ANNAMACHARYA
INSTITUTE OF TECHNOLOGY AND SCIENCES
(AUTONOMOUS)

Approved by AICTE, New Delhi & Permanent Affiliation to JNTUA, Anantapur.

Three B. Tech Programmes (CSE , ECE & CE) are accredited by NBA, New Delhi,Accredited by NAAC with 'A' Grade , Bangalore.

A-grade awarded by AP Knowledge Mission. Recognized under sections 2(f) & 12(B) of UGC Act 1956.

Venkatapuram Village, Renigunta Mandal, Tirupati, Andhra Pradesh-517520.

Department of Artificial Intelligence

Academic Year 2023-24

III. B.Tech I Semester
Biology for Engineers
(20AMC9901)

Prepared By

Mr. M. Murali
Assistant Professor, AITS

==========

Course Objectives: 1.To provides basic understanding about life and life Process. Animal and plant systems.
2. To understand what Biomolecules, are, their structures are functions. Application of certain Biomolecules in Industry.
3. Brief introduction about human physiology and bioengineering.
4. To understand hereditary units, i.e. DNA (genes) and RNA and their synthesis in living organism. How biology Principles can be applied in our daily life using different technologies.
5. Brief introduction to the production of transgenic microbes, Plants and animals.

Course Outcomes

After studying the course, the student will be able to:
1. Explain about cells and their structure and function. Different types of cells and basics for classification of living Organisms.
2. Explain about Biomolecules, their structure and function and their role in the living organisms. How Biomolecules are useful in Industry.
3. Briefly about human physiology.
4. Explain about genetic material, DNA, genes and RNA how they replicate, pass and preserve vital information in living Organisms.
5. Know about application of biological Principles in different technologies for the production of medicines and Pharmaceutical molecules through transgenic microbes, plants and animals.

Unit I: Introduction to Basic Biology

TOPICS

1. Evolution types and Darwin's theory,
2. Cell as Basic unit of life, cell theory, Cell shapes, Cell Structure, Cell cycle.
3. Chromosomes.
4. Prokaryotic and eukaryotic Cell.
5. Plant Cell, Animal Cell,
6. Plant tissues and Animal tissues,
7. Brief introduction to five kingdoms of classification.

Unit Outcomes:

1. After completing this unit, the student will be able to summarize the basis of life. (L1)
2. Understand the difference between lower organisms (Prokaryotes) from higher organisms (Eukaryotes). (L2)
3. Understand how organisms are classified. (L3)

Unit II: Introduction to Biomolecules

TOPICS

1. Carbohydrates,
2. Lipids, proteins,
3. Vitamins and minerals,
4. Nucleic acids (DNA and RNA) and their types.
5. Enzymes, Enzyme application in Industry. Large Scale production of enzymes by Fermentation.

Unit Outcomes:

1. After completing this unit, the student will be able to understand what are Biomolecules? Their role in living cells, their structure, function and how they are produced. (L1)
2. Interpret the relationship between the structure and function of nucleic acids. (L2)

3. Summarize the applications of enzymes in industry. (L3)
4. Understand what is fermentation and its applications of fermentation in industry (L4)

Unit III: Human Physiology

TOPICS

1. Nutrition: Nutrients or food substances.
2. Digestive system,
3. Respiratory system, (Aerobic and Anaerobic Respiration). Respiratory organs, respiratory cycle. Excretory system.

Unit Outcomes:

1 .After completing this unit, the student will be able to understand what nutrients are (L1)
2.3. Understand the mechanism and process of important human functions (L2 & L3)

Unit IV: Introduction to Molecular biology and recombinant technology

TOPICS

1. Biology and recombinant DNA Technology,
2. Prokaryotic gene and Eukaryotic gene structure.
3. DNA replication, Transcription and Translation. rDNA technology.
4. Introduction to gene cloning.

Unit Outcomes:

1. After completing this unit, the student will be able to understand and explain about gene structure and replication in prokaryotes and Eukaryotes
(L1)
2. How genetic material is replicated and also understands how RNA and proteins are synthesized.
(L2)
3. Understand about recombinant DNA technology and its application in different fields. (L3)
4. Explain what is cloning. (L4)

Unit V: Application of Biology

TOPICS

1. Brief introduction to industrial Production of Enzymes,
2. Pharmaceutical and therapeutic Proteins, Vaccines and antibodies.

3. Basics of biosensors, biochips, Bio fuels, and Bio Engineering.
4. Basics of Production of Transgenic plants and animals.

Unit Outcomes:

1. After completing this unit, the student will be able to understand. How biology is applied for production of useful products for mankind.
(L1)
2. What are biosensors, biochips etc. (L2)
3. Understand transgenic plants and animals and their production

UNIT-I

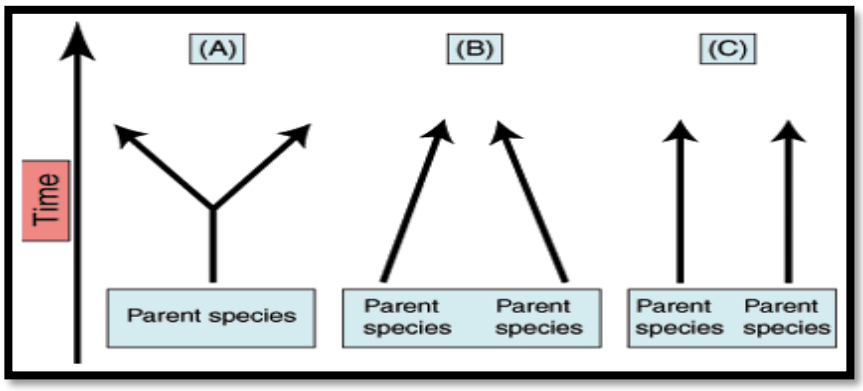
INTRODUCTION TO BASIC BIOLOGY

==========

What is evolution:- Evolution is the change in the characteristics of a species over several generations and relies on the process of natural selection. The theory of evolution is based on the idea that all species are related and gradually change over time.

Evolution relies on there being genetic variation in a population which affects the physical characteristics (phenotype) of an organism. Some of these characteristics may give the individual an advantage over other individuals which they can then pass on to their offspring.

Types of evolution:-Evolution over time can follow several different patterns. Factors such as environment and predation pressures can have different effects on the ways in which species exposed to them evolve. Shows the three main types of evolution: Divergent, Convergent and Parallel evolution.



A) Divergent B) Convergent C) Parallel

A-D ivergent Evolution:- When people hear the word "evolution," they most commonly think of divergent evolution, the evolutionary pattern in which two species gradually become increasingly

different. This type of evolution often occurs when closely related species diversify to new habitats. On a large scale, divergent evolution is responsible for the creation of the current diversity of life on earth from the first living cells. On a smaller scale, it is responsible for the evolution of humans and apes from a common primate ancestor.

B-Convergent Evolution:- Convergent evolution causes difficulties in fields of study such as comparative anatomy. Convergent evolution takes place when species of different ancestry begin to share analogous traits because of a shared environment or other selection pressure. For example, whales and fish have some similar characteristics since both had to evolve methods of moving through the same medium: water.

C-Parallel Evolution:- Parallel evolution occurs when two species evolve independently of each other, maintaining the same level of similarity. Parallel evolution usually occurs between unrelated species that do not occupy the same or similar niches in a given habitat.

Darwin's theory of evolution

Charles Darwin's theory of evolution states that evolution happens by natural selection. Individuals in a species show variation in physical characteristics. This variation is because of differences in their genes. Individuals with characteristics best suited to their environment are more likely to survive, finding food, avoiding predators and resisting disease. These individuals are more likely to reproduce and pass their genes on to their children. Individuals that are poorly adapted to their environment are less likely to survive and reproduce. Therefore their genes are less likely to be passed on to the next generation. As a consequence those individuals most suited to their environment survive and, given enough time, the species will gradually evolve.

The theory has two main points, said **Brian Richmond**, curator of human origins at the American Museum of Natural History in New York City. "All life on Earth is connected and related to each other," and this diversity of life is a product of "**modifications of populations by natural selection**, where some traits were favored in and environment over others," he said. More simply put, the theory can be described as "descent with modification," said **Briana Pobiner**, an anthropologist and educator at the Smithsonian Institution National Museum of Natural History in Washington, D.C., who specializes in the study of human origins. The theory is sometimes described as "survival of the fittest," but that can be misleading, Pobiner said. Here, "**fitness" refers not to an organism's strength or athletic ability, but rather the ability to survive and reproduce.**

For example, a study on human evolution on 1,900 students, published online in the journal Personality and Individual Differences in October 2017 found that many people may have trouble finding a mate because of rapidly changing social technological advances that are evolving faster than humans. "Nearly 1 in 2 individuals face considerable difficulties in the domain of

mating," said lead study author **Menelaos Apostolou**, an associate professor of social sciences at the University of Nicosia in Cyprus. "In most cases, these difficulties are not due to something wrong or broken, but due to people living in an environment which is very different from the environment they evolved to function in.

The cell organelles and its function

Cell is the fundamental unit of life

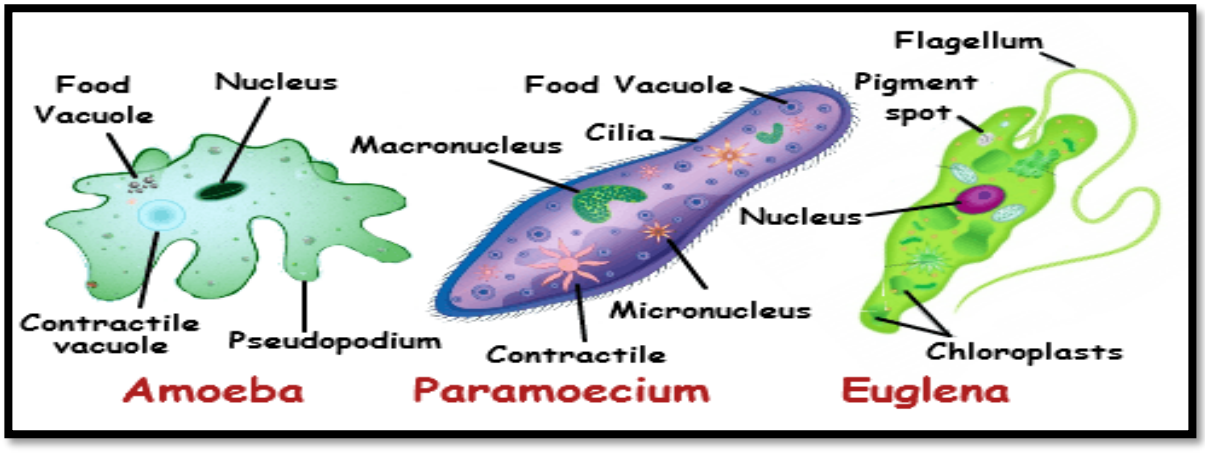
- The cell is a Latin word for "a little room".
- Robert Hook (1665) discovered Cell.
- All the living organisms are made up of cell. It is the structural and functional unit of life because whole body is made up of cells It is known as the fundamental unit of life because it regulates all the functions inside an organisms

Types of cells:-1. Unicellular 2 Multicelluar

Unicellular organisms:

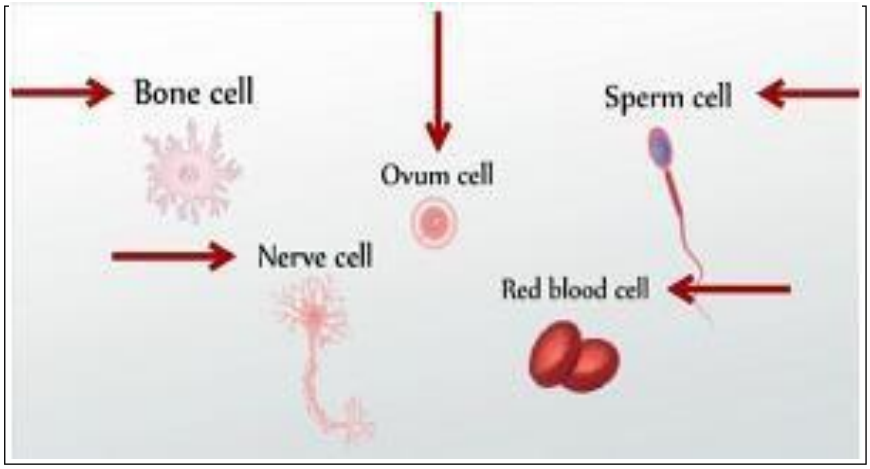
- composed of single cell
- Single cell constitute the structure and entire function of the organisms

e.g. Amoeba, Paramecium, Euglena



Multicellular organism:-composed of many cells, division of lobour can be seen in these organisms

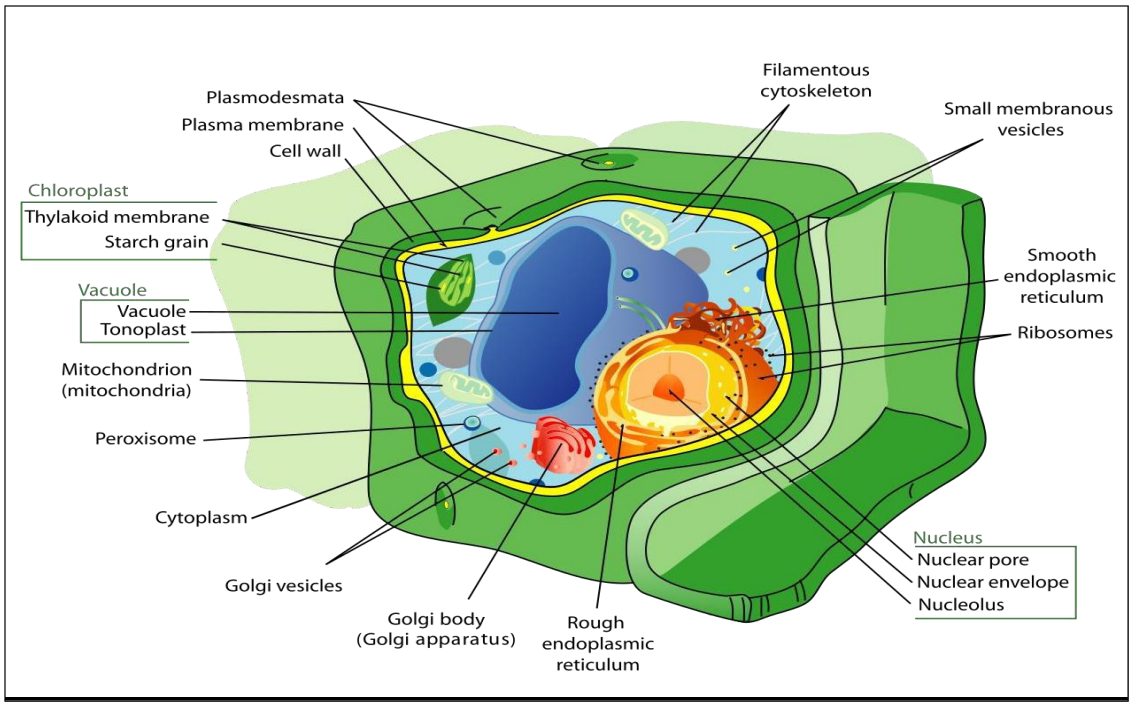
e.g. plants , animals, human beings



Cell Structure

Cells are made up of components called cell organelles. A cell is capable to live and perform all their respective functions due to the presence of cell organelles.

The structure seen in almost every cell is same: Plasma membrane, nucleus and cytoplasm**.**



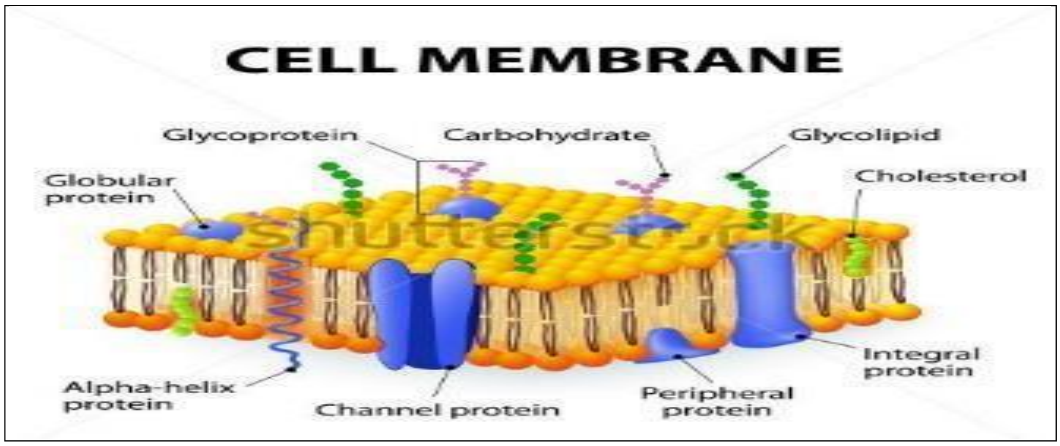
Cell Wall

- Found in plant cells outside the plasma membrane

- Rigid covering made up of cellulose
- Provide structural support to the plants

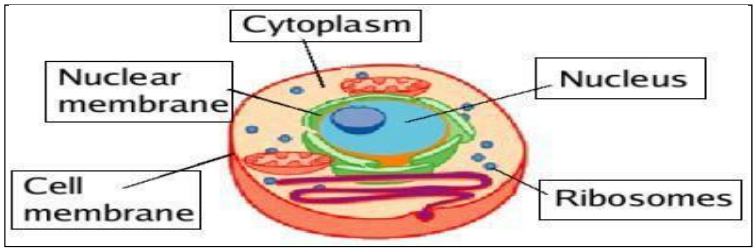
Plasma membrane and its function

- It is the outermost covering of the cell.
- It is called as selective permeable membrane (because it prevents movement of some materials).
- It helps in diffusion and osmosis
- Composed of bilayer of lipid and protein



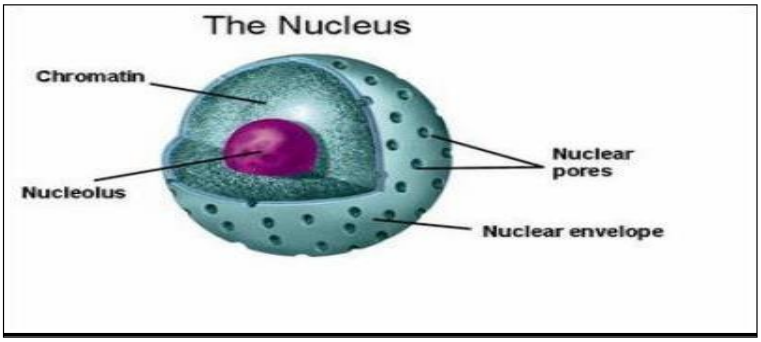
Cytoplasm

- thick solution composed of water, salts and proteins that fills the cell
- surrounded by cell membrane,
- Nucleus of the cell is surrounded by the cytoplasm



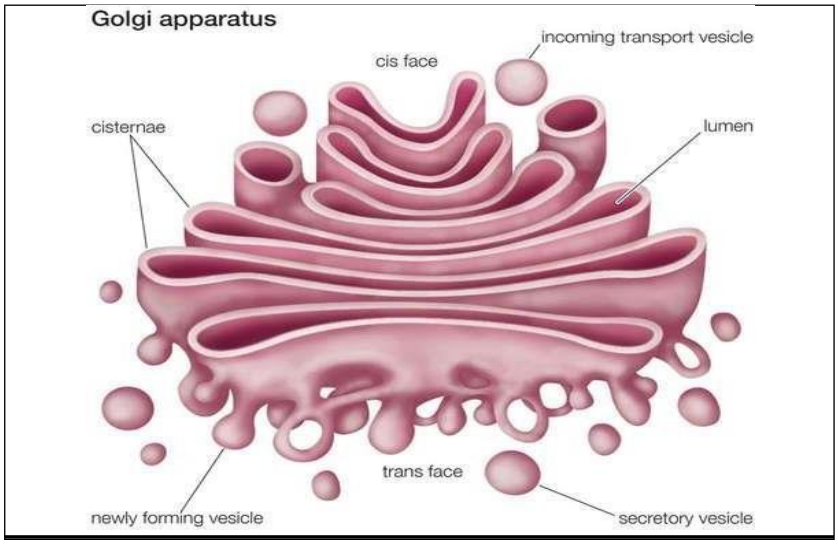
Nucleus

- Small, round and membrane bound structure near center of a cell
- Fluid inside the nucleus in called nucleoplasam
- Covered by double layer called nuclear membraneplays a central role in cellular activities/reproduction.
- Nucleus contains thread like structure called chromatin material which gets condensed into chromosomes. The chromosomes contain information for inheritance of features from parents to next generations in the form of DNA(Deoxyribo Nucleic Acid) and protein molecules.
- the functional segments of DNA are called genes



Golgi Apparatus

- First described by a scientist Camillo Golgi
- It is a system of membrane bound vesicles called cisterns
- It functions include the storage, modification and package of cell products
- The complex sugars are made from simple sugars in the Golgi apparatus
- It is also involved in the formation of lysosomes.

