Controlling temperature and chemical composition.
- c. Living matter grows and develops
 - i. This refers to an increase in the size and “differentiation” of cells.
 1. Differentiation – changes in cells that make them suited for specific functions.
- d. Living matter Reproduces and passes on genetic material as a blueprint for growth and subsequent reproduction.
 - i. This is really biogenesis. Life has to reproduce in order to continue the species.
- e. Living matter acquires matter and energy from the external environment and converts it into different forms.
 - i. Refers to the “ingestion” or “absorption” of materials (feeding) and then metabolizing materials for the creation of energy etc to carry out bodily functions.
- f. Living matter responds to stimuli from the environment and adapts.
 - i. Organisms must adapt to their environment in order to survive.
 1. ex: A fish will slow down its gill rate in cold water
 2. ex: A plant will grow toward the light.

Section 1 – Lesson 2 – Classification Systems

Classification: The grouping together of ideas, things etc. on the basis of similarity.

Ex: classifying trees as plants
Classifying all horses as animals

Taxonomy: The branch of biology that deals with the classification of *living things*.

Taxonomist: A person who works at or studies taxonomy.

Classification Systems (History)

- A classification system is a way to identify an organism and place it into the correct group of related organisms (similar characteristics).

Aristotle (2000 yrs ago).

Aristotle made the **First** attempt at classification.

He divided ALL organisms into **TWO** large groups he called kingdoms.

The two groups were called kingdom *Animalia* and kingdom *Plantae*

- Animals were classified on the basis of where they lived. (Land, water, air)
- Plants were classified on the basis of their structure. (herbs, shrubs, trees)

Ernest Haeckel (1866)

Proposed a **THIRD** kingdom – **Protista**

Kingdom protista was a “dumping” ground to help deal with organisms that were neither animals nor plants.

Ex: Euglena – had characteristics of both plants and animals, so placed within Kingdom Protista.

As biologists learned more about structure and function of different organisms, more kingdoms were added.

Kingdom Fungi was proposed.

- Organisms from this kingdom were originally classified as plants, but fungi are *not* photosynthetic and are heterotrophic, so they became a separate kingdom.

Robert Whittaker (1969)

Proposed a 5 Kingdom classification system based upon the following:

- a. Number of cells
- b. Presence or absence of a nucleus
- c. Mode of Nutrition.

Today's SIX(6) Kingdom Classification System

- Kingdoms:
1. Kingdom Animalia
 2. Kingdom Plantae
 3. Kingdom Fungi
 4. Kingdom Protista
 5. Kingdom Bacteria or Monera
 6. Kingdom Archaea

All six kingdoms are separated into the **THREE DOMAINS** of Life.

- A. Domain Bacteria – Kingdom Bacteria or Monera
- B. Domain Archaea – Kingdom Archaeobacteria or Archaea
- C. Domain Eukarya – Kingdoms Animalia, Plantae, Protista and Fungi

Note: Domain Eukarya originates from the word *Eukaryotic* meaning to have a *nucleus*.

NOTE: *Domains are the largest group of classification. Kingdoms are just below domains.*

Characteristics of Kingdoms

- **Kingdom Plantae** organisms are:
 - Multicellular
 - Contain specialized tissues and cells.
 - Photosynthetic
 - Autotrophic (capable of making own food)
 - Non-motile or sessile (non moving)
 - Eukaryotic
 - Reproduce sexually and asexually.
 - Cell walls composed of ***Cellulose***
 - ***Cellulose*** – glucose based material found in cell wall of plants.
 - Divided into two groups:
 - ***Non – flowering plants***
 - ***Flowering plants***

- **Kingdom Animalia** organisms are:
 - Multicellular
 - Contain specialized tissues and cells.
 - Heterotrophic (must obtain food from outside sources).
 - Motile
 - Eukaryotic
 - Reproduce sexually (higher animals) and asexually (lower animals)
 - Divided into TWO groups according to presence or absence of a backbone:
 - **Invertebrates** : Without backbone
 - **Vertebrates** : With a backbone

- **Kingdom Fungi** organisms are:
 - Unicellular or Multicellular
 - Heterotrophic (obtain food by absorption)
 - Non motile
 - Reproduction is both sexual and asexual
 - Saprophytic or parasitic
 - Made up of Hyphae/mycelium
 - Mycelium = a mass of hyphae
 - Eukaryotic
 - Cell walls composed of ***chitin***
 - ***Chitin*** – skeletal – like material found in the cell walls of fungi.

