

Al-Mustaqbal University

College of Engineering and Technologies

Biomedical Engineering Department



Biology

Lecture: 1

Introduction to Biology

(Definition, sub-disciplines, life processes, and Hierarchal system)

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Introduction to Biology

Introduction

This module chapter is to familiarize with basic concepts of biological science, the nature and origin of life, scientific methods and the subject matter of biology.

Learning Objectives: After completing this chapter you will be expected to:

- ✓ define the term biology
- ✓ explain scientific methods
- ✓ know the origin and the nature of life

The meaning and scope of biology

Biology: is the study of life and living organisms, it is derivative from The Greek word „**bio**“ means life and „**logos**“ means study of. In the late 1700s Pierre-Antoine de Monet and Jean-Baptiste de Lamarck coined the term biology. Earlier study of living things was restricted to the pure Science like **Botany** and **Zoology** that together comprise the **Biology**. But as the time passed new branches evolved. New technologies developed in pure subjects as well as in applied fields, which gave rise to a very broad concept of science called Biological Sciences. **Biological Sciences:** is an extensive study covering the minute workings of chemical substances inside living cells to the broad scale concepts of ecosystems and global environmental changes.

Theories on Origin of life

Several attempts have been made from time to time to explain the origin of life on earth. As a result, there are several theories which offer their own explanation on the possible mechanism of origin of life. Following are some of them:

1. Theory of Special Creation: according to this theory, all the different forms of life that occur today on planet earth have been created by God, the almighty.

Theory of Spontaneous Generation: this theory assumed that living organisms could arise suddenly and spontaneously from any kind of non-living matter. One of the firm believers in spontaneous generation was Aristotle, the Greek philosopher (384-322 BC).

2. Theory of Catastrophism: It is simply a modification of the theory of Special Creation. It states that there have been several creations of life by God, each preceded by a catastrophe resulting from some kind of geological disturbance. According to this theory, since each catastrophe completely destroyed the existing life, each new creation consisted of life form different from that of previous ones.

3. Cosmozoic Theory: according to this theory, life has reached this planet Earth from other heavenly bodies such as meteorites, in the form of highly resistance spores of some organisms. This idea was proposed by Richter in 1865 and supported by Arrhenius (1908) and other contemporary scientists. The theory did not gain any support. This theory lacks evidence, hence it was discarded.

4. Theory of Chemical Evolution: this theory is also known as Materialistic Theory or Physico-chemical Theory. According this theory, Origin of life on earth is the result of a slow and gradual process of

chemical evolution that probably occurred about 3.8 billion years ago. This theory was proposed independently by two scientists - A.I.Oparin, a Russian scientist in 1923 and J.B.S Haldane, an English scientist, in 1928.

Sub- disciplines or Branches of Biology

Biology encompasses various sub-disciplines or branches. Some of the branches of biology are as follows:

- **Anatomy:** the study of the animal form, particularly the human body.
- **Biochemistry:** the study of the structure and function of cellular components, such as proteins, carbohydrates, lipids, nucleic acids, and other biomolecules, and of their functions and transformations during life processes.
- **Botany:** the scientific study of plants.
- **Cell biology:** the study of cells at the microscopic or at the molecular level. It includes studying the cells' physiological properties, structures, organelles, interactions with their environment, life cycle, cell division, and apoptosis.
- **Ecology:** the scientific study of the relationships between plants, animals, and their environment.
- **Genetics:** a science that deals with heredity, especially the mechanisms of hereditary transmission and the variation of inherited characteristics among similar or related organisms.
- **Immunobiology:** a study of the structure and function of the immune system, innate and acquired immunity, the bodily distinction of self from non-self, and laboratory techniques involving the interaction of antigens with specific antibodies.
- **Microbiology:** the branch of biology that deals with microorganisms and their effects on other living organisms.

- **Molecular Biology:** the branch of biology that deals with the formation, structure, and function of macromolecules essential to life, such as nucleic acids and proteins, and especially with their role in cell replication and the transmission of genetic information.
- **Mycology:** the study of fungi.
- **Neurobiology:** the branch of biology that deals with the anatomy, physiology, and pathology of the nervous system.
- **Parasitology:** the study of parasites and parasitism.
- **Pathology:** the study of the nature of the disease and its causes, processes, development, and consequences.
- **Physiology:** the biological study of the functions of living organisms and their parts.
- **Psychobiology:** the study of mental functioning and behavior in relation to other biological processes.
- **Toxicology:** the study of how natural or man-made poisons cause undesirable effects in living organisms.
- **Virology:** the study of viruses.
- **Zoology:** The branch of biology that deals with animals and animal life, including the study of the structure, physiology, development, and classification of animals.
- **Entomology:** the scientific study of insects.
- **Ichthyology:** the study of fishes.
- **Herpetology:** the science of reptiles and amphibians.
- **Ornithology:** the science of birds.
- **Mammalogy:** the study of mammals.
- **Primatology:** the science that deals with primates.