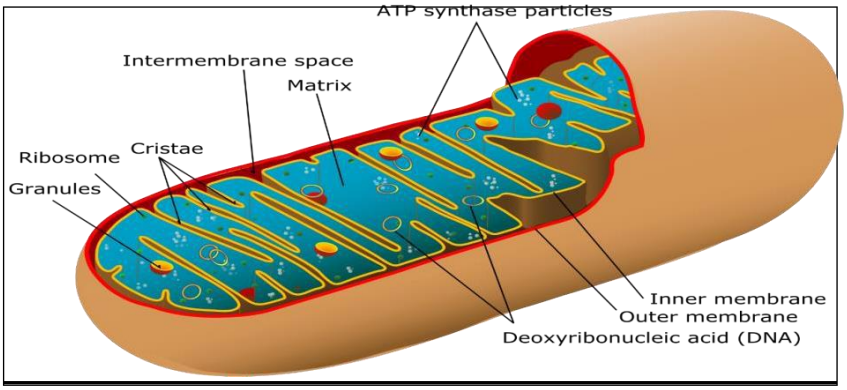


Lysosomes

- Sac like structure in a cell surrounded by membrane contain powerful digestive enzymes (enzymes are made by RER) to digest the worn-out cell organelles, bacteria etc.
- When the cell gets damaged, lysosomes may burst and the enzymes digest their own cell, hence called as "Suicidal bags of a cell". It is a waste disposal system of the cell.

Mitochondria

- It is covered by a double membrane
- Outer membrane is very porous and the inner membrane is deeply folded creating a large surface area for ATP (Adenosine Triphosphate) molecule synthesis.
- ATP is the energy currency of a cell; hence the Mitochondria are called as Power House of a Cell
- Mitochondria have their own DNA and Ribosome's therefore they can make their own proteins

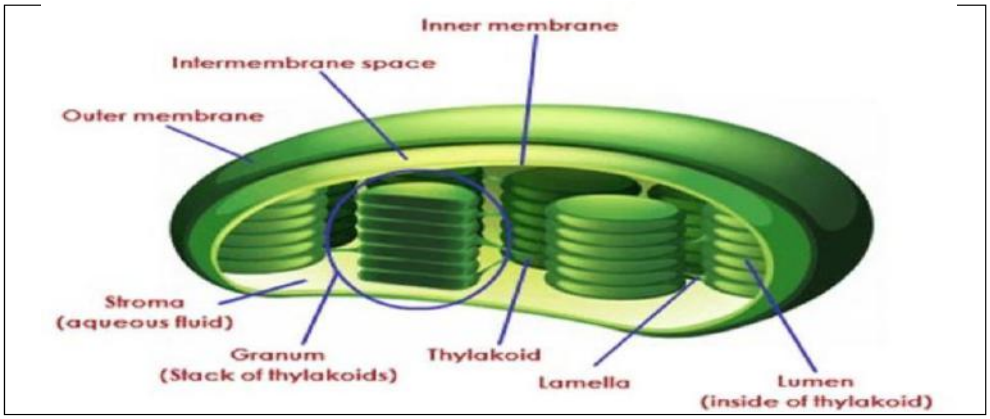


Plastids

***** Double membrane bound structure
* Present only in plant cells
* Have their own DNA and ribosome's
* Enfolding of membrane is called thylakoids and matrix is called stroma, seat for enzymatic actions

Two types:

1. Chloroplasts: - Colored Plastids: chloroplasts –contain green pigment (chlorophyll) and useful in photosynthesis; also contains various other pigments like yellow or orange
2. Leucoplasts: - White or colorless plastids; stores materials such as oils, proteins, fats etc.



Cell theory

The cell (from Latin cella, meaning "small room is the basic structural, functional, and biological unit of all known organisms. A cell is the smallest unit of life. Cells are often called the **"Building blocks of life".** The study of cells is called cell biology, cellular biology, or cytology. Cells consist of cytoplasm enclosed within a membrane, which contains many Biomolecules such as proteins and nucleic acids. Most plant and animal cells are only visible under a microscope, with dimensions between 1 and 100 micrometers. Organisms can be classified as unicellular (consisting of a single cell such as bacteria) or multicellular (including plants and animals). Most unicellular organisms are classed as microorganisms. The number of cells in plants and animals varies from species to species; it has been estimated that humans contain somewhere around 40 trillion (4×10^{13}) cells. The human brain accounts for around 80 billion of these cells. In biology, cell theory is the historic scientific theory, now universally accepted, that living organisms are made up of cells, that they are the basic structural/organizational unit of all organisms, and that all cells come from pre-existing cells. Cells are the basic unit of structure in all organisms and also the basic unit of reproduction. The three tenets to the cell theory are as described below: All living organisms are composed of one or more cells. The cell is the basic unit of structure and organization in organisms. Cells arise from pre-existing cells.

Cell shapes in prokaryotes and eukaryotes

General characteristics of prokaryotic and eukaryotic cells

Prokaryotes

1. Prokaryotes are organisms that consist of a single prokaryotic cell of the domains Bacteria and Archaea.
2. All prokaryotes have plasma membranes, cytoplasm, ribosomes, DNA, and lack 3.Membrane-bound organelles. Many also have polysaccharide capsules.

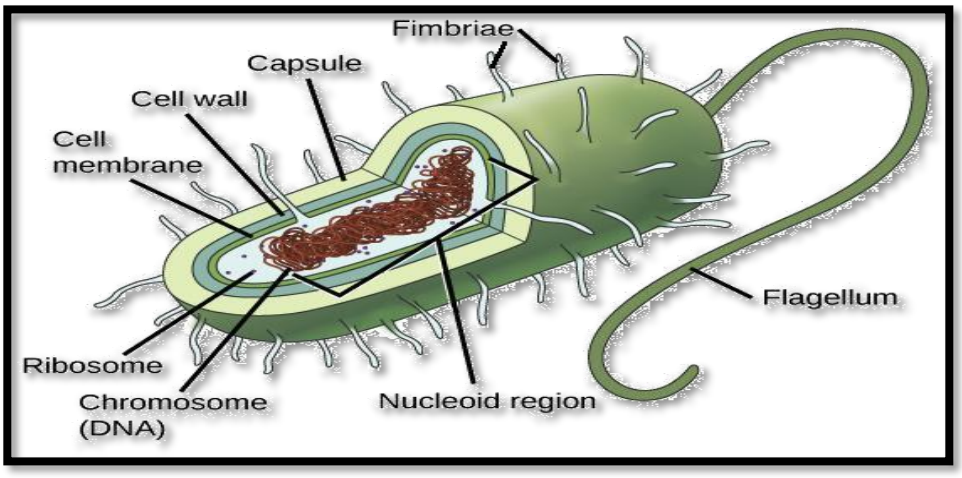
Examples of Prokaryotes:

- Escherichia Coli Bacterium (E. coli)
- Streptococcus Bacterium.
- Streptomyces Soil Bacteria.
- Archaea.

The characteristics of prokaryotic cells are:

- Membrane bound **cell organelles** such as Mitochondria, Golgi apparatus, Chloroplasts are absent.
- A membrane bound well defined nucleus is absent.
- Genetic material is circular **DNA** and occurs naked in the **cell** cytoplasm. ...

- The **cell size** ranges from 0.1 to 5.0 micrometer in size.



Eukaryotes

1. Eukaryotic cells are one or more celled organisms. Tend to be 10 to 100 times the size of prokaryotic cells.
2. Eukaryotic organisms include protozoans, algae, fungi, plants, and animals. .... The genome of eukaryotic cells is packaged in multiple, rod-**shaped** chromosomes as opposed to the single, circular-**shaped** chromosome that characterizes most prokaryotic **cells**.

Eukaryotic cells shaps:-Animal cells, plant cells, fungi, and protists are eukaryotes (eu = true). Prokaryotic cells are typically shaped as either **spheres** (called **cocci**), rods (called **bacilli**), or **spirals**.

Examples of Eukaryotic Cells:

- **Animals** such as cats and dogs have eukaryotic cells.
- **Plants** such as apple trees have eukaryotic cells.
- **Fungi** such as mushrooms have eukaryotic cells.
- Protists such as amoeba and paramecium have eukaryotic cells.
- Insects have eukaryotic cells.

What are four main characteristics of a eukaryotic cell

- a membrane-bound nucleus.
- numerous membrane-bound organelles (including the endoplasmic reticulum, Golgi apparatus, chloroplasts, and mitochondria)
- Several rod-shaped chromosomes. What are 4 differences between prokaryotic and eukaryotic cells?

Main characteristics of a eukaryotic cell and Prokaryotic Cells

Following are the substantial **difference between Prokaryotic Cells** and **Eukaryotic Cell**: ... Organelles like mitochondria, ribosomes, Golgi body, endoplasmic reticulum, **cell** wall, chloroplast, etc. are absent in **prokaryotic cells**, while these organelles are found in **eukaryotic** cells.

Prokaryotic Cell	Eukaryotic cell
Nucleus is absent	Nucleus is present
Membrane-bound nucleus absent.	Membrane-bound Nucleus is present.

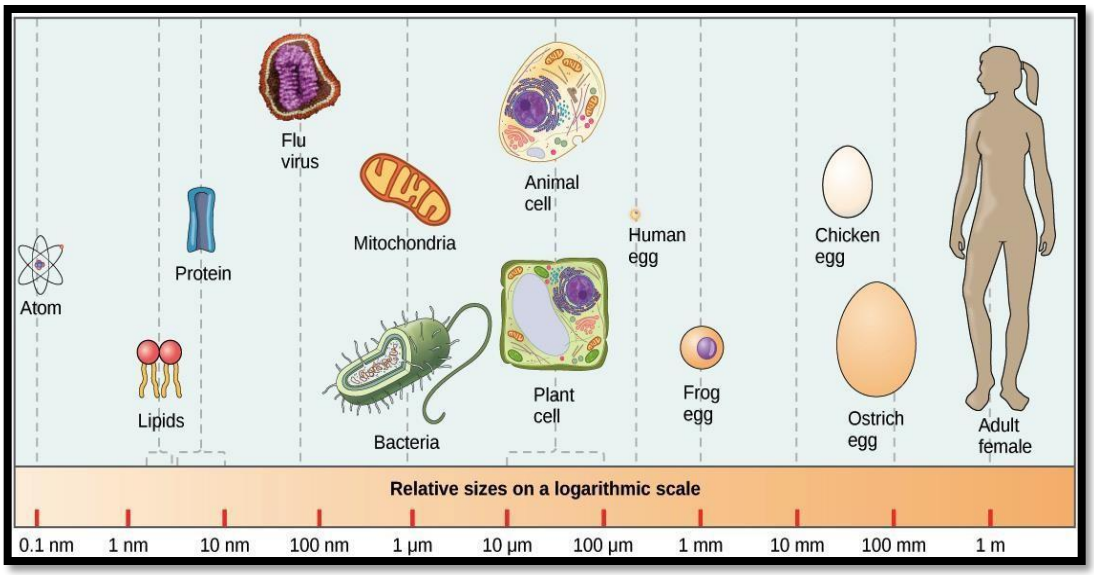
All cells share four common components:

- A plasma membrane: an outer covering that separates the cell's interior from its surrounding environment.
- Cytoplasm: a jelly-like cytosol within the cell in which other cellular components are found.
- **DNA**: the genetic **material** of the cell.
- Ribosomes: where protein synthesis occurs.

Components

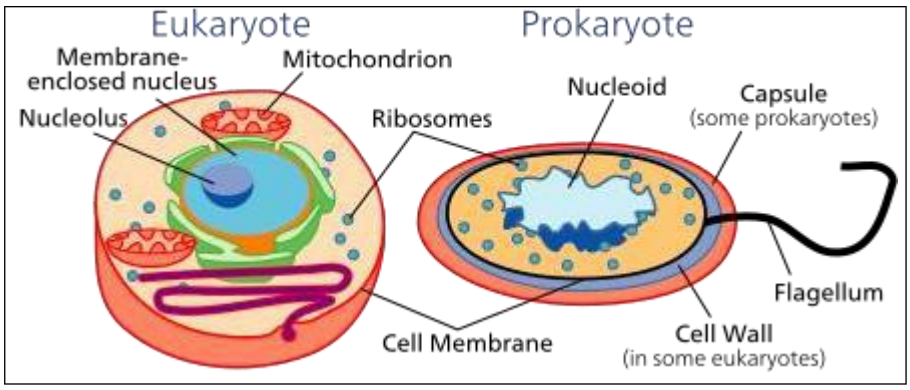
1. The **plasma membrane** is an outer covering that separates the cell's interior from its surrounding environment.
2. **Cytoplasm** consists of the jelly-like cytosol inside the cell, plus the cellular structures suspended in it. In eukaryotes, cytoplasm specifically means the region outside the nucleus but inside the plasma membrane.
3. **DNA** is the genetic material of the cell.
4. **Ribosomes** are molecular machines that synthesize proteins.

Cell size



Common Prokaryotic Cell Shapes			
Name	**Description**	**Illustration**	**Image**
Coccus (pl. cocci)	Round		
Bacillus (pl. bacilli)	Rod		
Vibrio (pl. vibrios)	Curved rod		
Coccobacillus (pl. coccobacilli)	Short rod		
Spirillum (pl. spirilla)	Spiral		
Spirochete (pl. spirochetes)	Long, loose, helical spiral		

Common Prokaryotic Cell Arrangements		
Name	**Description**	**Illustration**
Coccus (pl. cocci)	Single coccus	
Diplococcus (pl. diplococci)	Pair of two cocci	
Tetrad (pl. tetrads)	Grouping of four cells arranged in a square	
Streptococcus (pl. streptococci)	Chain of cocci	
Staphylococcus (pl. staphylococci)	Cluster of cocci	
Bacillus (pl. bacilli)	Single rod	
Streptobacillus (pl. streptobacilli)	Chain of rods	



- Cocci: spherical shape
- Bacilli: cylindrical or rod shape
- Spirilla: a curves rod long enough to form spirals
- Vibrio: a short curved rod (comma) shaped
- Spirochete: long helical shape

	Eukaryotic Cell	**Prokaryotic Cell**
Nucleus	Present	Absent (nucleoid)
Chromosomes	More than one	One - but not a true chromosome; Plasmids present
Cell Type	May be unicellular or multicellular	Unicellular

True Membrane-bound Nucleus	Present (Lysosomes, Golgi-complex, Endoplasmic Reticulum, Mitochondria, Chloroplasts)	Absent
Telomeres	Present (Linear DNA)	Circular DNA; does not need telomeres
Genetic Recombination	Mitosis, fusion of gametes	Partial, un-directional transfer of DNA
Lysosomes/Peoxisomes	Present	Absent
Microtubules	Present	Absent (rare)
Edoplasmic Reticulum	Present	Absent
Mitochondria	Present	Absent
Cytoskeleton	Present	Present
DNA associated with proteins	Yes	No
Ribosomes	Larger (80S); 70S in organelles due to symbiosis	Smaller (70S)
Vesicles	Present	Present
Golgi Apparatus	Present	Absent
Mitosis	Yes	No; binary fission
Chloroplasts	Present in plants	Absent; chlorophyll is scattered in the cytoplasm
Cell Size	10-100 µm	1-10 µm
Permeability of Nuclear Membrane	Selective	not present in cell
Cell Wall	Present on Plant and Fungi cells (chitin)	Present (peptidoglycan)

Vacuoles	Present	Present
Flagella	Present; for movement	Present; for propulsion

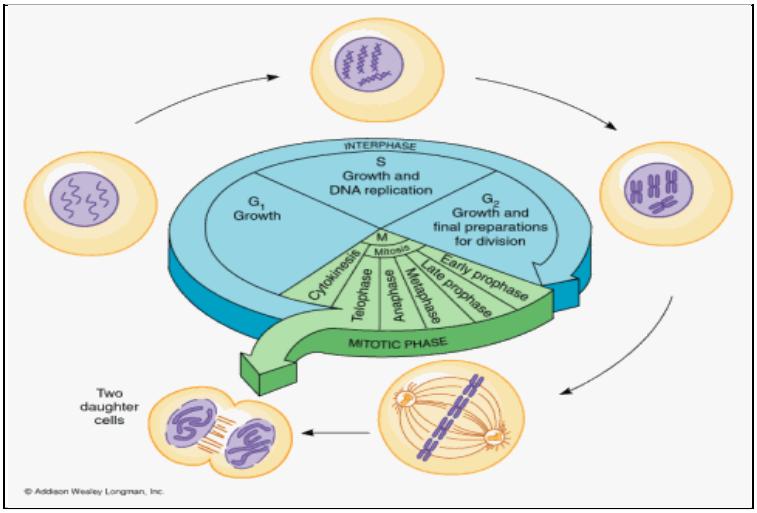
Cell cycle how the cells are divided

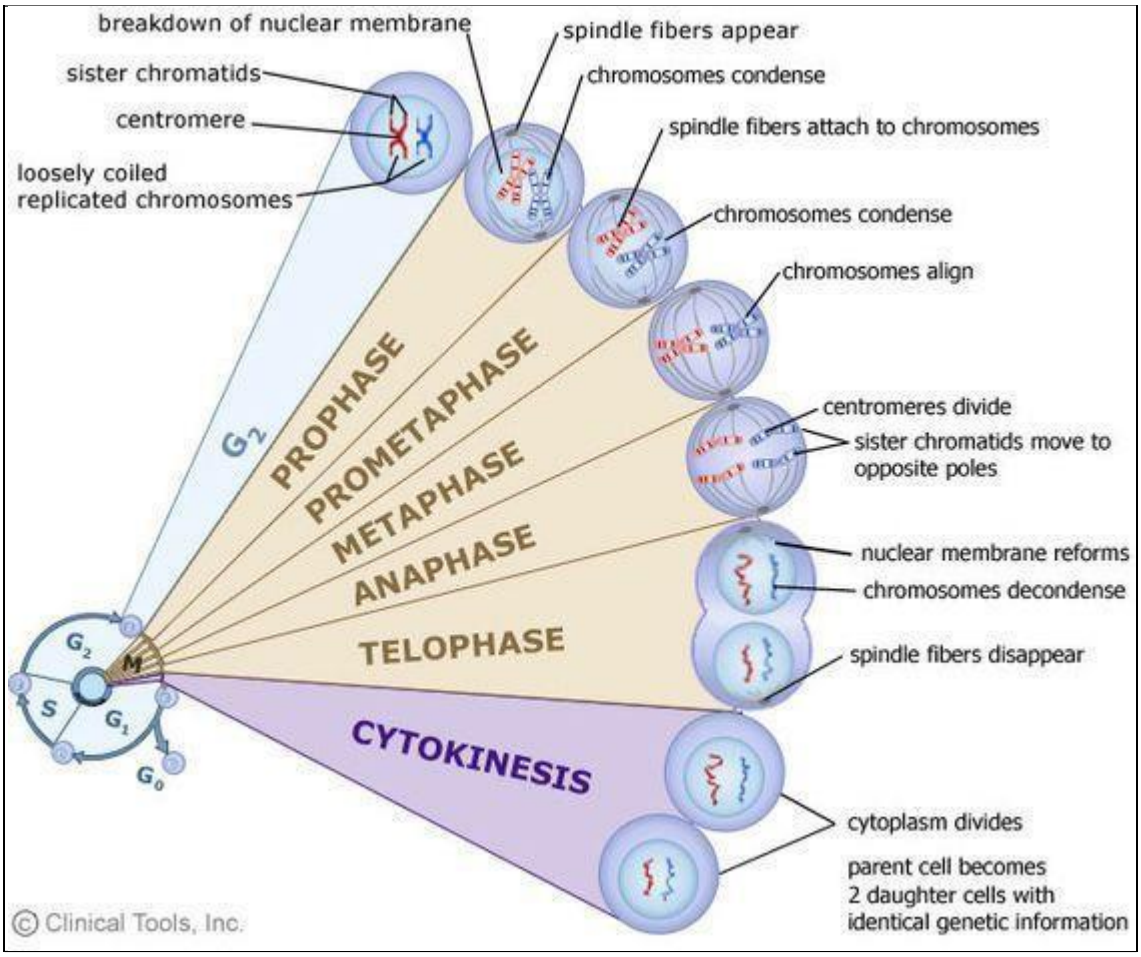
1. The eukaryotic cell cycle. Cells that are destined to divide progress through a series of stages denoted G1, S, G2, and M phases (mitosis).