Ex: Unicellular = yeast, multicellular = mushroom

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- **Kingdom Protista** organisms are:
 - Unicellular (one cell)
 - Colonial (living in groups) or multicellular
 - Autotrophic (euglena) and heterotrophic (by ingestion)
 - Some are motile
 - Eukaryotic

Ex: Paramecium, Euglena, Volvox, Amoeba

 - **Kingdom Bacteria or Monera** organisms are:
 - Unicellular
 - Reproduction is asexual
 - Cell walls composed of *peptidoglycan*
 - Prokaryotic (no true nucleus present)
 - Some are Saprophytic or Parasitic
 - Saprophytic = feeding on dead substances
 - Parasitic = feeding on living organisms.
 - Autotrophic (cyanobacteria) or heterotrophic.
 - Microscopic
 - Nonmotile and motile
 - Motility accomplished by means of a *flagellum*.
 - Found in THREE shapes:
 - **Round** = Coccus (cocci - plural)
 - **Spiral** = Spirillus (Spirilli – plural)
 - **Rod** = Bacillus (bacilli – plural)

 - **Kingdom Archaea or Archaeobacteria**
 - Similar to bacteria
 - Survive in *extreme* environments. (volcanoes, hot springs, ocean vents)
 - Biochemically and genetically different than bacteria
 - Has same shapes as other bacteria
 - Found as three types:
 - Methanogens = Producers of methane.
 - Halophiles = “salt loving” bacteria
 - Thermophiles = “heat loving” bacteria

Modern Taxonomy

Modern Taxonomy

Taxonomy done today. The sorting and grouping of organisms based upon similar characteristics.

Modern taxonomy is based upon the work of *Carolus Linnaeus*.

Carolus Linnaeus

- Swedish Botanist (1701 – 1778)
- The “Founder” of Modern Taxonomy
- Based his grouping on Structural similarities in organisms.
- Provided the following major groupings or Taxons in a *hierarchy*:
 - Kingdom (broadest group)
 - Phylum
 - Class
 - Order
 - Family
 - Genus
 - Species (most specific)
- **Taxon – A group of similar organisms based upon similar characteristics**
 - **Ex: Kingdom = a taxon**

NOTE: The more taxons two organisms have in common, the more closely related they are.

Ex:

Taxon	Human	Lynx	Daffodil
Kingdom	Animalia	Animalia	Plantae
Phylum	Chordata	Chordata	Anthophyta
Class	Mammalia	Mammalia	Monocotyledonae
Order	Primates	Carnivora	Liliales
Family	Hominidae	Felidae	Amarylidaceae
Genus	<i>Homo</i>	<i>Lynx</i>	<i>Narcissus</i>
Species	<i>sapiens</i>	<i>canadensis</i>	<i>pseudonarcissus</i>

Humans and Lynx have 3 taxons in common so they are more closely related.

Notes about Linneaus' Hierarchy

- Kingdom – Contains a group of related *phyla*
- Phylum - Contains a group of related *classes*
- Class - Contains a group of related *orders*
- Order - Contains a group of related *families*
- Family - Contains a group of related *genuses*
- Genus - Contains a group of related *species*
- Species - Contains a group of related *organisms are that are able to interbreed and produce fertile offspring*

Binomial Nomenclature

- A system of providing a ***Scientific Name*** for an organism.
- Invented by **Linneaus**

A Scientific Name

- Made up of the ***Genus*** and ***Species*** names of an organism.
- Genus name is ALWAYS Capitalized.
- Species name is **never** capitalized.
- Both names are *Italicized*.
- Genus name can be abbreviated.
 - Ex: *Canis lupus* – Scientific name of the Wolf
 - Ex: *D. melanogaster* – Scientific name of Drosophila fly

Dichotomous Keys

Dichotomous Key

An identification key used by scientists to name and group organisms.
Dichotomous keys are used to ***classify*** organisms.

