1st W The science of Biology

Biology is the study of life. The word "biology" is derived from the Greek words "bios" (meaning life) and "logos" (meaning "study"). In general, biologists study the structure, function, growth, origin, evolution and distribution of living organisms.

Biology is important because it helps us understand how living things work and how they function and interact on multiple levels. Advances in biology have helped scientists do things such as develop better medicines and treatments for diseases, understand how a changing environment might affect plants and animals, produce enough food for a growing human population and predict how eating new food or sticking to an exercise regimen might affect our bodies.

The science which deals with the study of living objects and their life processes is called biology (Greek words, bios – life, logos – study). It covers all aspect of the study of living creatures like occurrence, classification, ecology, economic importance, external form, organization, internal structure, nutrition, health and other body functions, reproduction, life history, inheritance and origin. Being broad – based and multi- disciplinary, the term biology is often replaced by the term life sciences or biological sciences. Aristotle is known as the 'Father of biology'. The term biology was coined by Lamarck.

There are three major branches of biology – botany, zoology and microbiology. **Botany** is the branch of biology which deals with the study of different aspects of plants. **Theophrastus** is known as the father of Botany. **Zoology** is the branch of biology connected with the study of different aspects of animals. Aristotle is known as the father of Zoology. **Microbiology** is the branch of biology dealing with the study of different aspects of microorganism. **Leeuwenhoek** is known as the father of Microbiology.

MAIN BRANCHES OF BIOLOGY

Some of the main branches of biology are briefly discussed below:

1. **Taxonomy: I**t is the science of identification, nomenclature and classification of organisms.
2. **Morphology:** It is the study of external form, size, shape, colour, structure and relative position of various living organ of living beings.
3. **Anatomy:** It is the study of internal structure which can be observed with unaided eye after dissection.
4. **Histology:** It is the study of tissue organization and structure as observed through light microscope.
5. **Cytology:** It is the study of form and structure of cells including the behavior of nucleus and other organelles.
6. **Cell Biology:** It is the study of morphological, organizational, biochemical, physiological, genetic, developmental, pathological and evolutionary aspects of cell and its components.
7. **Molecular Biology:** It is the study of the nature, physicochemical organization, synthesis working and interaction of bio-molecules that bring about and control various activities of the protoplasm.
8. **Physiology:** It is the study of different types of body functions and processes.
9. **Embryology:** It is the study of fertilization, growth, division and differentiation of the zygote into embryo or early development of living beings before the attainment of structure and size of the offspring.
10. **Ecology:** It is the study of living organisms is relation to other organism and their environment.
11. **Genetics:** It is the study of inheritance of characters or heredity and variations. Heredity is the study of expression and transmission of traits from parents to offspring.

12. Evolution: It studies the origin of life as well as new types of organism from the previous ones by modifications involving genetic changes and adaptations.

13. Virology: It is the study of viruses in all their aspects.

Characteristics of living organisms

Living organisms have the following characteristics in common:

- **Movement** - they can move and change their position.
- **Reproduction** – they can make more of the same kind of organism as themselves.
- **Sensitivity** – they can detect or sense stimuli and respond to them.
- **Growth** - they can permanently increase their size or dry mass by increasing the number or size of their cells.
- **Respiration** – they can create chemical reactions that break down nutrient molecules in living cells to release energy.
- **Excretion** – they can excrete toxic materials, waste products of metabolism, and excess substances (note that excretion is not the same as egestion).
    - **Nutrition** - they can take in and absorb nutrients such as organic substances and mineral ions. These nutrients contain the raw materials or energy needed for growth and tissue repair.

2nd W: Living Cell Characteristics

Cells are the basic units composing all life, essentially a "biology unit." A unicellular organism consists of a single cell, while multicellular organisms are composed of billions of cells, organized at different levels. Cells may vary in appearance and function, yet no matter how different cells may appear, there are many shared characteristics of living cells.

I-Growth and Development

Normally, cells grow to a certain size and then stop. Cells cease growing because of intrinsic and extrinsic factors.

Growth factors are proteins in the cell's environment that attach to the plasma membrane, directing cells to continue growing. Growth factors cause cells to grow without initiating cell division. Other cells in the immediate environment may secrete growth factors into the cellular environment to influence the growth of other cells, as in the case of nerve growth factor (NGF). Researchers are contemplating the use of growth factors as a means of promoting wound healing.

Cells may stop growing after the cell membrane, which envelops the cell, touches the membranes of other cells. Certain genes within the cell direct the synthesis of proteins which halt cell growth. When any of these pathways goes awry, cells grow unchecked, resulting in cancer tumor formation, according to the National Center for Biotechnology Information.

II-Homeostasis

Homeostasis denotes a constant internal environment. To survive, cells must maintain a stable environment within itself, regardless of changes outside the cell. Cell membranes allow cells to regulate the situation within cells. Certain substances must stay inside, whereas other substances must stay outside the boundaries.