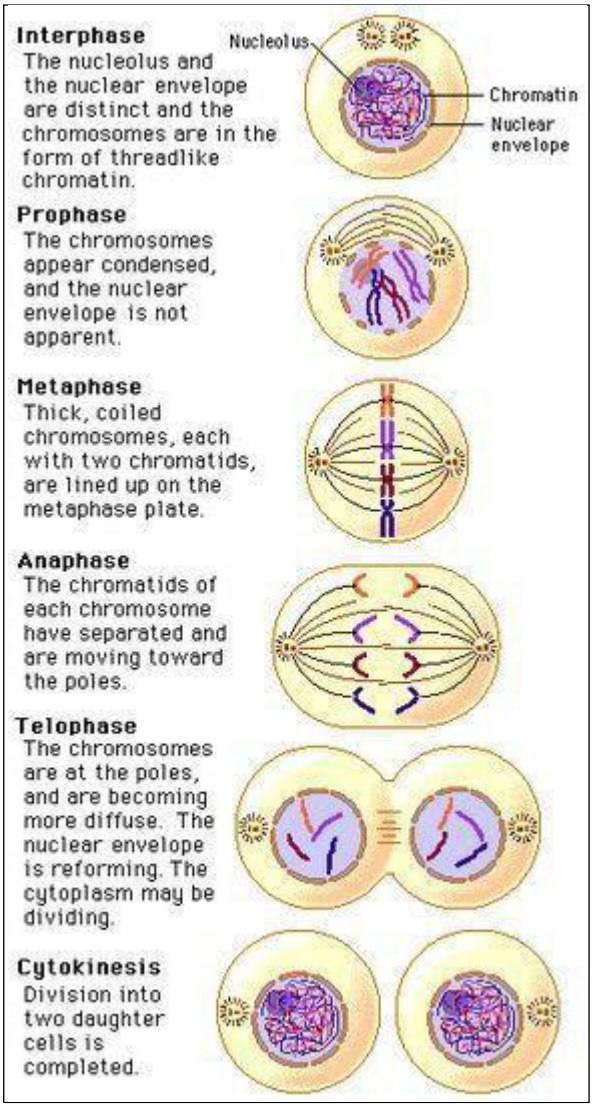
2. This diagram shows the progression of a cell through mitosis to produce two daughter cells.

3. The original diploid cell had two pairs of chromosomes, for a total of four individual chromosomes. During S phase, these have replicated to yield eight sister chromatids.

4. After mitosis is complete, there are two daughter cells each containing four chromosomes.




breakdown of nuclear membrane
spindle fibers appear
sister chromatids
chromosomes condense
centromere
spindle fibers attach to chromosomes
loosely coiled
replicated chromosomes
chromosomes condense
chromosomes align
G2
PROPHASE
PROMETAPHASE
METAPHASE
ANAPHASE
TELOPHASE
CYTOKINESIS
centromeres divide
sister chromatids move to
opposite poles
nuclear membrane reforms
chromosomes decondense
spindle fibers disappear
cytoplasm divides
parent cell becomes
2 daughter cells with
identical genetic information
G2
M
S
G1
G0
© Clinical Tools, Inc.



Chromosome and how it is divided

Chromosomes are the things that make organisms what they are. They carry all of the information used to help a cell grow, thrive, and reproduce. **Chromosomes** are made up of DNA. Segments of DNA in specific patterns are called genes. You will find the **chromosomes** and genetic material in the nucleus of a cell.

A carrier of genetic information that is visible under an ordinary light microscope. ... Generally the nucleus of a human cell contains two sets of **chromosomes**'one set given by each parent. Each set has 23 single **chromosomes**: 22 autosomes and an X or a Y sex **chromosome**.

Why do we have 46 chromosomes?

46 chromosomes in a human call, arranged in 23 pairs. These **46 chromosomes** carry the genetic information that's passed from parent to child through heredity..... This is because our **chromosomes**

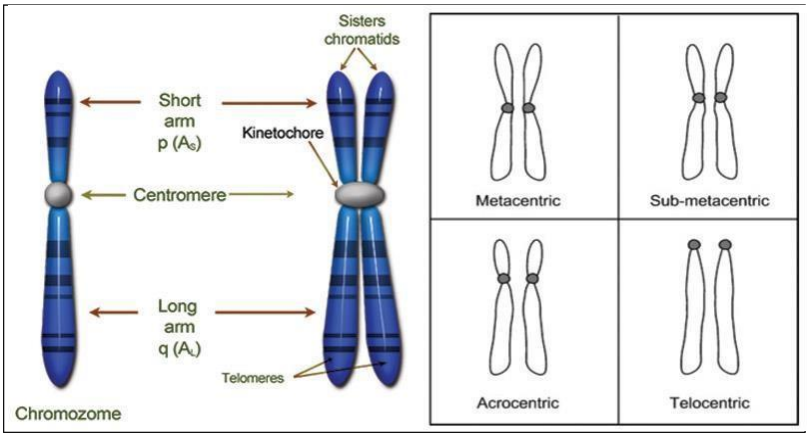
exist in matching pairs – with one **chromosome** of each pair being inherited from each biological parent.

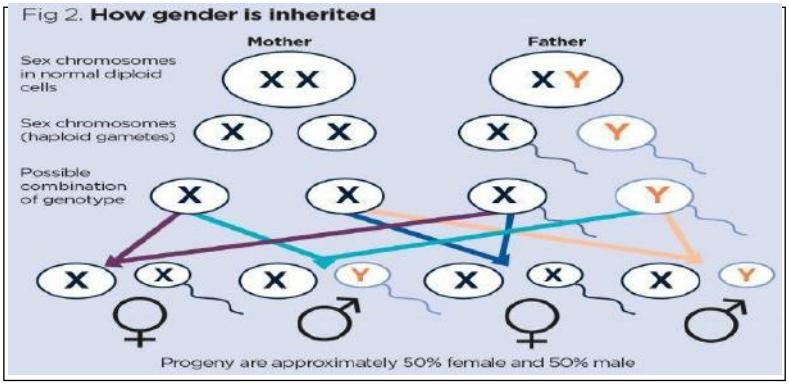
Main function of chromosomes

Chromosomes facilitate proper **cell** division and replication. The main function of the chromosome is to fit the DNA inside the nucleus. As we all know, that our DNA is too long, if we unwind all the DNA of a **cell**, it is up to 2 meters in length

2 main types of chromosomes

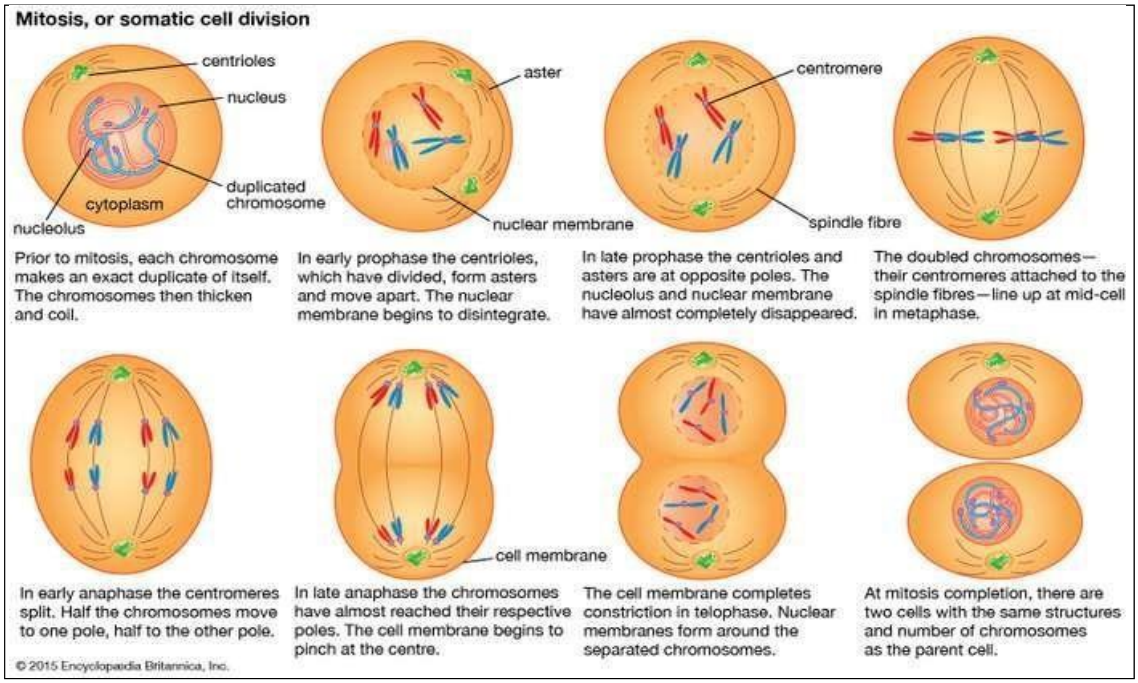
Chromosomes in **humans** can be divided into two types: autosomes (body chromosome(s)) and allosome (sex chromosome(s)). Certain genetic traits are linked to a **person's** sex and are passed on through the sex chromosomes. The autosomes contain the rest of the genetic hereditary information.





In unicellular organisms, cell division is the means of reproduction; in multicellular organisms, it is the means of tissue growth and maintenance. Survival of the eukaryotes depends upon interactions

between many cell types, and it is essential that a balanced distribution of types be maintained. This is achieved by the highly regulated process of cell proliferation. The growth and division of different cell populations are regulated in different ways, but the basic mechanisms are similar throughout multicellular organisms.



Differences between plant and animal cells

What are the three main differences between a plant and animal cell?

Major structural differences between a plant and an animal cell include: Plant cells have a cell wall, but animals cells do not. Cell walls provide support and give shape to plants. Plant cells have chloroplasts, but animal cells do not.

Differences between plant and animal cells

Cells are the basic unit of a living organism and where all life processes are carried out. **Animal cells** and **plant cells** share the common components of a nucleus, cytoplasm, mitochondria and a **cell** membrane. **Plant cells** have three extra components, a vacuole, chloroplast and a **cell** wall.

Four similarities between plant and animal cells

Structurally, **plant and animal cells** are very similar because they are both eukaryotic **cells**. They both contain membrane-bound organelles such as the nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, and peroxisomes. Both also contain similar membranes, cytosol, and cytoskeletal elements.

Are Golgi bodies in plant and animal cells

Quick look: **Golgi apparatus**(or complex, or **body**, or 'the '**Golgi**') is found in all **plant and animal cells** and is the term given to groups of flattened disc-like structures located close to the endoplasmic reticulum .....Destination 1: within the **cell**, to organelles called lysosomes.

The cell is the fundamental unit of life. All the life activities are carried out by cells. The organisms are classified based on the number of cells present in them. Unicellular organisms are single-celled, while multicellular organisms have a large number of cells.

Unicellular organisms are believed to be one of the earliest forms of life on earth. Eventually, more complex multicellular organisms evolved from these unicellular life forms over the aeons. Multicellular organisms have specialized cells with complicated cell organelles, which unicellular organisms typically lack.

In an ecosystem, plants have the role of producers while animals have taken the role of consumers. Hence, their daily activities and functions vary, so do their cell structure. Cell structure and organelles vary in plants and animals, and they are primarily classified based on their function. The difference in their cell composition is the reason behind the difference between plants and animals, their structure and functions.

Each cell organelle has a particular function to perform. Some of the cell organelles are present in both plant cell and the animal cell, while others are unique to just one. Most of the earth's higher organisms are eukaryotes, including all plant and animals. Hence, these cells share some similarities typically associated with eukaryotes.

For example, all eukaryotic cells consist of a nucleus, plasma membrane, cytoplasm, peroxisomes, mitochondria, ribosomes and other cell organelles.

Differences between Plant Cell and Animal Cell

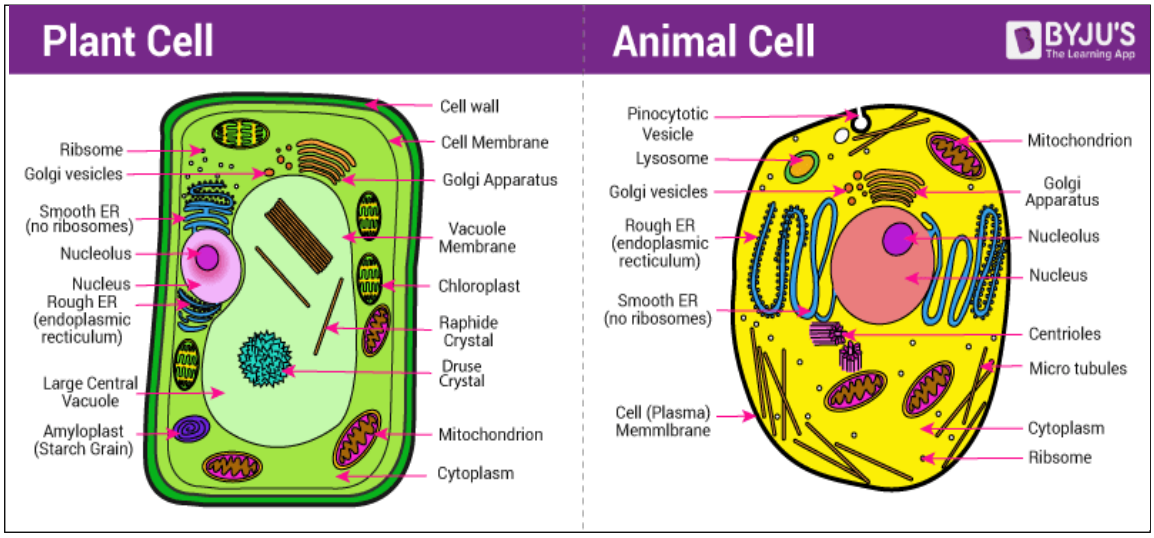


Diagram showing the Difference between Plant cell and Animal cell

As stated above, both plant and animal cells share a few common cell organelles, as both are eukaryotes. The function of all these organelles is said to be very much similar. However, the major differences between the plant and animal cells, which significantly reflect the difference in the functions of each cell.

The major differences between the plant cell and animal cell are mentioned below:

Plant Cell	**Animal Cell**
Cell Shape	
Square or rectangular in shape	Irregular or round in shape
Cell Wall	
Present	Absent
Plasma/Cell Membrane	
Present	Present
Endoplasmic Reticulum	
Present	Present

Nucleus	
Present and lies on one side of the cell	Present and lies in the centre of the cell
Lysosomes	
Present but are very rare	Present
Centrosomes	
Absent	Present
Golgi Apparatus	
Present	Present
Cytoplasm	
Present	Present
Ribosomes	
Present	Present
Plastids	
Present	Absent
Vacuoles	
Few large or a single, centrally positioned vacuole	Usually small and numerous
Cilia	
Absent	Present in most of the animal cells
Mitochondria	
Present but fewer in number	Present and are numerous

Mode of Nutrition	
Primarily autotrophic	Heterotrophic

Conclusion

Both plant and animal cells comprise membrane-bound organelles, such as endoplasmic reticulum, mitochondria, the nucleus, Golgi apparatus, peroxisomes, lysosomes. They also have similar membranes, such as cytoskeletal elements and cytosol. The plant cell can also be larger than the animal cell. The normal range of the animal cell varies from about 10 – 30 micrometres and that of plant cell range between 10 – 100 micrometres.

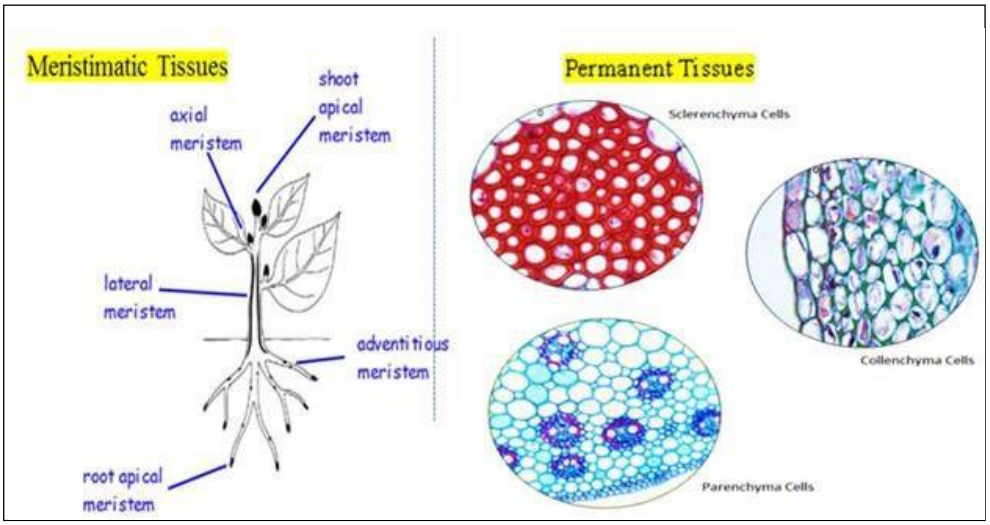
Plant tissues and its function

Types of Plant Tissues

Plant tissues can be broadly classified based on the ability of the cells to divide into Merismatic tissue and Permanent tissue.

Merismatic tissues consist of a group of cells that have the ability to divide. These tissues are small, cuboidal, densely packed cells which keep dividing to form new cells. These tissues are capable of stretching, enlarging and differentiating into other types of tissues as they mature. Meristematic tissues give rise to permanent tissues. Merismatic tissues can be of three types depending on the region where they are present: Apical meristems, lateral meristems, and intercalary meristems.

Permanent tissues are derived from the merismatic tissues and have lost their ability to divide. They have attained their mature form. They are further classified into two types: Simple and complex permanent tissues.



Browse more Topics under Anatomy Of Flowering Plants

- Tissue System
- Stem
- Leaf
- Inflorescence
- Secondary Growth
- Flower
- The Fruit
- The Seed
- Classification of Flowering Plants
- Anatomy of Dicotyledonous and Monocotyledonous Plants

Permanent Tissues

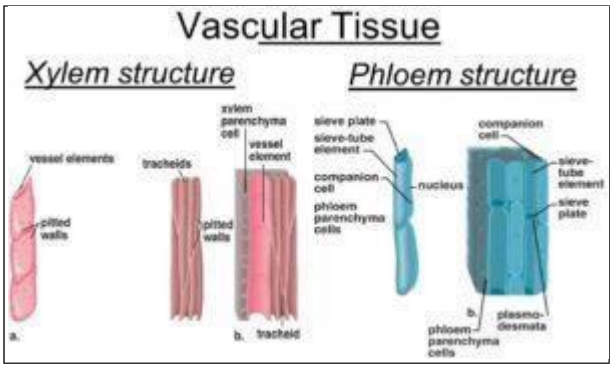
The permanent tissues form the major portion of the plant.

Simple Permanent tissues

- **Parenchyma**– These tissues are found in the soft parts of a plant such as the roots, stems, leaves, and flowers. The cells of this tissue are loosely packed and contain large intercellular spaces between them. Each cell has a vacuole at the center. The functions of parenchyma tissues are storage, photosynthesis, and to help the plant float on water.
- **Collenchyma-** Are similar to parenchyma cells with thicker cell walls. They are meant to provide mechanical support to the plant structure in parts such as petiole of the leaf.
- **Sclerenchyma-** The cells of this tissue are dead. They are rigid, contain thick and lignified secondary walls. Their main function is to provide strength and support to parts of the plant.

Complex Permanent Tissue

Unlike simple permanent cells which look the same and are made up of one type of cells, complex permanent tissues are made up of more than one type of cells. These different types of cells coordinate to perform a function. Xylem and Phloem are complex permanent tissues and are found in the vascular bundles in the plants.



Xylem- It consists of tracheids, vessels, xylem parenchyma and xylem fibres. Tracheids and vessels are hollow tube-like structures that help in conducting water and minerals. The xylem conducts only in one direction i.e vertically. The xylem parenchyma is responsible for storing the prepared food and assists in the conduction of water. Xylem fibres are supportive in function.

Phloem- It consists of four of elements: sieve tubes, companion cells, phloem fibres and the phloem parenchyma. Unlike the xylem, phloem conducts in both directions. It is responsible for transporting food from the leaves to the other parts of the plant. Phloem contains living tissues except for fibres that are dead tissues.