A dichotomous key is composed of a series of paired statements (called a couplet) containing **opposing choices**.

Ex: 1a. Organism has wings go to 2
1b. Organism does NOT have wings go to 3

Note: A dichotomous key **should** move from the general to the specific.

Common Names versus Scientific Names

Common Name: Name commonly used for an organism. Ex: dog

Why are scientific names used rather than common names?

- **Common names are NOT precise.**
 - Ex: The word cat can describe many kinds of cats not just the domestic cat.
- **Common names can give misleading information.**
 - Using the name fish for an organism such as a starfish is not accurate.
 - Starfish are not fish!!!

Modern Techniques of Classification

Today, scientists use the following techniques to help them classify and identify organisms.

- A. Evidence from the Fossil Record (Radioactive Dating)
- B. Evidence from Anatomy (Comparative Structural Anatomy)
- C. Evidence from Embryonic Development (Comparative Embryology)
- D. Evidence from Biochemistry (Amino Acids)
- E. Evidence from DNA (DNA sequencing)
- F. Metabolic Behaviour
- G. Phylogeny
- H. Cladistics

Why do scientists use these techniques?

Biologists use these techniques to classify organisms on the basis of their similarity and the existence of a common ancestor.

NOTE: A common ancestor would suggest that similar organisms are related.

A. Evidence from the Fossil Record

Scientists use **Carbon Dating** (uses radioactive isotope → C-14) to find the **ages of organisms**. Carbon dating can tell the age of an organism up to 50000 yrs ago.

The age of an organism can help tell if it was an ancestor of some species.

Ex: Archaeopteryx is believed to be an ancestor of today's birds.

B. Evidence from Anatomy (Comparative Structural Anatomy)

Structural anatomy is the comparison of bones found in certain animals to suggest a common ancestor.

Looks at the Homologous (similar) structures of differing organisms that would indicate a similar evolutionary origin.

Ex: Human arm, Bat wing, Horse's leg and whale flipper are all similar suggesting a common ancestor. Thus, these organisms may be related.

C. Evidence from Embryonic Development (Comparative Embryology)

Comparative embryology is the comparison of early embryos of organisms to suggest a common ancestor.

Ex: Embryos of tunicates have structures similar to tadpole embryos (flexible notochord, long dorsal nerve cord (spinal cord)).

This would suggest that these organisms have a common ancestor. They are classified with other vertebrates (presence of a back bone).

D. Evidence from Biochemistry

Biochemical techniques that look at the arrangement of Amino Acids.

Amino Acid: the basic building block of proteins

Similar Amino acid patterns/sequences would suggest the organisms are related or share a common ancestor.

Ex: Human blood and baboon blood are very close in amino acid sequence. Therefore humans, for example, are more closely related to baboons than they are horses.

E. Evidence from DNA

DNA – Deoxyribonucleic Acid (the molecule that determines the genetic makeup of an organism).

DNA analysis maps out the genetic sequencing of an organism.

___ The closer the DNA sequences of two organisms, the more closely related they are.

F. Evidence from Metabolic Behaviour

The ability to digest certain substances or if an organism is a producer, consumer or decomposer can be used to classify organisms.

G. Phylogeny

Phylogeny - The evolutionary history of an organism.

Phylogeny is used to trace the history of an organism to help classify it. An organism is classified using a *Phylogenic Tree*.

Phylogenic tree (similar to family trees)

A tree that shows the relationships among various organisms. It is a hypothesis about the evolutionary relationships among organisms.

Looking at Phylogenetic Trees

The root of the tree suggests a common ancestor. All organisms above the root share some part of the characteristics of the common ancestor. These are called *Primitive Characteristics*.

Primitive Characteristics: Characteristics originally present in a common ancestor that have been passed on to other organisms.