Cells control the amount of water coming in and going out, to preserve the equilibrium of water inside the cell with respect to the quantity outside the cell. In the same vein, certain vital cellular processes only take place under very specific pH and temperature conditions. pH is the measure of the acidity of a substance.

Cells maintain such stability with the aid of feedback loops. In a feedback loop, a cell detects changes in the concentration of certain substances, such as sodium, and then alters the amount of these substances entering and exiting the cell by tweaking components embedded in the cell membrane.

Internal and External Cell Movement

All cells display some sort of motion, whether internally or externally. Cell movement occurs in both unicellular and multicellular organisms. Internal cell movement refers to organelles inside the cell moving to other parts of the cell with the help of the cell's internal cytoskeleton.

Many cells also move independently of one another. Cells move as a result of thin external structures such as cilia and flagella. The synchronous flapping of the many cilia propels single-celled organisms such as paramecia through liquids, while a single flagellum whips back and forth to push sperm cells forward to unite with an egg cell.

III-Cellular Reproduction

Most cells reproduce through the process of mitosis, also known as cell division. Mitosis occurs in both unicellular and multicellular organisms. Cells duplicate themselves for procreation in the case of unicellular creatures, while mitosis in multicellular organisms replaces old cells and is responsible for tissue growth.

Mitosis results in two daughter cells that have the exact genetic material of the original cell. In mitosis, the genetic material — which dictates structure and function in each cell — duplicates and the cell divides down the middle, with each new cell possessing structures identical to the original cell.

IV-Energy Use in Cells

Cells need energy to power all functions, including protein production and cell division. Energy used by cells typically takes the form of a compound called adenosine triphosphate, or ATP. In many cells, a substance called glucose, a simple type of sugar, reacts chemically with oxygen to produce ATP.

V-Anabolism and Catabolism Definition and Examples

Anabolism and catabolism are the two broad types of biochemical reactions that make up metabolism. Anabolism builds complex molecules from simpler ones, while catabolism breaks large molecules into smaller ones.

1-Anabolism Definition

Anabolism or biosynthesis is the set of biochemical reactions that construct molecules from smaller components. Anabolic reactions are endergonic, meaning they require an input of energy to progress and are not spontaneous. Typically, anabolic and catabolic reactions are coupled, with catabolism providing the activation energy for anabolism. The hydrolysis of adenosine triphosphate (ATP) powers many anabolic processes. In general, condensation and reduction reactions are the mechanisms behind anabolism.

Anabolism Examples

A metabolic pathway that can be either catabolic or anabolic depending on energy availability is called an amphibolic pathway. The glyoxylate cycle and the citric acid cycle are examples of amphibolic pathways. These cycles can either produce energy or use it, depending on cellular needs.

Anabolic reactions are those that build complex molecules from simple ones. Cells use these processes to make polymers, grow tissue, and repair damage. For example:

Glycerol reacts with fatty acids to make lipids:

$CH_2OHCH(OH)CH_2OH + C_{17}H_{35}COOH \rightarrow CH_2OHCH(OH)CH_2OOCC_{17}H_{35}$

Simple sugars combine to form disaccharides and water:

$C_6H_{12}O_6 + C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11} + H_2O$

Amino acids join together to form dipeptides:

$NH_2CHRCOOH + NH_2CHRCOOH \rightarrow NH_2CHRCONHCHRCOOH + H_2O$

Carbon dioxide and water react to form glucose and oxygen in photosynthesis:

$6CO2 + 6H2O \rightarrow C6H12O6 + 6O2$

Anabolic hormones stimulate anabolic processes. Examples of anabolic hormones include insulin, which promotes glucose absorption, and anabolic steroids, which stimulate muscle growth. Anabolic exercise is anaerobic exercise, such as weightlifting, which also builds muscle strength and mass.

2- Catabolism Definition

Catabolism is the set of biochemical reactions that break down complex molecules into simpler ones. Catabolic processes are thermodynamically favorable and spontaneous, so cells use them to generate energy or to fuel anabolism. Catabolism is exergonic, meaning it releases heat and works via hydrolysis and oxidation.

Cells can store useful raw materials in complex molecules, use catabolism to break them down, and recover the smaller molecules to build new products. For example, catabolism of proteins, lipids, nucleic acids, and polysaccharides generates amino acids, fatty acids, nucleotides, and monosaccharides, respectively. Sometimes waste products are generated, including carbon dioxide, urea, ammonia, acetic acid, and lactic acid.

Catabolism Examples

Catabolic processes are the reverse of anabolic processes. They are used to generate energy for anabolism, release small molecules for other purposes, detoxify chemicals, and regulate metabolic pathways. For example:

During cellular respiration, glucose and oxygen react to yield carbon dioxide and water

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

In cells, hydroxide peroxide decomposes into water and oxygen:

$2H_2O_2 \rightarrow 2H_2O + O2$

Many hormones act as signals to control catabolism. The catabolic hormones include adrenaline, glucagon, cortisol, melatonin, hypocretin, and cytokines. Catabolic exercise is aerobic exercise such as a cardio workout, which burns calories as fat (or muscle) is broken down.