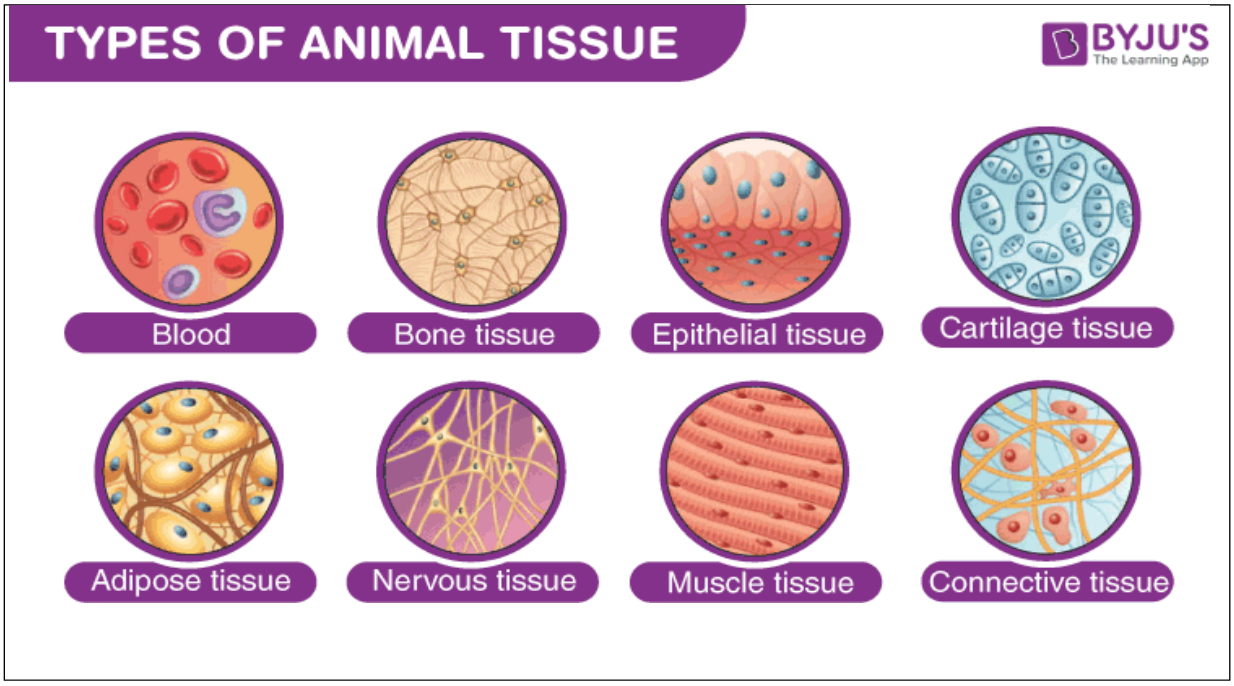
Functions of plant tissues

Plant tissues have different functions depending upon their structure and location

- Help provide mechanical strength to organs.
- They help in providing the elasticity and flexibility to the organs.
- They help the tissues to bend easily in various parts of a plant like- leaf, stem, and branches without damaging the plant
- The xylem and phloem tissues help in transportation of material throughout the plants
- They divide to produce new cells and help in the growth of the plants.
- They help in various cellular metabolisms like photosynthesis, regeneration, respiration, etc.

Animal tissues and its function

The animal cells are grouped together to form animal tissues. These tissues vary in their structure, function, and origin.The animal tissues are divided into epithelial, connective, muscular and nervous tissues. Let us have a glimpse of each type of animal tissue in detail.



Types of Animal Tissue

The different types of animal tissues include:

Epithelial Tissue

Epithelial tissues form the protective covering and inner lining of the body and organs. These tissues were the first to evolve during evolution and were first formed during embryonic development. They develop from the ectoderm, mesoderm and endoderm of the embryo.

Characteristics of Epithelial Tissues
Following are the important characteristics of epithelial tissues:

1. These can be single-layered or multi-layered.
2. The tissues have the power to regenerate.
3. These are held together by gap junctions, tight junctions, zonula adheren, desmosomes, or interdigitation.
4. The plasma membrane of these cells is specialized into flagella, cilia, and microvilli.

Classification of Epithelial Tissues

The epithelial tissues can be classified as:

Classification	Function

Sensory epithelium	To perceive stimuli
Glandular epithelium	Secretes chemicals
Pigmented epithelium	Imparts colour in retina
Absorptive epithelium	For absorption

Connective Tissue

Connective tissues develop from the mesodermal cells of the embryo. they support and bind other tissues in the body. These are made up of three components:

- **Intercellular Matrix:** It is made up of mucopolysaccharide, specifically hyaluronic acid.
- **Cells:** The major cells include fibroblasts, adipocytes, plasma cells and mast cells.
- **Fibres:** Connective tissues are made up of three types of fibres, namely, collagen fibre, elastic fibre, reticular fibre.

The connective tissues perform the following functions:

1. They attach organs and tissues together.
2. They store fat in the form of adipose tissues.
3. They help in repairing tissues.
4. They prevent the organs from mechanical shocks.
5. The organs also help in defence.

Classification of Connective Tissues

The connective tissues are classified as follows:

Classification	Function
Connective Tissue Proper	A protection to the body
Vascular Tissue	Transport of materials in the body
Skeletal Tissue	It supports the body and gives it proper shape and form

Muscular Tissue

The muscular tissue develops from the mesoderm of the embryo. It is classified into three types:

- Cardiac
- Smooth
- Skeletal

Muscular tissue performs the following functions:

1. It helps in movement and locomotion.
2. It supports the bones and other structures.
3. It is responsible for peristalsis and parturition.

Classification of Muscular Tissue

The muscular tissue can be classified as:

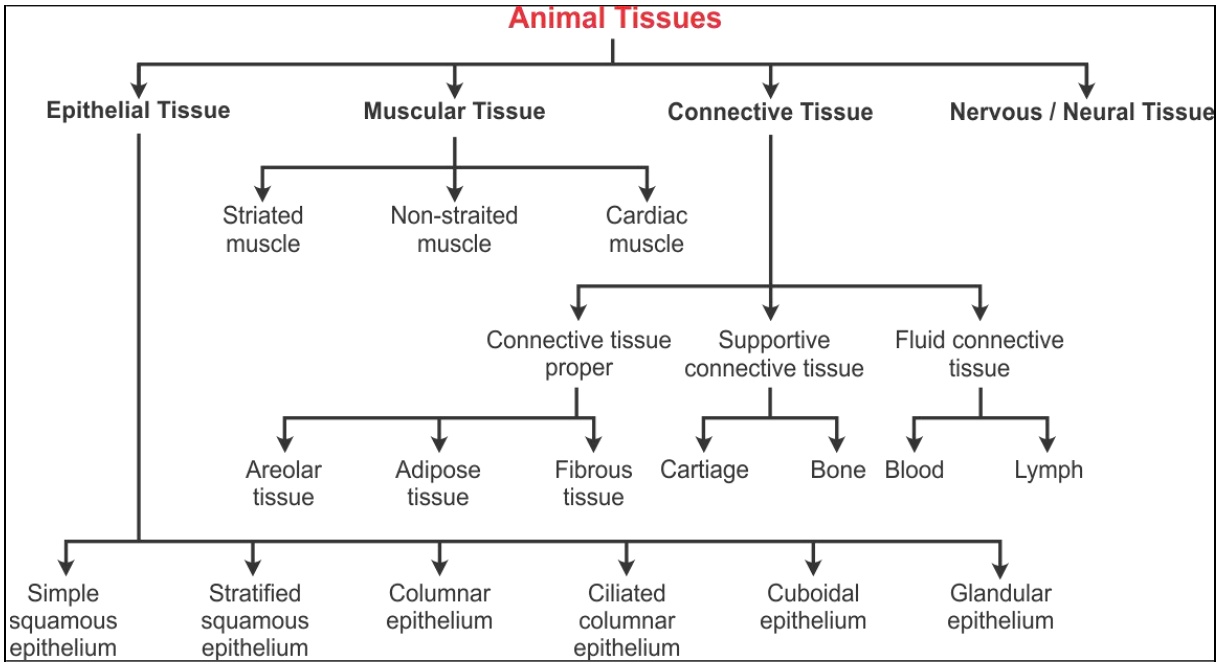
Classification	Function
Cardiac	It helps in blood circulation and keeps the heart pumping
Smooth	These help in peristalsis and other involuntary functions of the body.
Skeletal	Provide support, help in movement and maintain homeostasis

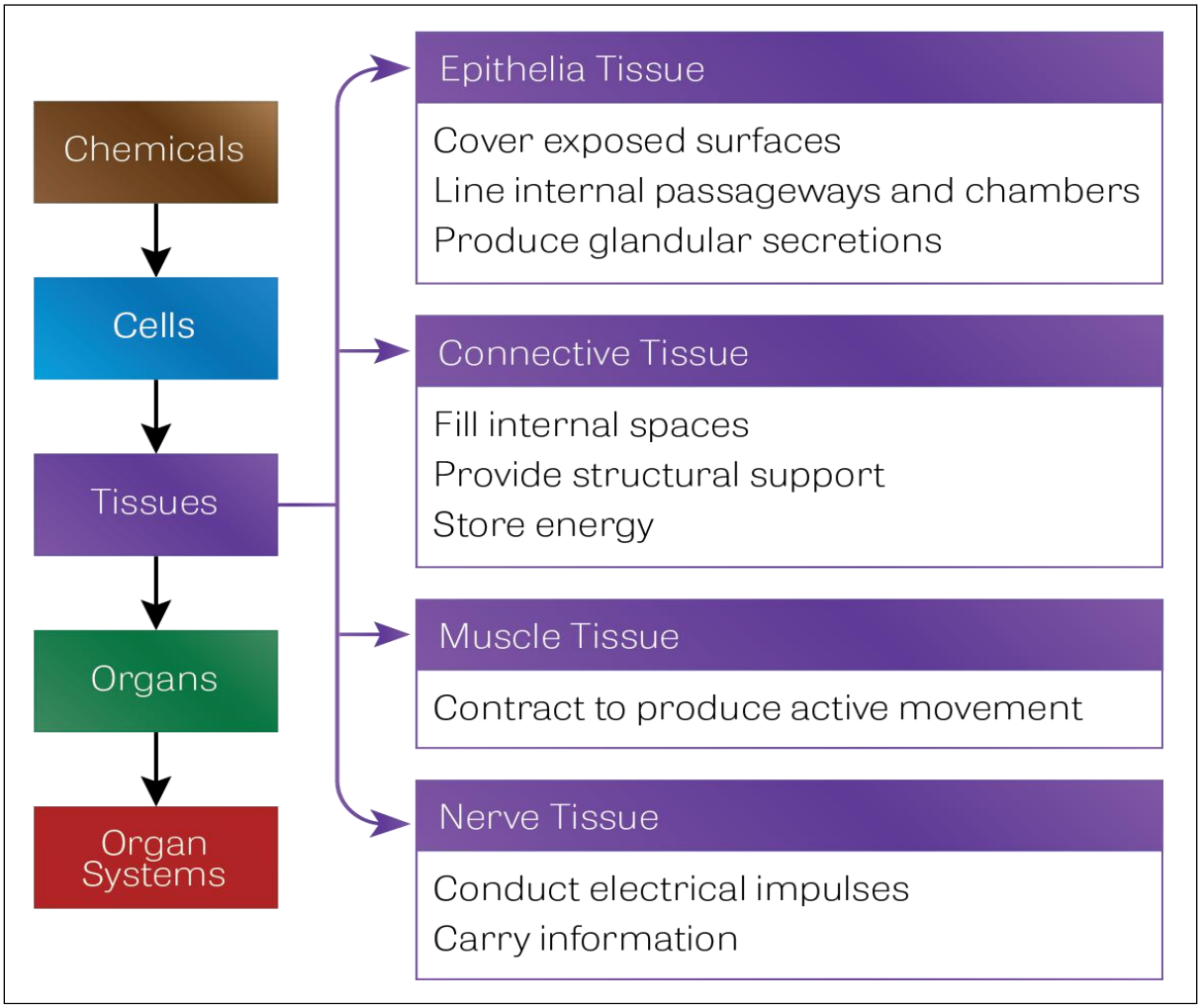
Nervous Tissue

Nervous tissue makes up the peripheral and the central nervous system. It develops from the ectoderm of the embryo. It possesses the ability to initiate and transmit the nerve impulse. Its main components include:

- **Neurons –** These are the structural and functional unit of nervous system. It comprises an axon, cell body and dendrites.
- **Neuroglia –** These are special cells found in the brain and spinal cord. They provide support to the neurons and fibres.
- **Neurosecretory Cells –** These function as endocrine organs. They release chemical from the axons direcly into blood.

Animal tissues class 9 gives a detailed overview of the epithelial, connective, muscular and nervous tissues in human body. Stay tuned with BYJU'S to know more about the animal tissues, its types or other related topics.

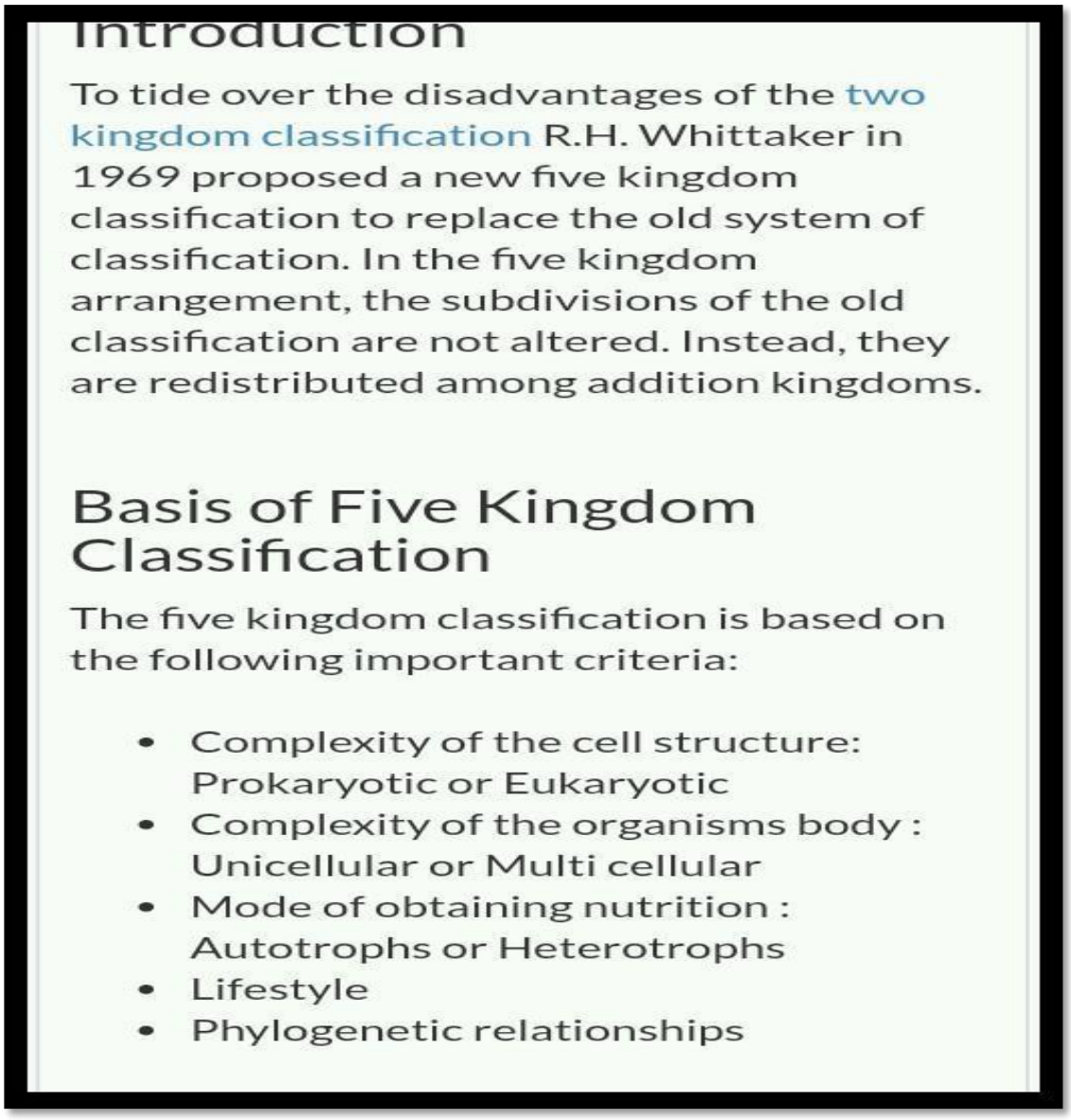




Five kingdom classification

R.H.Whittaker at 1969:- proposed an elaborate five kingdom classification – Monera, Protista, Fungi, Plantae and Animalia. The main criteria of the five kingdom classification were cell

structure, body organisation, mode of nutrition and reproduction, and phylogenetic relationships.



What are the 5 kingdoms and examples:-

It became very difficult to group some living things into one or the other, so early in the past century the two kingdoms were expanded into five kingdoms: **Protista** (the single-celled eukaryotes); **Fungi** (**fungus** and related organisms); **Plantae** (the **plants**); **Animalia** (the animals);

Monera (the prokaryotes).

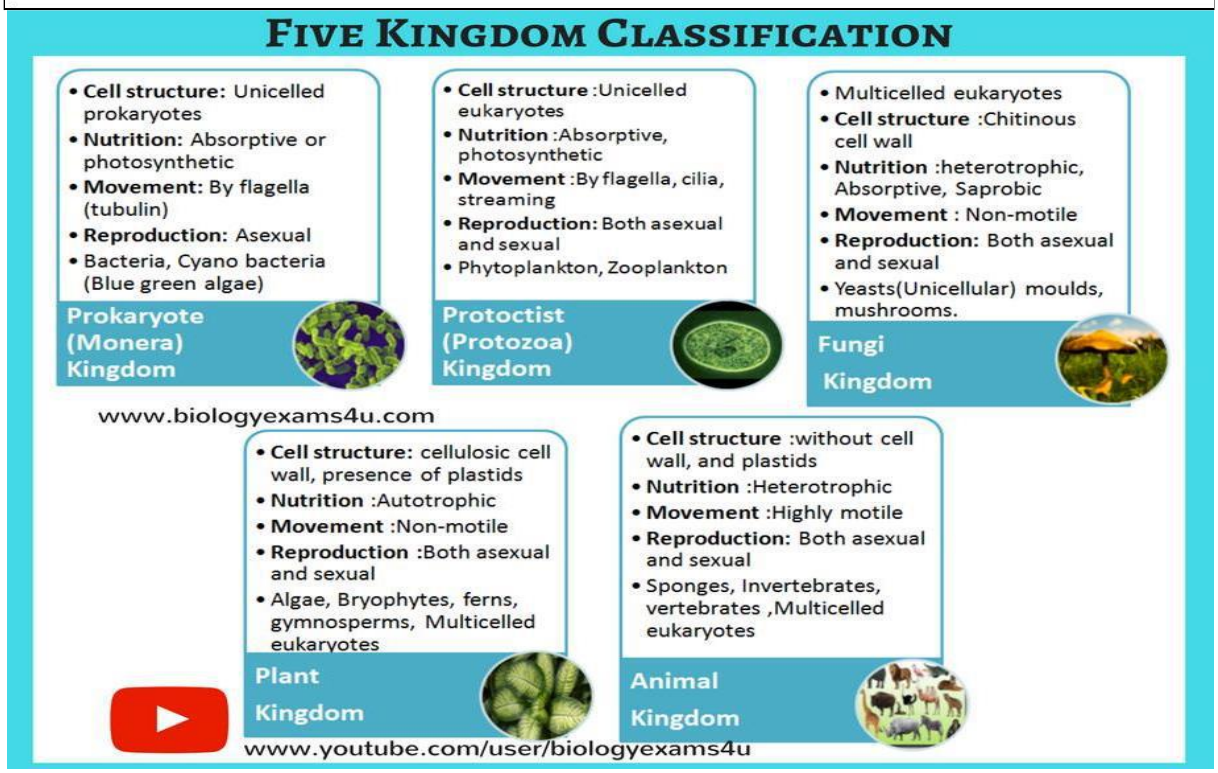
Five kingdom concept

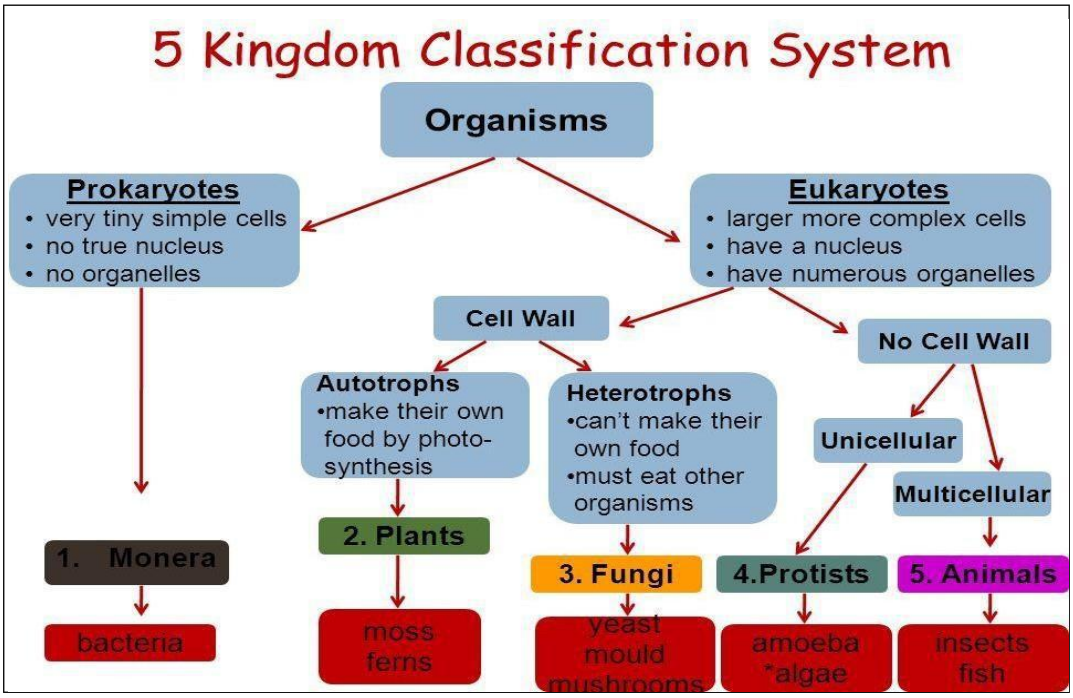
Robert H Whittaker in 1960, suggested first classification system, gained popularity

Organisms are placed in five kingdoms based on at least three major criteria

1. **Cell type** – prokaryotic or eukaryotic
2. **Level of organisation** – solitary and colonial, unicellular or multicellular
3. **Nutritional type** – Ingestive, absorptive or photoautotrophic

1. **Kingdom Monera**, contains all prokaryotic organisms
2. **Kingdom Protista**, are eukaryotes - unicellular organisation, either solitary cells or colonies of cells lacking true tissue - ingestive, absorptive or photoautotrophic
3. **Kingdom Animalia** contains multicellular animals with cell wall less eukaryotic – ingestive
4. **Kingdom Plantae** – Multicellular – Cell walled eukaryotic – Photoautotrophic
5. **Kingdom Fungi** – eukaryotic, multinucleate – often septate mycelium - absorptive





UNIT-II
INTRODUCTION TO BIOMOLECULES

==========

Carbohydrates sources and function

Definition:-Carbohydrates are one of the three main classes of foods and a source of energy. **Carbohydrates** are mainly sugars and starches that the body breaks down into glucose (a **simple** sugar that the body can use to feed its cells).