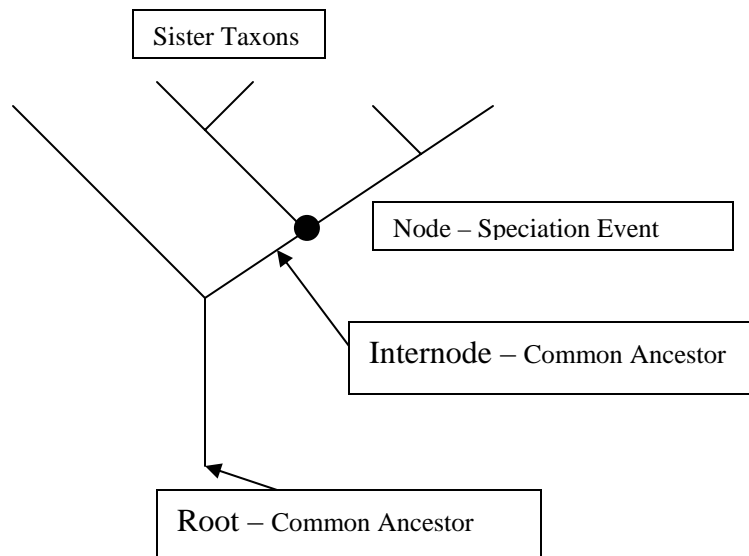
Branches in the tree suggest New Species that have evolved. Each species that has evolved would have new features called *Derived Characteristics*.

Derived Characteristics: These are **new** characteristics that have evolved in an organism as the organism has adapted to its environment etc.

H. Cladistics

Cladistics: A classification system based upon phylogeny. Based upon the idea that there is a common ancestor and new species gain derived characteristics.

Cladograms – Branching diagrams used to trace the evolutionary history of organisms and to then classify them.



Speciation Event: The separation of organisms into different groups or species.

Internode: A common ancestor to any branches above it.

Root: A common ancestor to all organisms above it.

Sister Taxons: organisms that are very closely related.

Classification of Viruses

Structure of Viruses

- **ALL** viruses are composed of:
 - Strands of genetic material (**DNA or RNA**) surrounded by a **Protein** coat called a **CAPSID**.
 - Viruses containing RNA are called **Retroviruses**.

Characteristics of Viruses

- No cellular structure
 - No cytoplasm, organelles or membranes
- Not able to grow or reproduce independently
- Not able to exchange gases(respire) independently
- Act as parasites
- Rely on **HOST** cell for survival

Note: These characteristics prove that viruses are Nonliving.

Viral Reproduction

Viruses reproduce via **TWO METHODS**.

- a. The Lytic Cycle
- b. The Lysogenic or Provirus Cycle

A. The Lytic Cycle (Ex: T4 Bacteriophage)

- A short cycle – about 30 minutes
- Produces up to 200 viruses
- Virus injects its DNA/RNA into a host cell.
- Genetic material of virus takes over machinery of cell and produces new viral cells.
- **HOST CELL IS DESTROYED.**

The Five (5) stages of the Lytic Cycle

- a. Attachment – The virus attaches itself to the host's cell wall.
- b. Entry – The virus injects its DNA/RNA into the host cell.
- c. Replication – The host's cellular metabolism reproduces the viral DNA or RNA.
- d. Assembly – New viral particles are made by the host cell's machinery (protein synthesis).
- e. Lysis or Release – The host cell's plasma membrane and cell wall break open releasing new viruses. The host cell dies.

B. The Provirus or Lysogenic Cycle

- Viral DNA/RNA enters cell and becomes part of cell's DNA. (Called a provirus when this happens)
- Viral DNA is reproduced with cell DNA.
- Viral DNA can exist in this form for years without harm to host cell.
- When active, the provirus separates from host cell DNA and undergoes Lytic cycle.
- Host cell is NOT usually destroyed.

EX: HIV, Herpes

NOTE: Viruses are classified on the basis of the TYPE OF DISEASE they cause.