Human biology: is the branch of biology that focuses on humans in terms of evolution, genetics, anatomy and physiology, ecology, and

epidemiology. It can be a subfield of Primatology since humans belong to the group of primates, particularly of the family Hominidae (Species: *Homo sapiens*).

Life processes in animals & plants

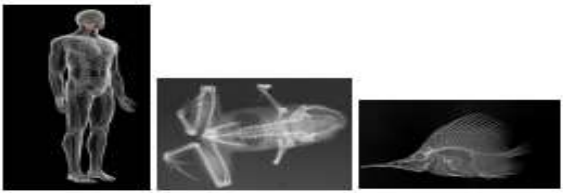


Life Processes: are the series of actions that are essential to determine if an animal is alive.

What are the Life Processes?

There are seven essential processes in common: movement, respiration, sensitivity, growth, reproduction, excretion and nutrition.

1. Movement

- Animals do this to look for food and shelter, and to escape from danger. They can move because their bodies are supported by:

Type	Features	Examples
Endoskeleton	<ul style="list-style-type: none"> • Bones/Cartilage are inside • Grows as animals grow 	
Exoskeleton	<ul style="list-style-type: none"> • Hard outer shells • Does not grow • Shed and replaced 	
Hydrostatic	<ul style="list-style-type: none"> • No bones • Internal fluids held within body 	

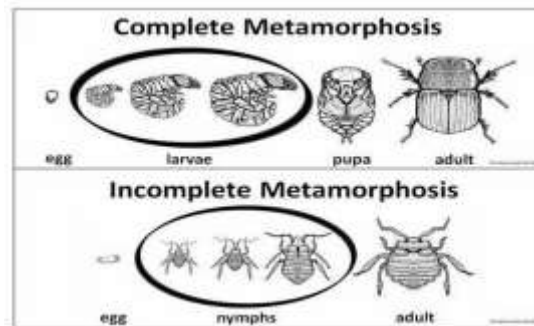
- Plants move towards sunlight, roots grow into the soil. They move slower than animals.

2. Reproduction



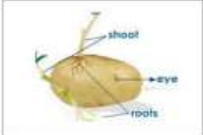
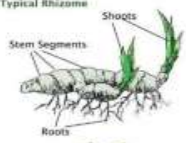
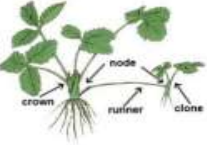
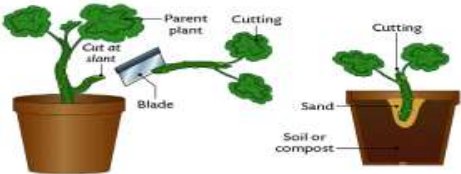
Living things do this so that they will not become extinct.

- Animals can reproduce by:
 - Giving birth.
 - Laying eggs.
 - asexual reproduction (e.g. Hydra jelly fish sprout babies like buds growing from parent's body).

Baby animals can resemble mini adults or some will undergo partial/complete metamorphosis.



- Plants grow from:

<ul style="list-style-type: none"> • Seeds 	<ul style="list-style-type: none"> • Spores (ferns & mosses) 
<ul style="list-style-type: none"> • Asexual <ul style="list-style-type: none"> ○ tubers (potatoes)  ○ rhizomes (onions, ginger);  ○ runners (strawberries)  	<ul style="list-style-type: none"> • Plant grafting & budding. 

3. Sensitivity

Living things notice and react/respond to changes around them.

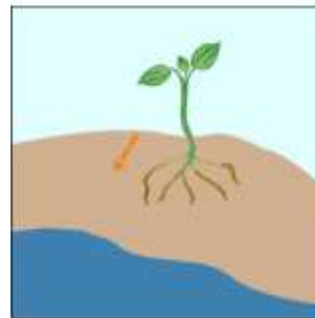
- Animals use their five senses:

- Sight (eyes)
- Hearing (ears)
- Smell (nose)
- Touch (skin, feelers)
- Taste (tongue).