Example: - carbohydrate is an organic compound such as sugars, starches, celluloses and gums, that occurs in living tissues and food. It is important for nutrition since it can be broken down into energy by people or animals.

Sources:- Carbohydrates are found in a wide array of both healthy and unhealthy **foods**—**bread**, **beans**, **milk**, popcorn, **potatoes**, cookies, spaghetti, soft drinks, **corn**, and **cherry pie**. They also come in a variety of forms. The most common and abundant forms are sugars, fibers, and **starches**.

Types: - Carbohydrates are divided into **four types**:

1. Monosaccharide's 2.Disaccharides 3.Oligosaccharides 4. Polysaccharides

1.Monosaccharides

- Simplest group of carbohydrates and often called simple sugars since they cannot be further hydrolyzed.
- Colorless, crystalline solid which are soluble in water and insoluble in a non-polar solvent.
- These are compound which possesses a free aldehyde or ketone group.
- The general formula is $C_n(H2O)_n$or $C_nH_{2n}O_n$.
- They are classified according to the number of carbon atoms they contain and also on the basis of the functional group present.
- The monosaccharides thus with 3,4,5,6,7… carbons are called trioses, tetroses, pentoses, hexoses, heptoses, etc., and also as aldoses or ketoses depending upon whether they contain aldehyde or ketone group.
- Examples: **Glucose, Fructose, Erythrulose, Ribulose.**

Oligosaccharides

- Oligosaccharides are compound sugars that yield 2 to 10 molecules of the same or different monosaccharides on hydrolysis.
- The monosaccharide units are joined by glycosidic linkage.
- Based on the number of monosaccharide units, it is further classified as disaccharide, trisaccharide, tetrasaccharide etc.
- Oligosaccharides yielding 2 molecules of monosaccharides on hydrolysis is known as a disaccharide, and the ones yielding 3 or 4 monosaccharides are known as trisaccharides and tetrasaccharides respectively and so on.
- The general formula of disaccharides is $C_n(H2O)_{n-1}$and that of trisaccharides is $C_n(H2O)_{n-2}$ and so on.
- Examples: **Disaccharides include sucrose, lactose, maltose, etc.**
- Trisaccharides are Raffinose, Rabinose.

Polysaccharides

- They are also called as "glycans".
- Polysaccharides contain more than 10 monosaccharide units and can be hundreds of sugar units in length.
- They yield more than 10 molecules of monosaccharide on hydrolysis.
- Polysaccharides differ from each other in the identity of their recurring monosaccharide units, in the length of their chains, in the types of bond linking units and in the degree of branching.
- They are primarily concerned with two important functions ie. Structural functions and the storage of energy.
- They re further classified depending on the type of molecules produced as a result of hydrolysis.

- They may be **homopolysaccharide**s, containing monosaccharides of the same type or **heteropolysaccharides** i.e., monosaccharides of different types.
- Examples of Homopolysaccharides are **starch, glycogen, cellulose, pectin.**
- Heteropolysaccharides are Hyaluronic acid, Chondroitin.

The Lipids sources and function

A **lipid** is chemically defined as a substance that is insoluble in water and soluble in alcohol, ether, and chloroform. **Lipids** are an important component of living cells. Together with carbohydrates and proteins, **lipids** are the main constituents of plant and animal cells. Cholesterol and triglycerides are **lipids**.

What are the 4 main functions of lipids

- Role of lipids in the body. ...
- Chemical messengers. ...
- **Storage** and provision of energy. ...
- Maintenance of temperature. ...
- Membrane lipid layer formation. ...
- Cholesterol formation. ...
- Prostaglandin formation and role in inflammation. ...
- The "fat-soluble" vitamins.

lipids important for humans

1. Lipids are needed to protect and insulate your body.
2. To keep your internal body temperature regular, there is a layer of **fats** just beneath the skin that is made from **lipids**.
3. Similarly, there is a layer of **fats** also around your vital organs that keeps them protected from injuries.

5 major functions of lipids in the body

Within the body, lipids function as an
1. Energy reserve,
2. Regulate hormones,
3. Transmit nerve impulses,
4. Cushion vital organs,
5. Transport **fat**-soluble nutrients.

The classifications of lipid

Based on this **classification** system, **lipids** have been divided into eight categories:
1. Fatty acyls,
2. Glycerolipids,
3. Glycerophospholipids,
4. Sphingolipids,
5. Saccharolipids
6. Polyketides (derived from condensation of ketoacyl subunits); and
7. Sterol **lipids** and

8. Prenol **lipids**

Protein definition and sources, functions

Definition:-Proteins are large, complex molecules that play many critical roles in the body. They do most of the work in cells and are required for the structure, function, and regulation of the body's tissues and organs.

Proteins are made up of chemical 'building blocks' called amino acids. Your body uses amino acids to build and repair muscles and bones and to make hormones and enzymes. They can also be used as an energy source.
Proteins are called body building food. These are essential for growth and repair of body tissue. It is a source of amino acids which is used by the body to form structures into it.

The discovery of protein:-

Proteins were discovered in 1838 by Jöns Jakob Berzelius. Named from the Greek word 'protas' meaning 'of primary importance', they are now the most studied macronutrient on the planet.

Functions of proteins:-

Proteins have multiple functions, including: acting as enzymes and hormones, maintaining proper fluid and acid-base balance, providing nutrient transport, making antibodies, enabling wound healing and tissue regeneration, and providing energy when carbohydrate and fat intake is inadequate

Important of proteins:-

Every cell in the human body contains protein. The basic structure of protein is a chain of amino acids. You need protein in your diet to help your body repair cells and make new ones. Protein is also important for growth and development in children, teens, and pregnant women.
.

The structure of proteins:-

The primary structure is comprised of a linear chain of amino acids. The secondary structure contains regions of amino acid chains that are stabilized by hydrogen bonds from the polypeptide backbone. These hydrogen bonds create alpha-helix and beta-pleated sheets of the secondary structure.

Protein formula:-

The general formula for proteins is as follows: $RCH(NH_2)COOH$, where C is carbon, H is hydrogen, N is nitrogen, O is oxygen, and R is a variable-composition and structure side chain. Proteins are the most functioning molecules in living beings, and they are essential for their survival.

The advantages of protein:-

Eating high-protein foods has many fitness benefits, including:

- Speeding recovery after exercise and/or injury.
- Reducing muscle loss.
- Building lean muscle.
- Helping maintain a healthy weight.
- Curbing hunger.

Storage proteins:-

Storage proteins serve as reserves of metal ions and amino acids, which can be mobilized and utilized for the maintenance and growth of organisms. They are particularly prevalent in plant seeds, egg whites, and milk. Perhaps the most thoroughly studied storage protein is ferritin, which stores iron.

Food sources of proteins:-

Animal-based foods (meat, poultry, fish, eggs, and dairy foods) tend to be good sources of complete protein,
while plant-based foods (fruits, vegetables, grains, nuts, and seeds) often lack one or more essential amino acid

Protein Deficiency

1. Edema which is characterized by swollen and puffy skin, is a classic symptom of kwashiorkor

2. Fatty Liver

Another common symptom of kwashiorkor is a fatty liver, or fat accumulation in liver cells

Left untreated, the condition may develop into fatty liver disease, causing inflammation, liver scarring and potentially liver failure.

3. Skin, Hair and Nail Problems

Protein deficiency often leaves its mark on the skin, hair and nails, which are largely made of protein.

For instance, kwashiorkor in children is distinguished by flaky or splitting skin, redness and patches of depigmented skin

Hair thinning, faded hair color, hair loss (alopecia) and brittle nails are also common symptoms

4. Loss of Muscle Mass

Your muscles are your body's largest reservoir of protein.

When dietary protein is in short supply, the body tends to take protein from skeletal muscles to preserve more important tissues and body functions. As a result, lack of protein leads to muscle wasting over time.

Proteins

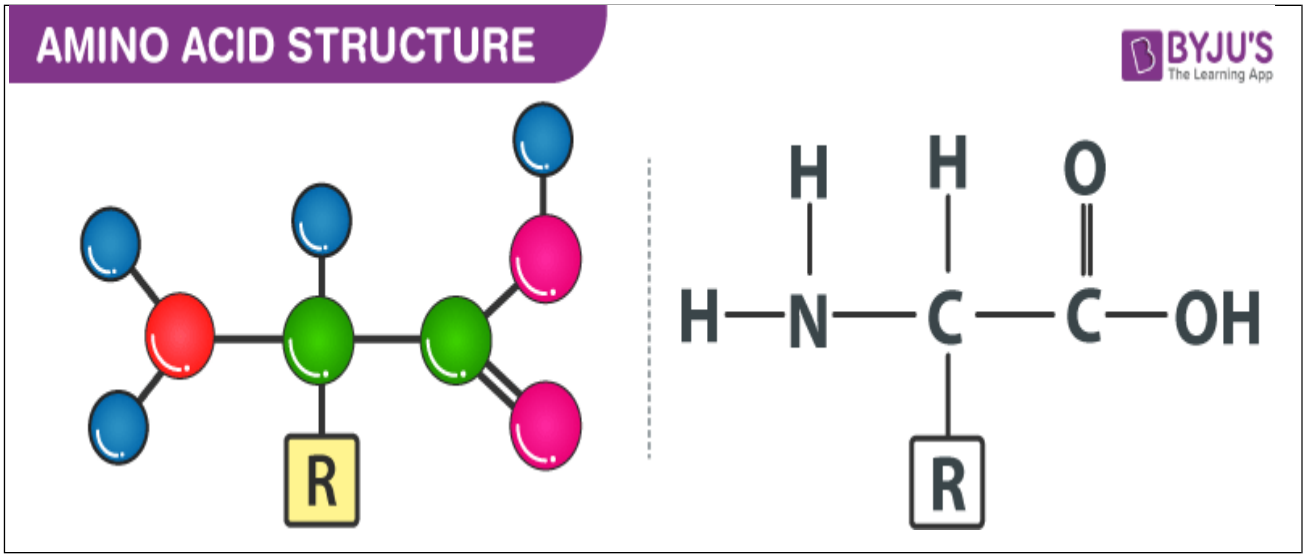
Proteins perform many vital functions in the living organisms. Proteins are present as enzymes (trypsin, lipases, amylase, etc.), hormones (Insulin), tissue fibres are made up of proteins (collagen, elastin, etc.). Some of the protein molecules take part in transportation (GLUT-4) across a membrane and also fight infection (antibodies).

RuBisCO (Ribulose bisphosphate carboxylase oxygenase), the enzyme in carbon fixation, is the most abundant protein present in the biosphere. **Collagen** is the most abundant protein present in animals.

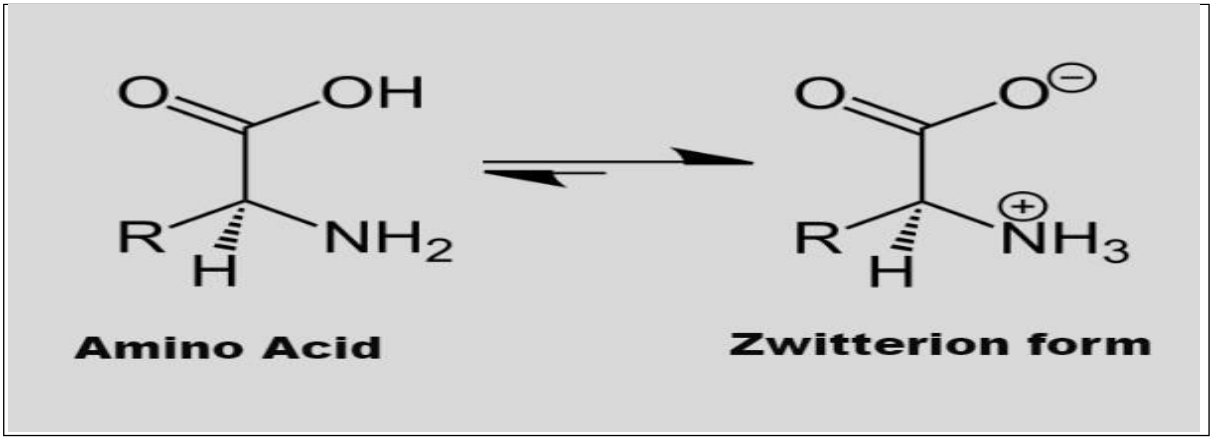
Protein Structure

Protein is a heteropolymer of amino acids. A linear protein molecule has a sequence of amino acids, that are linked by a peptide bond. Proteins are also known as polypeptides.

Amino Acids

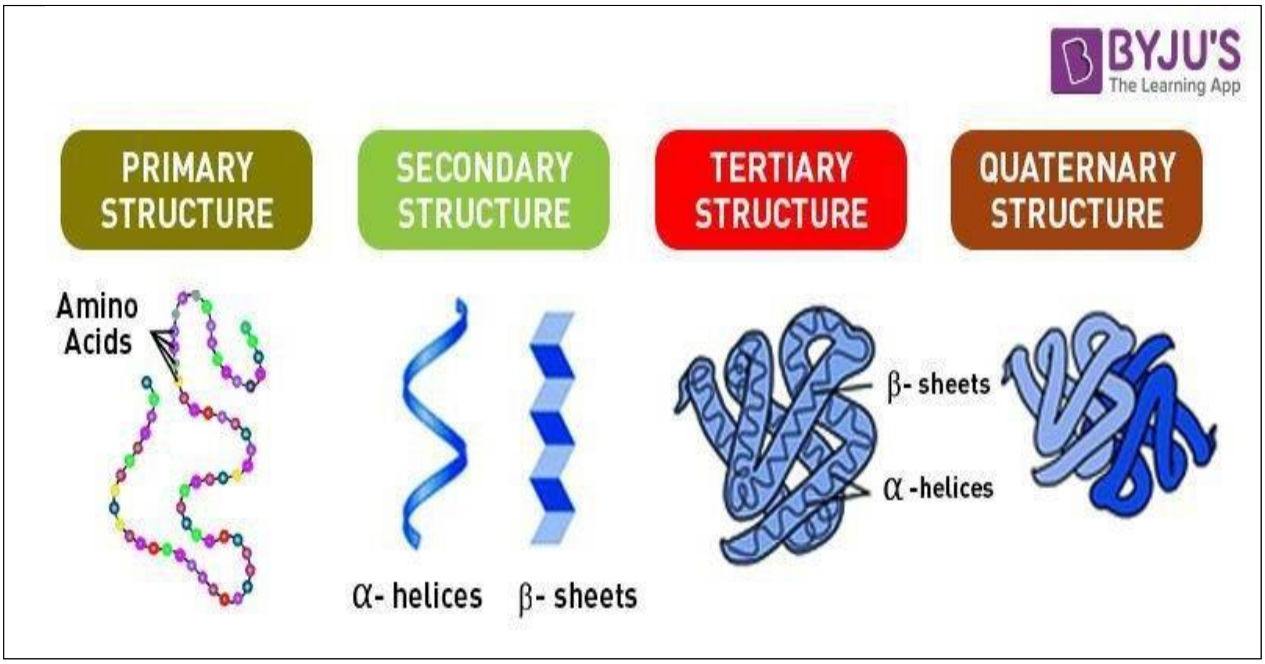


- Amino acids are organic compounds
- They are substituted methanes. The ***α***- carbon has various substituents so they are also called ***α***- amino acids
- The ***α***- carbon has an amino group, carboxylic group, hydrogen and a variable R group
- Based on the nature of the R group, there are 20 amino acids present in proteins
- Amino acids can exist in a **zwitterionic form,** which changes according to the pH of the solution to NH_3^+ (at low pH) or COO^- (at high pH)



- **Essential amino acids** are required through diet. There are 9 essential amino acids: valine, leucine, isoleucine, phenylalanine, tryptophan, lysine, histidine, methionine and threonine

- **Non-essential amino acids** are formed inside the body and include glycine, alanine, arginine, aspartic acid, asparagine, cysteine, glutamine, glutamic acid, serine, proline and tyrosine
- Amino acids can be basic (lysine), acidic (glutamic acid) or neutral (valine) based on the R group present
- Tryptophan, tyrosine and phenylalanine have an aromatic side chain



Primary Structure of protein is a long chain of amino acids in a specific sequence. The amino acid chain starts from N' and ends with C'. amino acids are linked by C-N **peptide bonds**. The peptide bond is formed between the carboxyl (-COOH) of one amino acid and amino group ($-NH_2$) of another amino acid. The process of peptide bond formation involves dehydration, one water molecule is released.

Secondary Structure of a protein has a helical structure. The long thread of amino acids is folded right-handed to form ***α*-helix** or are arranged as **β**-pleated sheets, which consist of **β-strands,** laterally joined by at least 2-3 hydrogen bonds**.**

Tertiary Structure of protein is highly folded. Protein chains are folded like a hollow woollen ball. It is a three-dimensional organisation, which is required for optimum activity.

Quaternary Structure is required when a protein is made up of more than one polypeptide chain or has subunits. These spheres of subunits or polypeptides may be arranged as linear strings or form a cube or plate. E.g. Haemoglobin consists of 4 subunits, 2 subunits each of α and β type.

Vitamins functions and deficiency symptoms

Functions and deficiency symptoms are listed in the table.

The vitamins			
vitamin	**alternative names/forms**	**biological function**	**symptoms of deficiency**
Water-soluble			
Thiamin	vitamin B_1	component of a coenzyme in carbohydrate metabolism; supports normal nerve function	impairment of the nerves and heart muscle wasting
Riboflavin	vitamin B_2	component of coenzymes required for energy production and lipid, vitamin, mineral, and drug metabolism; antioxidant	inflammation of the skin, tongue, and lips; ocular disturbances; nervous symptoms
Niacin	nicotinic acid, nicotinamide	component of coenzymes used broadly in cellular metabolism, oxidation of fuel molecules, and fatty acid and steroid synthesis	skin lesions, gastrointestinal disturbances, nervous symptoms
Vitamin B_6	pyridoxine, pyridoxal, pyridoxamine	component of coenzymes in metabolism of amino acids and other nitrogen-containing compounds; synthesis of hemoglobin, neurotransmitters; regulation of blood glucose levels	dermatitis, mental depression, confusion, convulsions, anemia

The vitamins			
vitamin	**alternative names/forms**	**biological function**	**symptoms of deficiency**
Water-soluble			
Folic acid	folate, folacin, pteroylglutamic acid	component of coenzymes in DNA synthesis, metabolism of amino acids; required for cell division, maturation of red blood cells	impaired formation of red blood cells, weakness, irritability, headache, palpitations, inflammation of mouth, neural tube defects in fetus
Vitamin B_{12}	cobalamin, cyanocobalamin	cofactor for enzymes in metabolism of amino acids (including folic acid) and fatty acids; required for new cell synthesis, normal blood formation, and neurological function	smoothness of the tongue, gastrointestinal disturbances, nervous symptoms
Pantothenic acid		as component of coenzyme A, essential for metabolism of carbohydrate, protein, and fat; cofactor for elongation of fatty acids	weakness, gastrointestinal disturbances, nervous symptoms, fatigue, sleep disturbances, restlessness, nausea
Biotin		cofactor in carbohydrate, fatty acid, and amino acid metabolism	dermatitis, hair loss, conjunctivitis, neurological symptoms
Vitamin C	ascorbic acid	antioxidant; synthesis of collagen, carnitine,	swollen and bleeding gums, soreness and

The vitamins			
vitamin	**alternative names/forms**	**biological function**	**symptoms of deficiency**
Water-soluble			
		amino acids, and hormones; immune function; enhances absorption of non-heme iron (from plant foods)	stiffness of the joints and lower extremities, bleeding under the skin and in deep tissues, slow wound healing, anemia
Fat-soluble			
Vitamin A	retinol, retinal, retinoic acid, beta-carotene (plant version)	normal vision, integrity of epithelial cells (mucous membranes and skin), reproduction, embryonic development, growth, immune response	ocular disturbances leading to blindness, growth retardation, dry skin, diarrhea, vulnerability to infection
Vitamin D	calciferol, calatriol (1,25-dihydroxy vitamin D_1 or vitamin D hormone), cholecalciferol (D_3; plant version), ergocalciferolV(D_2; animal version)	maintenance of blood calcium and phosphorus levels, proper mineralization of bones	defective bone growth in children, soft bones in adults
Vitamin E	alpha-tocopherol, tocopherol, tocotrienol	antioxidant; interruption of free radical chain reactions; protection of polyunsaturated fatty acids, cell membranes	peripheral neuropathy, breakdown of red blood cells

The vitamins			
vitamin	**alternative names/forms**	**biological function**	**symptoms of deficiency**
Water-soluble			
Vitamin K	phylloquinone, menaquinone, menadione, naphthoquinone	synthesis of proteins involved in blood coagulation and bone metabolism	impaired clotting of the blood and internal bleeding

Minerals sources and functions

Minerals are those elements on the earth and in foods that our bodies need to develop and function normally. Those essential for **health** include calcium, phosphorus, potassium, sodium, chloride, magnesium, iron, zinc, iodine, chromium, copper, fluoride, molybdenum, manganese, and selenium.

Types of minerals:-

The two kinds of minerals are: macrominerals and trace minerals. Macro means "large" in Greek (and your body needs larger amounts of macrominerals than trace minerals). The macromineral group is made up of **calcium**, phosphorus, magnesium, **sodium**, **potassium**, chloride, and **sulfur**.

The most important minerals:-

Macrominerals

Mineral	Function
Phosphorus	Important for healthy bones and teeth; found in every cell; part of the system that maintains acid-base balance
Magnesium	Found in bones; needed for making protein, muscle contraction, nerve transmission, immune system health
Sulfur	Found in protein molecules

Essential minerals:-

Minerals include **calcium**, phosphorus, sodium, **potassium**, magnesium, manganese, **sulfur**, **chloride**, iron, iodine, fluoride, zinc, **copper**, selenium, **chromium** and **cobalt** (which is part of the vitamin B12/cobalamine)

Humans use minerals:-

While **minerals** are frequently **used** to create the materials **used** in the construction of roads and buildings, they also serve as critical components in the manufacturing of high-tech electronics, next-generation vehicles and other everyday devices

What minerals do we eat everyday:-

Your body needs larger amounts of some minerals, such as **calcium**, to grow and stay healthy. Other minerals like **chromium**, copper, **iodine**, iron, selenium, and zinc are called trace minerals because you only need very small amounts of them each day

What minerals do you need daily:-

According to Nutritionists, These Are the 7 Ingredients Your Multivitamin Should Have

- Vitamin D. Vitamin D helps our bodies absorb **calcium**, which is important for bone health. ...
- **Magnesium**. **Magnesium** is an essential nutrient, which means that we must get it from food or supplements. ...
- **Calcium**. ...
- Zinc. ...
- Iron. ...
- Folate. ...
- Vitamin B-12.

How many minerals are there:-

As of November 2018, the International Mineralogical Association had recognized about 5,400 **minerals**. About 30 to 50 new **minerals** are described and one or two **minerals** are discredited each year.

What are the 7 types of minerals:-

Silicates, oxides, sulfates, sulfides, carbonates, native elements, and halides are all major mineral groups.

- Silicates.
- Oxides.
- Sulfates.
- Sulfides.
- Carbonates.
- Native Elements.
- Halides.

What are the 3 types of minerals;-

- Native elements. eg. Gold, Silver, Mercury, graphite, diamond.
- Oxides. eg corundum (incl. sapphire), hematite, spinel.
- Hydroxides. eg. Goethite, brucite.
- Sulfides. eg. Pyrite, galena, sphalerite.

- Sulfates. eg. Baryte, gypsum.
- Carbonates. eg. Calcite, magnesite, dolomite.
- Phosphates. eg. Apatite, monazite.
- Halides. eg.

Minerals make up most of the earth and are an important part of our everyday life.

Minerals are simply naturally occurring substances which have a crystalline structure. There are many thousands of minerals recognized, but only about 30 are most common.

Classification

Minerals, being natural chemicals, are classified according to their chemistry and crystal form.

A basic classification for minerals is:

- Native elements. eg. Gold, Silver, Mercury, graphite, diamond.
- Oxides. eg corundum (incl. sapphire), hematite, spinel.
- Hydroxides. eg. Goethite, brucite.
- Sulfides. eg. Pyrite, galena, sphalerite.
- Sulfates. eg. Baryte, gypsum.
- Carbonates. eg. Calcite, magnesite, dolomite.
- Phosphates. eg. Apatite, monazite.
- Halides. eg. Fluorite, halite (rock salt).
- Silicates (most common)
- Orthosilicates. eg. Garnet, olivine.
- Ring silicates. eg. Tourmaline, beryl.
- Chain silicates. eg. Pyroxenes, amphiboles.
- Sheet silicates. eg. Muscovite mica, biotite mica, clay minerals
- Framework silicates. eg. Quartz, feldspars, zeolites

The Nucleic Acids and their types

Introduction:- Nucleic acids were discovered in 1868, when twenty-four-year-old Swiss physician **Friedrich Miescher** isolated a new compound from the nuclei of white blood cells. Nucleic acids are naturally occurring chemical compounds that serve as the primary information-carrying molecules in cells. They play an especially important role in directing protein synthesis. The two main classes of nucleic acids are deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

Nucleic acids are large bimolecular that play essential roles in all cells and viruses. A major function of nucleic acids involves the storage and expression of genomic information. Deoxyribonucleic acid, or DNA, encodes the information cells need to make proteins

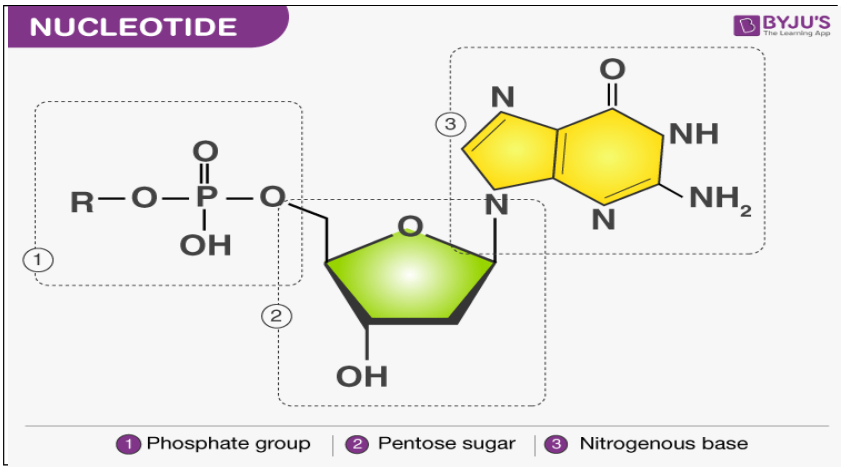
Nucleic Acids

Nucleic acids are found in all the living cells. Even a virus contains nucleic acids (DNA or RNA). DNA and RNA contain genetic information.

- Friedrich Miescher discovered nucleic acid and named it **nuclein**
- They are also known as polynucleotides, a polymer of nucleotide

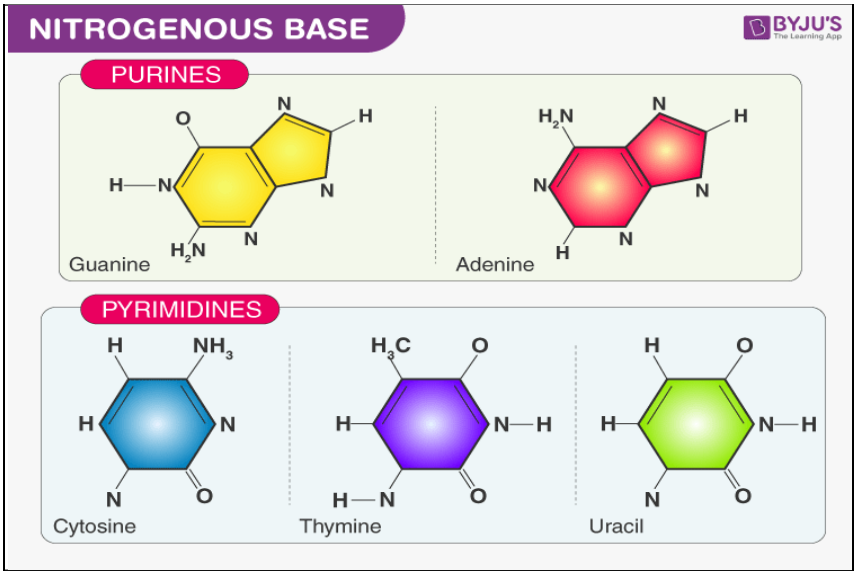
Nucleotide

A nucleotide has three components: a nitrogenous base, a pentose sugar and a phosphate group



Nitrogenous base- There are two types of nitrogenous bases:

1. Purine: Adenine and Guanine
2. Pyrimidine: Thymine, Cytosine and Uracil



Sugar- DNA contains deoxyribose sugar and RNA contains ribose sugar molecules.

Nitrogenous bases attached to sugar are called **Nucleosides.**

Phosphate- Phosphate group is attached to sugar by the phospho-ester bond. Nucleosides with attached phosphates are called **Nucleotides.**

Nucleotides are joined by 3'- 5' phosphodiester bonds to form polynucleotides. DNA and RNA are polynucleotides. The long chain of polynucleotides is folded further to form secondary and tertiary structures.

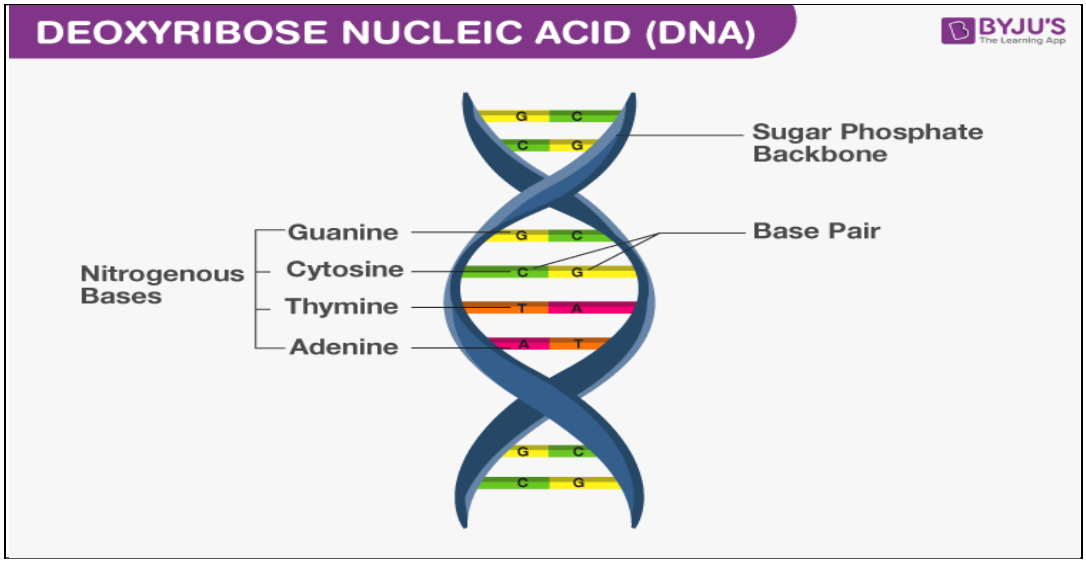
DNA

- Watson and Crick gave the double helix model
- DNA consists of antiparallel strands of polynucleotide chains, which are coiled in the right-hand direction
- The backbone of DNA is formed by sugar and phosphate and the nitrogenous bases are projected inside
- Nitrogenous bases of one strand are attached to the nitrogenous bases of the antiparallel strand

Adenine pairs with thymine by two hydrogen bonds (A=T)

Guanine (G) pairs with cytosine (C) by three hydrogen bond

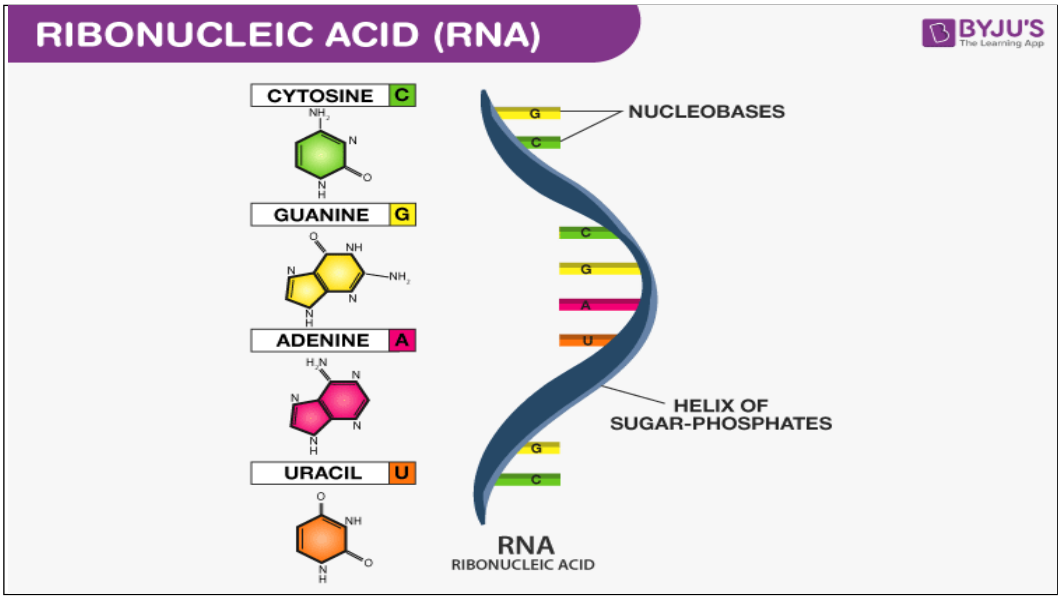
- Each helical turn is composed of 10 base pairs with a pith of 34 Å. The distance between any two base pairs is 3.4 Å
- DNA is packaged in the form of nucleosomes and then further to chromatin fibres of chromosomes



To read more about DNA structure and inheritance click here

RNA

- RNA is a single-stranded polynucleotide chain
- RNA contains ribose sugar and uracil in place of thymine
- There are three types of RNA, mRNA, tRNA and rRNA
- mRNA provides the template for protein synthesis
- **Ribozymes** are RNA molecules. They act as an enzyme and catalyse biochemical reactions



The structure of these Nucleic Acids

Nucleic acids are polymers which are made up monomer units called as nucleotides. Each nucleotide consists of three parts:

a. A nitrogen base(a base that contains N nitrogen atoms)

b. A five-carbon sugar

c. A Phosphate group

There are five nitrogen bases that are found in nucleic acids. Adenine, guanine, thiamin and cytosine are found in DNA, whereas, Adenine, guanine, uracil and cytosine are found in RNA. These nitrogen bases pair up very specifically and are held together by weak hydrogen bonds. Adenine always pairs up with thymine by two hydrogen bonds while guanine pairs up with cytosine with three hydrogen bonds.

Structure of DNA

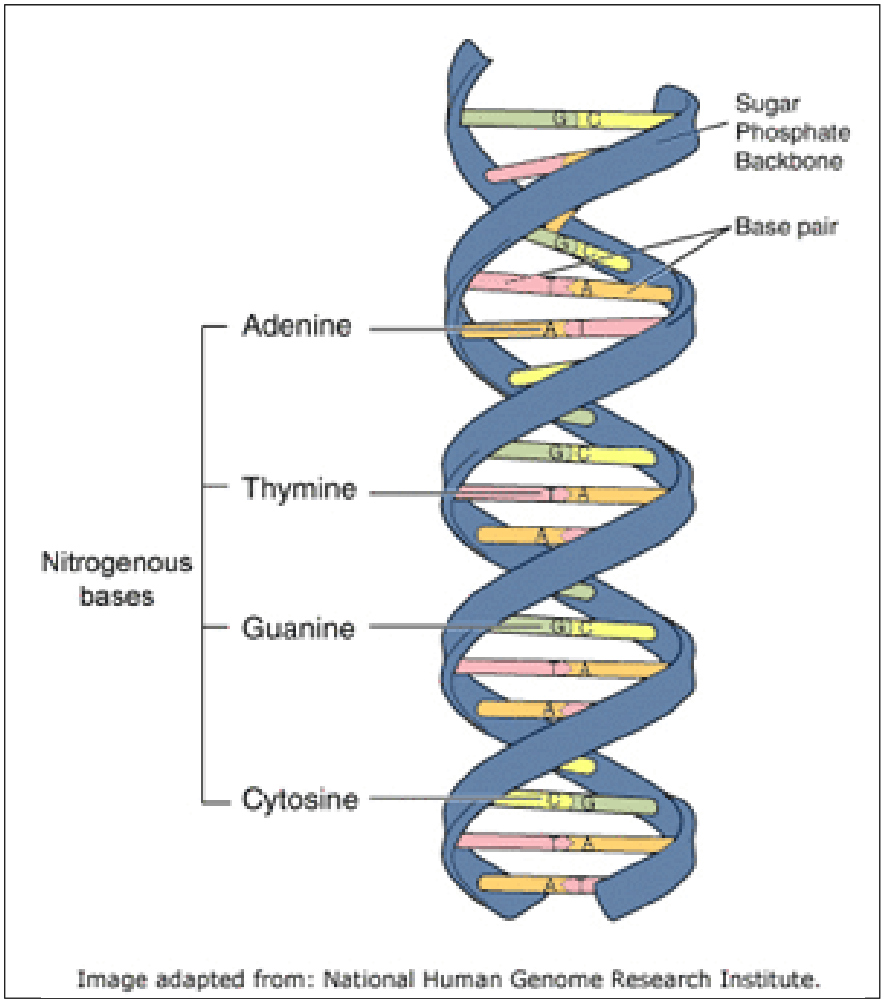


Image adapted from: National Human Genome Research Institute.

DNA has a double-stranded structure helical structure formed from two polynucleotide chains. Each of these chains is also helical in nature. The two helical chains which intertwine with each other are held together by the hydrogen bonds between the paired nitrogen bases. When the two helical chains intertwine, the hydrophobic nitrogen bases are on the inside while the phosphate groups on the outside.This hydrogen bonding between complementary bases on each strand provides a mechanism for the DNA replication and transmission of genetic information. DNA is present only in eukaryotic animals.