- Plants are also sensitive to their surroundings:

- Gear towards sunlight and water



- Respond to touch (e.g. the Venus Flytrap & Mimosa).



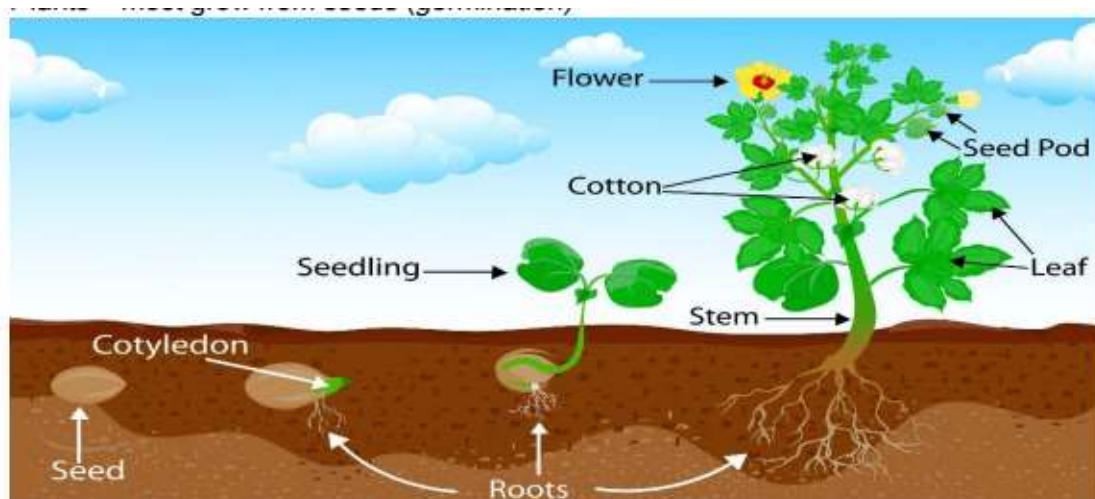
4. Growth

A living thing gets bigger, taller and heavier over time.

- Animals grow at a fairly steady pace until they reach adulthood. Every day as they get older their bodies are changing. Their skeleton grows with them, each bone getting bigger over time.

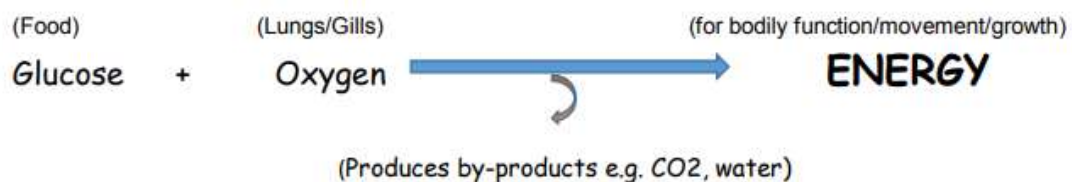
Arthropods - insects, spiders, crabs and other animals with external skeletons – grow by shedding their skeleton and grow a new one!

- Plants: most grow from seeds (germination)



5. Respiration

- The process by which nutrients taken in are converted to energy. Respiration is a chemical reaction and occurs in every cell in living things.



- Plants respire all the time because their cells need energy to stay alive, but plants can only photosynthesize when they are in the light.

* respiration is the opposite of photosynthesis.

Time of day	Photosynthesis	Respiration
Day	Active	Active
Night	None	Active

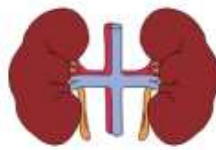
6. Excretion

The process by which waste materials produced by the body are removed.

- In animals, excretion gets rid of carbon dioxide, water and harmful substances (the by-products of respiration) from your body.



Excrete carbon dioxide as you breathe out.



Filter out nasties to produce urine, removing nitrogen waste from your body.



Sheds excess salt through sweat.

Types of Human Excretion

- Plants break down waste products at a much slower pace than animals.

During:

- Respiration (night) \longrightarrow Carbon dioxide (stomata and root cell walls) + Water (*transpiration) (tips of the leaves)
- Photosynthesis (day) \longrightarrow Oxygen (stomata, root cell walls and other routes)

Other plant wastes include resins, saps, latex and tannins (released into the soil surrounding the plant; leaves and flowers fall off of a plant).