Structure of RNA

Unlike DNA, RNA is a single-stranded nucleic acid polymer. It has four nucleotides namely adenine, guanine, cytosine and uracil. During the process of DNA replication, RNA is the first intermediary that is formed. Where DNA is quite stable and the ideal genetic material, RNA is reactive in nature and is sensitive to oxidising agents. In DNA, the complementary base pairing occurs between both the strands but in RNA, the base pairing occurs with bases within the same strand. RNA is found as the genetic material in prokaryotes.

RNA is different types depending upon their function:

1. **Messenger RNA(mRNA):** It helps to transfer the genetic information from the genes on the DNA to the ribosomes.

2. **Ribosomal RNA(rRNA):** This RNA forms the structural components of the ribosome. They play an active role in recognizing conserved portions of mRNAs and tRNAs. They also assist with the catalysis of protein synthesis. In eukaryotes, rRNA genes are looped out of the main chromosomal fibres and coalesce in the presence of proteins to form a cell organelle called the nucleolus. The nucleolus is where the rRNA genes are transcribed and the early assembly of ribosomes takes place.

3. **Transfer RNA(tRNA):** t-RNA help to transfer amino acid residues from amino acid pool to the site of proteins synthesis i.e ribosomes. Specific tRNAs exist for each of the 20 amino acids that needed for protein synthesis. In a few cases, more than one tRNA for each amino acid is present.

UNIT –III
HUMAN PHYSIOLOGY

==========

The human Digestive System

Definition: The system of organs responsible for getting food into and out of the body and for making use of food to keep the body healthy.

* The digestive system includes the salavary glands, mouth, esphagus, stomach, liver, gallblader, pancrease, small Intestine, large intestine, rectum, anus.

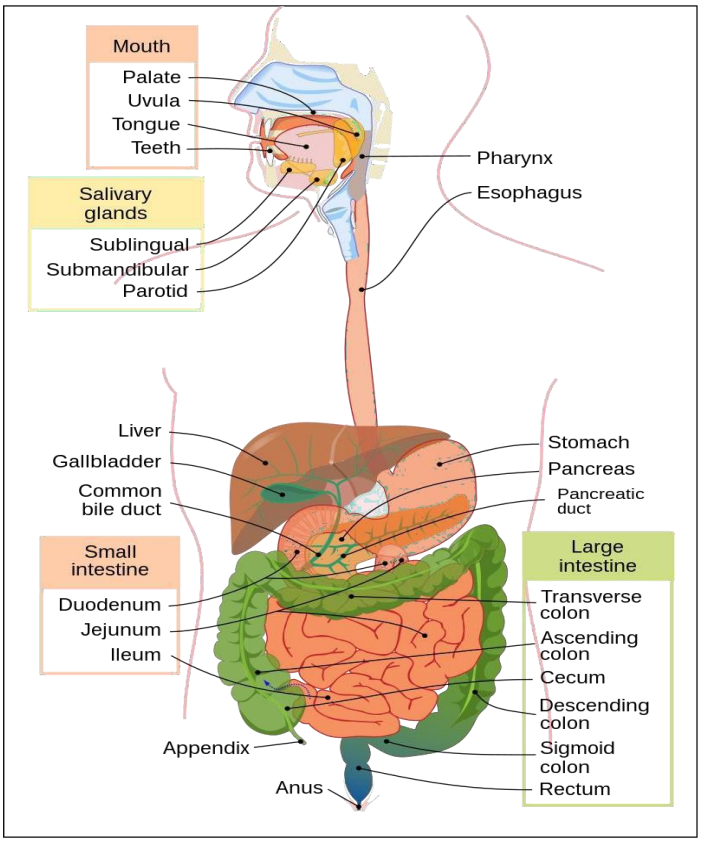
The digestive system is made up of the gastrointestinal tract(GI) also call the digestive tract and their liver, pancrease, and gallbladder. The GI tract is a series of hallow organs joined in a long twisting tube from the mouth to the anus. The hallow organs that make up the GI tract are the mouth, esophagus, stomach, small intestine, large intestine which includes the rectum and anus. Food enters the mouth and passes to the anus through the hallow organs of the GI tract. The liver, pancreas and gallbladder are the solid organs of the digestive system. The digestive system helps the body digest food.

* **Funtions:**

Ingestine = The taking of material into the digestive system
Propulsion of food through organs.
Breaks down food into usable molecules
Absorption of nutrients
Eliminates Waste

* **Digestive System Organs:**

Mouth->Pharyns->Esophagus->Stomach->Small Intestine->Large Intestine->rectum->Anus
Soild organs -> Liver, Pancrease, Gallbladder



* **Mouth:**

- Food begins its journey throught the digestive system in the mouth also knows as the oral cavity.
- Inside the mouth are many accessory organs that aid in the digestion of food the tongue, teeth, salivary glands.
- Teeth chop food into small pieces, which are moistered by saliva before the tongue and other muscles push the food into the Pharyns.

* **Pharynx:**
  - The pharynx or throat is a funnel shaped tube connected to the posterior end of the mouth.
  - The pharynx is responsible for the passing of masses of chewed food from the mouth to the esophagus.
  - The pharynx also play an important role in the respiratory sytem as air from the asal cavity passes through the pharynx on its way to the larynx and eventually the lungs.
  - Because the pharynx serves two different functionsit contain a flap of tissue known as the epiglottis that acts as a switch to play route food to the esophagus and air to the larynx.

* **Esophagus:**
- Esophagus is a muscular tube connecting.
- It carries swallowed masses of chewed food along its length.
- It is length of 25cm

* **Stomach:**
- The stomach is a muscular sac that is located on the left side of the abdominal cavity.
- The major organ acts as a storage food tank so that the body has time to digest large meals properly.
- The stomach also contains hydrochloric acid and digestive enzymes that continue the digestion of food that began in the mouth.
- Mixes fod with gastrio juices that contain enzymes break down – Proteins & lipids.
- Food found in the stomach is called Chyme, HCL acid in the stomach kills bacteria.

* **Small Intestine**: (20 Feets)
- The Small intestine is a long that is a part of about 1 inch in diameter and about 20 feet long that is a part of the gastrointestinal tract.
- It is a located just interior to the stomach and takes up most of the space in the abdominal cavity.
- The entire small intestine is coiled like a hose and the inside surface is full of many ridges and folds.
- These folds are used to maximize the digestion of food and absorption of nutrients.
- By the time food leaves the small intestine around 90% of all nutrients have been extracted from the food that entered it.
- Inner present in Villi ->
  Functions ->The digestive Food transfer into the blood cells.

* **Large Intestine:**
- The large intestine is a long thick tube about 2½ inches in diameter and about five feet long.
- It is Located just interior and wraps around the superior and Lateral border of the small intestine.

- The large intestine absorbs water and contains many symbiotic bacteria that aid in the breaking down of waste to extract some small amount of nutrients.
- The waste feces in the large intestine exit the body through the anal canal.
- In functions – Not digestive in small intestine of water, vitamins -> The large intestine transfer in to the blood cells.

* **Solid Organs:** Liver, Gallbladders, Pancreas

* **Liver and Gallbladders:**

- The liver located to the right of the stomach, just inferior to the diaphragm and seperior to the small intestine.
- The liver weight about 3 pounds and it is the second largest organ in the body.
- The liver has many different functions in the body.
- The main functions of the liver in digestine is the production of bile and its secretion into small intestine.
- The gallbladder is a small, pear-shaped organ, located just posterior to the liver.
- The gallbladder is used to store and recycle excess bile from the small intestine, so that it can be reused for the digestion of subsequent meals.

* **Pancreans:**

- The pancreas is a large gland located just inferior and posterior to the stomach.
- It is about 6 inches long and shaped like short lumpy snake with its 'head' connected to the duodenum and its trail pointing to the left wall of the abdominal cavity.
- The pancreas secretes digestive enzymes into the small intestine to complete the chemical digestion of foods.
- Regulate blood sugar by producting insulin.

* **Digestive Enzymes of organs:**

1) Salivary Gland = Salivary amylase

2) Stomach = Pepsin, Resine, Lipase

3) Small Intestine = Surcrase, Lactase, Maltase } Digestion of the carbohydrates(glucose/Fructose)
   Peptage = D.g -> Proteins(amino acids)
   Lypage = D.g -> Fatty acids

4) Pancrease = Pancreatic amylase -> Dg = Carbohydrates
   Trypsine = Proteins
   Lipase = Fats

5) Liver = Bile = D.g = Carbohydrates

The Human Respiratory System

What is Respiration: Respiration is a physical process by which we take in oxygen from the surrounding environment and release carbondioxide with the help of series of organs.

Respiration organs:

* Nasal Cavity
* Pharynx
* Larynx
* Primary Bronchi
* Lungs

For day -> 5800 ml lungs will take take. But only-> 500 ml taking.
Already storage in lungs -> 1200- 1400ml
Length : 2400m

The respiratory system refers to the mechanism of series of organs responsiblefor gas exchange in the body.

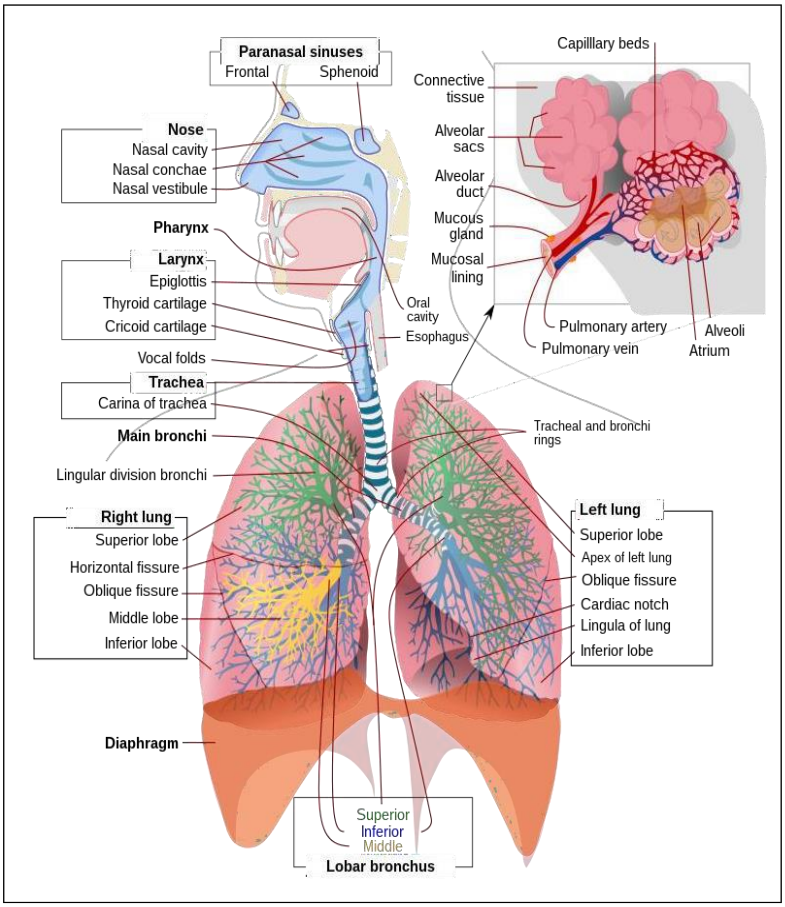
Respiratory system types:

1. Upper Respiratory Tract:
   - Nasal cavity
   - Pharynx
   - Larynx

2. Lowe Respiratory Tract:
   - Trachea
   - Primary Branchi
   - Lungs

Nasal Cavity 🡒 Phaynx 🡒 Larynx 🡒 Trachea 🡒 Primary Bronchi 🡒 Lungs 🡒 Bile 🡒

Alveoli 🡒 Alveoles



Nasal Cavity:

* The process of respiration (being) begins with nasal cavity.
* When we breath air flows o the nostils and enter the nasal cavity
* It consists of such cells which releases mucus.
* Mucus is a salty and sticky substance which helps in killing bacteria.
* It has guard hairs which block the inhalation of large particles.
* It also warms and humidifies the inhealed air.

Pharynx:

* It is also called throat.
* It is a muscular funnel extending 13cm long.
* It is further divided into three parts – Nasopharynx
  Oropharyme
  Laryngopharynx
* Upto this point (pharynx) food, drink and air share a common path.

Larynx:

* It's basic function is to keep food and drink out of the airway.
* At the top of the larynx is a spoon shaped flap of catilage called "Epiglottis".
* Epiglottis directs food and drink into the esophagus.
* Larynx also has a additional function of producing sound (That is why it is also called voice box).

Trachea:

* It is also called the wind pipe.
* It is a rigid tube, 12 cm in length.
* It is surrounded by "C" Shaped cartilage Rings.
* These rings provide "Flexibility and strength to trachea".
* In Respiratory system Trachea's main job is to transfer the air to next junction/passage caled primary bronchi.

Primary Branchi:

* It is also called branchi.

* It is divided into two parts:
* Right Lung → Superior lobe, Middle lobe, Interior lobe.
* Left Lung → Superior lobe, Inferior lobe.

* Right lung is larger than left lung.
* Both lungs weighs approximate 1.3 kg.

Bronchial Tree:

* The branches and sub-branches of primary brochi are called bronchules.
* Bromchules are root like structure which again divide into further branches and sub-branches which is called "Branchial Tree".
* The air passes through branchial tree to the next and final function of the respiratory system Alveoli.

Alveoli:

* Alveoli is the actual site of gaseous exchange of oxygen and carbondioxide between the lungs and the blood.
* Alveoli is called the basic unit of respiratory system.
* It looks like bunch of grapes.
* A single spherical ball like structure of alveoli is called Alveolus.
* Alveoli is a group of several Alveolus.

Alveolus:

- It is very thin and composed of a single cell membrane.
- It has blood capillaries
- The extremely thin membrane helps in very easy exchange of gases between the Alveolus and RBC's flowing through the cappilaries.
- The process of gas exchange occurs by a diffusion.

Central nervous system

The central nervous system (CNS) is made up of the brain and spinal cord. It is one of 2 parts of the nervous system. The other part is the peripheral nervous system, which consists of nerves that connect the brain and spinal cord to the rest of the body. The central nervous system is the body's processing centre.

Why is it called central nervous system:-

It controls things like thought, movement, and emotion, as well as breathing, heart rate, hormones, and body temperature. CNS is referred to as "central" because it combines information from the entire body and coordinates activity across the whole organism.

Classification:-

Broadly speaking, the nervous system is organized into two main parts, the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS is the processing centre of the body and consists of the brain and the spinal cord. Both of these are protected by three layers of membranes known as meninges

1. Central Nervous System (consists of the brain and spinal cord)
2. Peripheral Nervous System (includes all the nerves of the body)

Central Nervous System

Central Nervous System (CNS) is often called the central processing unit of the body. It consists of the brain and the spinal cord.

Brain

The brain is one of the important, largest and central organ of the human nervous system. It is the control unit of the nervous system, which helps us in discovering new things, remembering and understanding, making decisions, and a lot more. It is enclosed within the skull, which provides frontal, lateral and dorsal protection. The human brain is composed of three major parts:

1. **Forebrain**: The anterior part of the brain, consists of Cerebrum, Hypothalamus and Thalamus.
2. **Midbrain**: The smaller and central part of the brainstem, consists of Tectum and Tegmentum.
3. **Hindbrain**: The central region of the brain, composed of Cerebellum, Medulla and Pons.

Also read: Human Brain

Spinal Cord

The spinal cord is a cylindrical bundle of nerve fibers and associated tissues enclosed within the spine and connect all parts of the body to the brain. It begins in continuation with the medulla and extends downwards. It is enclosed in a bony cage called vertebral column and surrounded by membranes called meninges. The spinal cord is concerned with spinal reflex actions and the conduction of nerve impulses to and from the brain.

Peripheral Nervous System

Peripheral Nervous System (PNS) is the lateral part of the nervous system that develops from the central nervous system which connects different parts of the body with the CNS. We carry out both voluntary and involuntary actions with the help of peripheral nerves.

Also refer: Peripheral Nervous System

PNS includes two types of nerve fibers:

1. **Afferent nerve fibers** – These are responsible for transmitting messages from tissues and organs to the CNS.
2. **Efferent nerve-fibers** – These are responsible for conveying messages from CNS to the corresponding peripheral organ.

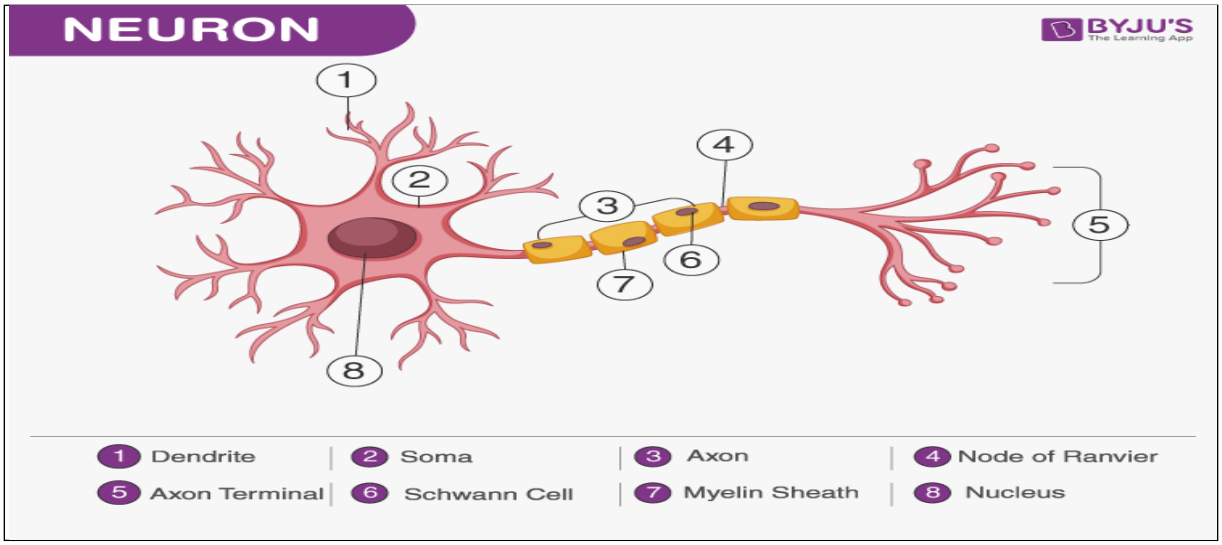
Classification of the peripheral nervous system:

Somatic neural system (SNS): It is the neural system that controls the voluntary actions in the body by transmitting impulses from CNS to skeletal muscle cells. It consists of the somatic nerves.

Autonomic neural system (ANS): The autonomic neural system is involved in involuntary actions like regulation of physiological functions (digestion, respiration, salivation, etc.). It is a self-regulating system which conveys the impulses from the CNS to the smooth muscles and involuntary organs (heart, bladder and pupil). The autonomic neural system can be further divided into:

1. Sympathetic nervous system
2. Parasympathetic nervous system

Neuron



A Neuron is a structured and functional unit of the nervous system and unlike other cells, neurons are irregular in shape and able to conduct electrochemical signals. The different parts of a neuron are discussed below.

- Dendrite stretches out from the cell body of a neuron, and it is the shortest fibre in the cell body.
- Axon is the longest thread on the cell body of a neuron and has an insulating and protective sheath of myelin around it.
- Cell body consists of cytoplasm and nucleus.
- Synapse is the microscopic gap between a pair of adjacent neurons over which nerve impulses pass, when moving from one neuron to the other.