Types of Plant Excretion

7. Nutrition

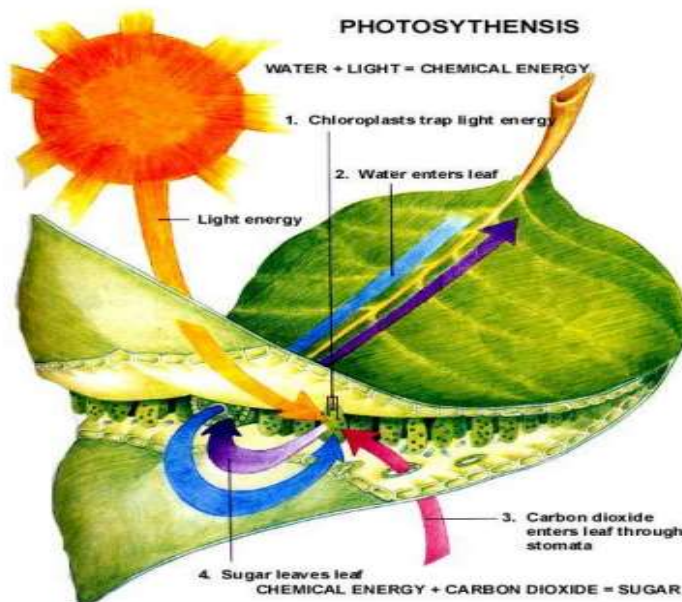
- Animals get nutrients to survive:
 - From food and water
 - By hunting.

Animals can be categorized into the type food they eat:

Carnivores Eat only meat	Herbivores Eat only plant sources	Omnivores Eat both meat and plants
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- Plants ‘make’ own food get nutrients by:
 - absorbing them from the soil
 - forming sugars through photosynthesis.

Photosynthesis = light energy + carbon dioxide and water $\xrightarrow{\text{convert into}}$ sugar.
 (+ pigment Chlorophyll) (sun)



Photosynthesis

How can we tell living things from non-living things?

By investigating whether it undergoes ALL life processes. Living things are made up of cells and regulate internal conditions e.g. body temperature (homeostasis).

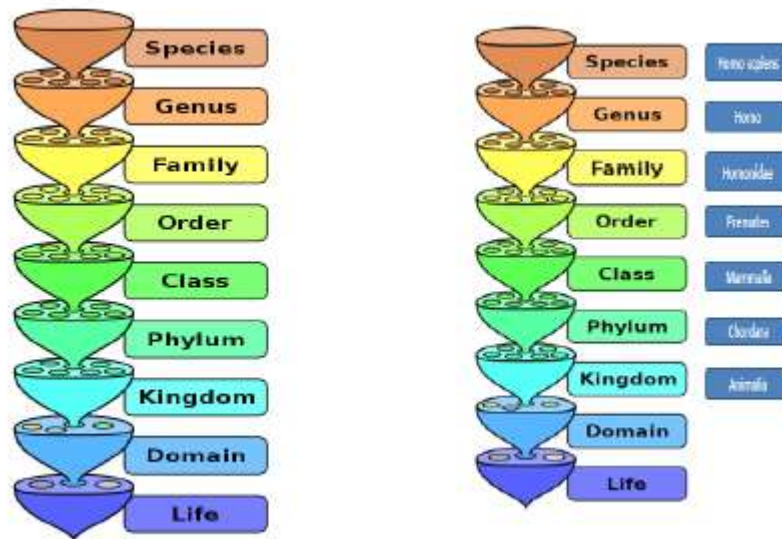


Taxonomy

Taxonomy: (which literally means “arrangement law”) is the science of classifying organisms to construct internationally shared classification systems with each organism placed into more and more inclusive groupings. This arrangement from larger to smaller is called a **hierarchical system**.

In the eighteenth century, a scientist named **Carl Linnaeus** first proposed organizing the known species of organisms into a hierarchical taxonomy. In this system, species that are most similar to each other are put together within a grouping known as a genus. Furthermore, similar genera (the plural of genus) are put together within a family. This grouping continues until all organisms are collected together into groups at the highest level. The current taxonomic system now has eight levels in its hierarchy, from

lowest to highest, they are: **species, genus, family, order, class, phylum, kingdom, domain**. Thus species are grouped within genera, genera are grouped within families, families are grouped within orders, and so on.



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