Explore more: Placebo Effect

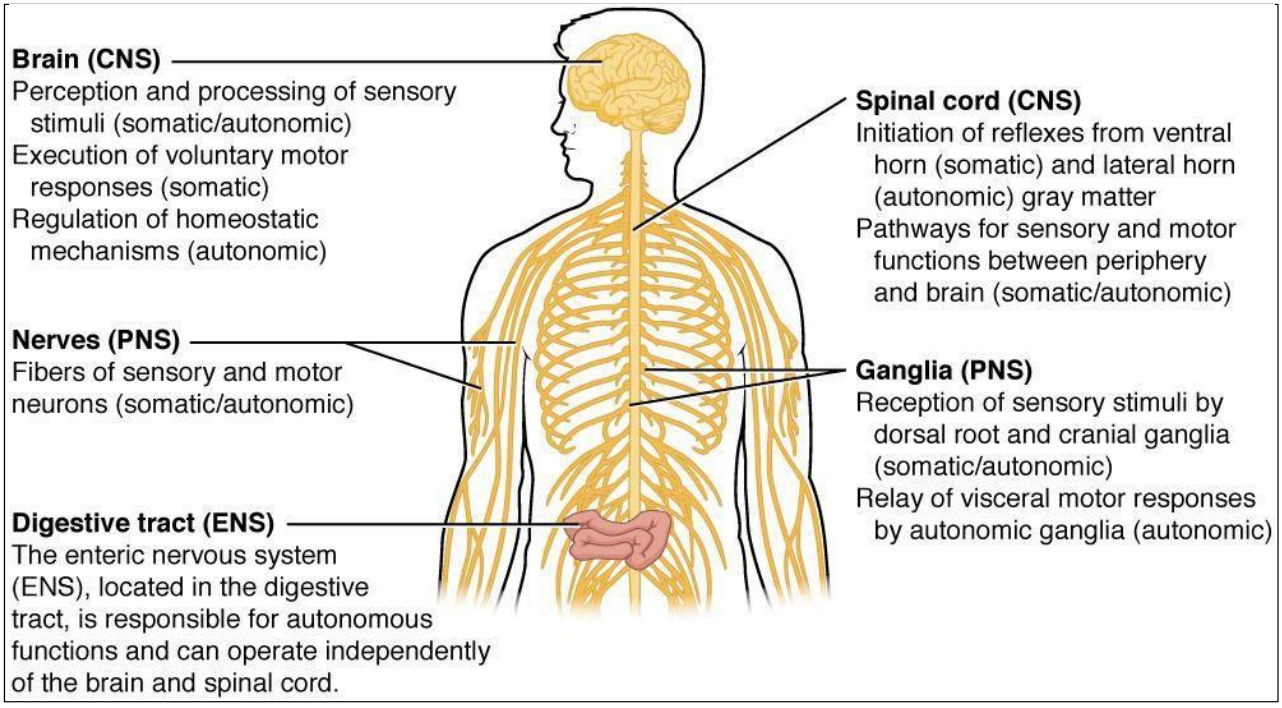
Nerves

Nerves are thread-like structures that emerge from the brain and spinal cord. It is responsible for carrying messages to all the parts of the body. There are three types of nerves. Some of these neurons can fire signals at speeds of over 119 m/s or above 428 km/h.

1. Sensory nerves send messages from all the senses to the brain.
2. Motor nerves carry messages from the brain to all the muscles.
3. Mixed nerves carry both sensory and motor nerves.

Also read: Nerves

Cranial nerves begin from the brain as these nerves carry impulses to start from the central nervous system. Certain cranial nerves belong to the group of mixed nerves while certain ones fall under sensory nerves. Spinal nerves originate from the spinal cord. All the spinal nerves carry impulses to and from the central nervous system and these are part of mixed nerves. The above nervous system diagram depicts the various nerves arising from various parts of the body.



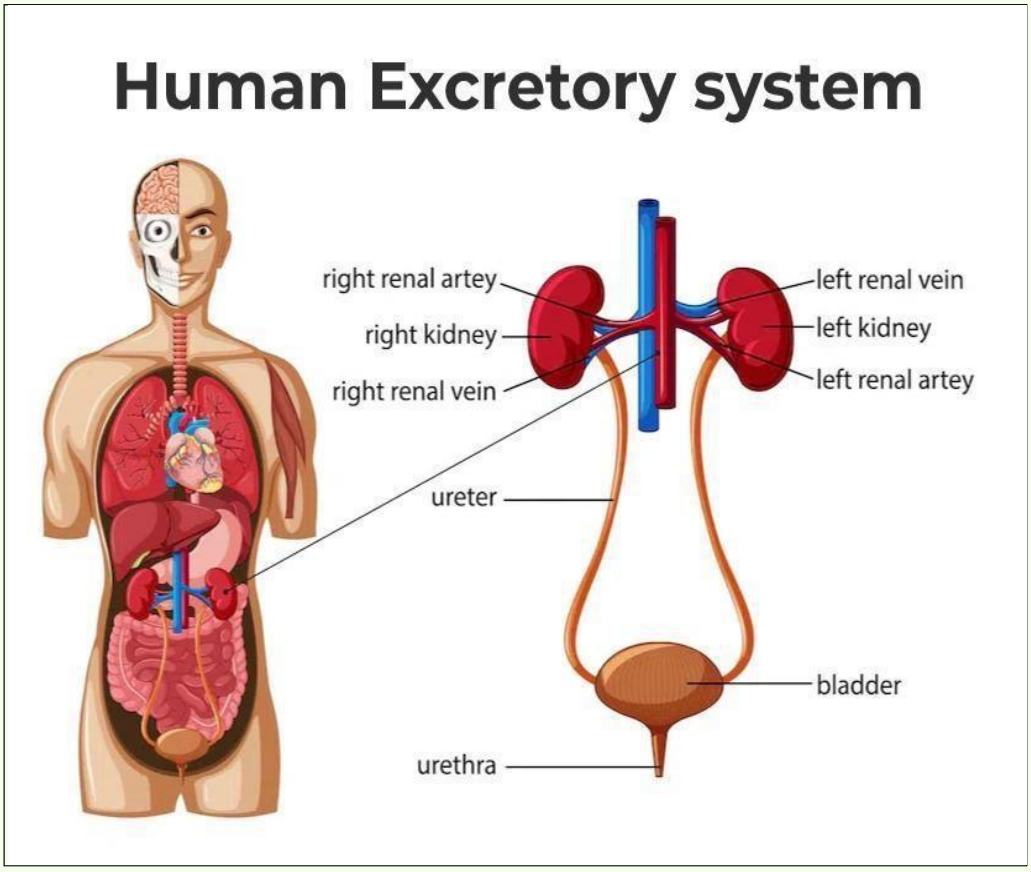
Excretory system in human beings

Human excretory system includes organs that facilitate the removal of nitrogenous wastes from the body.

The main excretory organs include kidney, ureter, urinary bladder and urethra. Kidneys filter the blood and urine is the filtrate obtained.

What is the excretory system short answer?

The excretory system is a vital biological system that removes excess and waste products from the body to maintain homeostasis. Most of these products are in fact used and broken down components of metabolism that leave the body in the form of urine, sweat, or feces.



Human excretory system:

(a) In humans, the excretory system consists of a pair of kidneys, a pair of ureters, urinary bladder and urethra.

(b) Kidneys are two bean shaped organs lying at the back of the abdomen, one on either side of the vertebral column. Waste products from the blood and urine are removed by the kidney.

(c) A Nephron is the basic filtration unit of the kidney. It is a cluster of thin walled blood capillaries.

(d) The urine produced by filtering the blood is transported to the urinary bladder. This is done by a pair of ureters. Ureters are long muscular tubes.

(e) Urinary bladder is a muscular bag like structure which can hold urine. The urinary bladder is under the control of nerves. When the bladder is full one get urge to urinate.

(f) This urine is thrown out of the body through urethra.

(g) Apart from the kidney, the skin and lungs are also helpful in the excretion.

The excretory system examples:-

Organs of excretion include the skin, liver, large intestine, lungs, and kidneys. All of them excrete wastes, and together they make up the excretory system. The skin plays a role in excretion through the production of sweat by sweat glands.

Human Excretory System is one of the types of life processes. Excretion helps to excrete out all the metabolic waste produced due to any reaction in the body. The excretion system is of two types i.e., the internal and external, human excretory system is an internal excretion system.

Excretion in Humans

Human Excretory System is a complete set of organs & tubes. All of them together make a complete mechanism to throw out the waste materials outside of the body. Though human body can able to excrete waste material in some other forms also. Like the means of the sweet, some waste materials can remove from the body. But the amount of waste removed from the body by the sweet is very less. Whereas by the largest excretory system, a huge amount of waste can be removed at a time.

It is very normal to create a waste product in the human body. Whatever we intake as food or drink, create waste product inside the body. They store in the cells. Also, there are some other important processes executed inside the body. These create waste products also. All the waste product needs to be removed. So, they have to store in the cell & at last, they are removed from the body.

Excretory System Organs

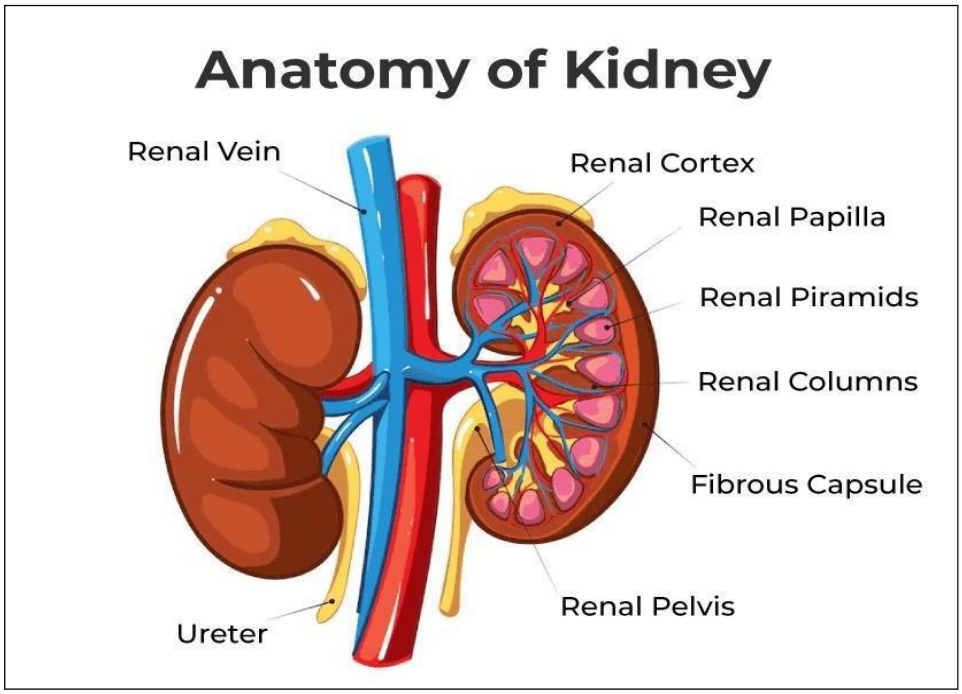
The human excretory system is a complete set of organs. There are many organs present that make the process easy. These organs together make the system a complicated one. There are the below-mentioned organs:

- Two sets of Kidneys
- Two sets of Ureters
- One Urinary Bladder
- One Urethra

Kidneys

Kidneys are the most important organ in the excretory system. It is a red bean shape structure present on both sides of the backbone. The normal size of a kidney is 10 -12 cm, the width of 5-7 cm, and the weight is approx 120-170g. There are excreted materials produced. Kidneys have a

hard outer layer. This is known as the **Capsule**. The Capsule can further be divided into two major parts.



- **Cortex:** This is the outermost layer of the kidney. This is completely made with connective tissues. There is a salt concentration than in the other areas of the kidney. Nephrons are the functional unit of the kidney. The part of the nephron lies in the cortex area. The Renal Capsule, Proximal Convoluted Tubule & Distal Convoluted Tubules are present in this part.
- **Medulla:** This is the inner part of the kidneys. Their pyramid-like structures are present. This place is a high-concentration area inside the kidney. Only the Henle's Loop of the nephron is present there. As Henle's Loop can able to reabsorb the salt. That is why this part has a high salt concentration. Also, the collecting ducts of the Nephron are present there. All the collecting ducts merge there & make a large collecting tube there.

Capsule

The outermost layer of the kidney is known as the capsule. It is hard in nature made up of stromal cells surrounded by connective tissue. It plays an important role in the development of kidneys.

Nephron

The functional unit of the Kidney has some anatomical structure there. This can be divided into some parts. This is responsible to reabsorb, secrete, and filtration of the waste product inside the kidneys. These units all together perform the production of the waste product.

- **Glomerulus:** It is the ball of tiny blood vessels. The small blood vessels come together & make a network of blood vessels there. The Afferent blood vessels & Efferent blood vessels make this network. In this way, the polluted blood comes to the nephron inside the kidney. It filters the blood & makes fresh blood. Then it comes out from the nephron.
- **Bowman's Capsule:** This is the free space in the nephron. The Glomerulus is surrounded by the Bowman's Capsule. There are three layers. All of them are made with epithelium layers. In those layers, there are small pores. This help to move forward those waste substances inside of the nephrons for further process.
- **Proximal Convoluted Tubules:** This is the first tube-like structure in the nephron. This tube is not linear. This means there are some loops present. These loops happen as there is a large length of the tube is convoluted there. In this part, the reabsorb of the important substances occurs.
- **Henle's Loop:** This is also a tube-like structure. There are two arms in this loop. One is ascending arm & another is descending arm. This area is also performed re-absorption. Water & salt are being reabsorbed here.
- **Distal Convoluted Tubules:** This is another part of the Nephron. This is also convoluted like the proximal convoluted tubules. Here, the secretion of some hormones & other substances is performed.

Types of Nephrons

Nephrons can be divided into two categories as per their size & location. As the Nephrons are situated in the Kidney, so there are two locations in the Kidney where the Nephrons can be located. The types are:

- **Cortical Nephron:** This is the main type of Nephron present in the human body. Nearly 80% of Nephrons fall under this category. This type of Nephron is mainly located in the Cortex of the Kidney. The maximum parts of the Nephron belong to the Cortex area of the Kidney. From the location of the Nephron, it is called the Cortical Nephron.
- **Juxtamedullary Nephron:** This is another type of Nephron. This type of Nephrons can be found small in amount. Nearly 20% of Nephrons fall under this category. Here, the Nephrons are mainly located inside the Medulla area of the kidney. So, as per the location of the Nephron, the name is allocated. They are small in size also.

Ureters

It is a thin tube-like structure. This comes out from the kidney by a special location, called Renal Pelvis. This helps to move the urine to the urinary bladder. This is made with small tissues. There are two ureters in the human body.

Urinary Bladder

This is the sac-like organ present in the human body. This helps to store the urine inside of it for a while. The capacity of the bladder is 500ml of urine. The bladder can be divided into two parts, they are the upper part & lower part. In the lower part, there is the neck. From the neck, the Urethra is attached to this area. The bladder is situated in the pelvic cavity of the human body.

Urethra

This is the muscular tube present after the urinary bladder. It helps to remove both the urine & the sperm. It is a long tube that opens nearly the prostate gland. Then it helps to remove the urine

produced in the kidney. There is a Sphincter muscle in the urethra. This helps to guard the opening of the urethra. It helps to regulate the removal of urine.

Urine Formation

The kidney is the major organ that performs the main function of urine formation. Inside the Glomerulus, due to the large pressure of the blood, waste products come inside the nephron. It then stores in the Bowman's Capsule for a while. Then the fresh blood comes out from the nephron or the kidney.

Inside the Glomerulus, the filtration process is completed. After that, the waste product i s stored inside the Bowman's Capsule. After that, it comes to the proximal convoluted tubules. There the reabsorption process takes place. This means from there some substances like Glucose, Water, etc are get reabsorbed. These will again move to the blood. There is a blood capillary close to the Proximal Convoluted Tubules. This will help to make the substances available there.

Then insides of Henle's Loop more reabsorption takes place. There are two different types of reabsorption takes place. In the ascending limb of Henle's Loop, the water is reabsorbed. But in the descending limb, water doesn't reabsorb. At last, in the Distal Convoluted Tubules, the secretion process takes place. With the help of the secretion process, some more waste products like Uria, Uric Acid, and Ammonia removes from the body.

Then the produced urine will come out from the renal pelvis of the kidney. Then it moves forward with the help of the Ureters & comes to the Urinary Bladder. Inside the bladder, the urine is stored for a certain amount of time. When the stored urine goes beyond the capacity of the bladder, it removes from the body. The removal of urine can take place with the help of the Urethra.

Functions of Human Excretory System

The main function of the excretory system is to produce urine or waste material. The process of the production of the water material is mainly inside the kidney. Also, some more functions are being served by the urinary bladder.

Kidney

The Nephrons are the functional unit of the kidney. The polluted blood comes to the nephron by the Afferent blood vessel in the Glomerulus. Thereby the help of the filtration process those waste materials come inside the nephrons. The fresh blood then returns to the body by the efferent blood vessels. The filtration process is completed by the high blood pressure inside the Glomerulus. Then those waste products are stored for some time inside the Bowman's capsule. Then the waste product comes inside the proximal convoluted tubules. There the reabsorption takes place. Some important substances are present in those waste products. As the filtration can't able to efficiently pick only the waste product. So, reabsorption takes place. Here, **NaCl, Glucose, Water, etc. gets reabsorbed.**

In Henle's Loop reabsorption also occur. There in the ascending limb of Henle's Loop, Sodium, Potassium, and Magnesium ions are gets reabsorbed. In the descending loop, only the **water & salt can be reabsorbed.**

At last, inside the Distal Convoluted Tubule, the secretion takes place. These harmful substances like Uria, Uric acid are secreted. Hence the urine is produced finally. Then they come together to the collecting duct. There they all mixed up & come out from the kidney by the renal pelvis.

Ureter

Here, the urine which is produced by the kidney moves to the urinary bladder. The only function of the Ureter is to carry the urine to the bladder.

Urinary Bladder

The main function of the Urinary Bladder is to store urine there. The receptors which are present on the walls of the Bladder send the signal to the Central Nervous System. It is then stretched & stores the urine inside it. Again, it receives the signal from the central nervous system & charges out the urine. This process is known as Micturition.

Urethra

This helps to finally throw out the urine outside of the body. Not only urine but is also used to eject sperm outside of the body. This is used as the common route. The sphincter muscle regulates the amount of urine that needs to be thrown out of the body. It is also controlled by the central nervous system.

Disorder of Human Excretory System

Following are the disorders which are related to the human excretory system are:

- **Renal Failure:** In this disease, the filtration process of the Glomerulus is affected mostly. As the kidney can't able to filter the blood, the production of urine hampers. In severe conditions, both kidneys may get failed.
- **Renal Caliculi:** This is the disorder commonly known as Kidney Stone. There create some stones inside the kidney with the help of insoluble salts. And they get stuck inside the kidney walls. This creates a large size kidney. When that pass, patients feel immense pain.
- **Nephritis:** This is also known as the Bright Diseases. In this case, there is inflammation of the kidney. Due to a disorder of the nephron. Some parts of the nephron start malfunctioning. This creates a problem. The inflammation of the Glomerulus can also cause this. In some cases, artificial kidneys are the only way to survive.

Regulation of Human Excretory System

If a kidney is damaged & can only able to work 15% or less than that, then dialysis is needed for that patient. There are mainly two types of dialysis present. one is for the routine patient. Another is for the scheduled patients. Routine patients need to come to the hospital or a specific location for dialysis purposes. But the scheduled patients need to do the dialysis at their own homes. As the dialysis process for them is quite easier than that of routine patients.

Here, a machine is attached to the body. It is the same as the kidney in our body. There are two transporters in the machine. One helps to deliver the polluted blood of the body to the machine. Inside the machine, the blood gets purified. All the waste products are gets filtered in the machine. Then the purified blood comes into the body of the patient again. This process is being done at some intervals. After every particular second, the blood needs to be again purified. In a single day, a human body can produce 32 ounces of waste product & water from its blood.

Importance of Human Excretory System

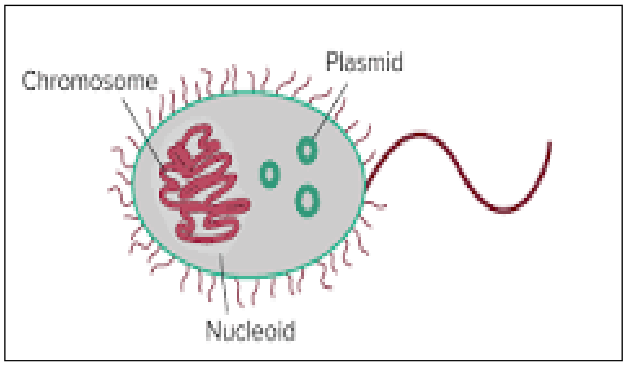
- Time by time, the body gets infected with waste which is removed by the human excretion system.

- Some poisons may arise inside the body if the waste product is stored for a long time. The removal of waste products is very important.
- If the waste cannot be thrown out outside of the body, then it will directly affect health.
- Human urine is the way, by which a large amount of waste can be thrown out.

UNIT-IV
INTRODUCTIOPN TO MOLECULAR BIOLOGY AND RECOMBINANT DNA TECNOLOGY

========== **Prokaryotic gene structure**

Prokaryotes generally have a single circular chromosome that occupies a region of the cytoplasm called a nucleoid. They also may contain small rings of double-stranded extra-chromosomal DNA called plasmids.



Characteristics of Prokaryotic Cell

They lack a nuclear membrane. Mitochondria, Golgi bodies, chloroplast, and lysosomes are absent. The genetic material is present on a single chromosome. The histone proteins, the important constituents of eukaryotic chromosomes, are lacking in them.

What is gene :-

- The term gene was coined by Danish botanist Wilhelm Johannsen.
- Gene is the basic functional unit of hereditary.
- The whole genome of an organism can be divided into genes.
- The genes code for proteins in a series of processes which are the building blocks of life.
- There are several types of genes with specific functions and positions.
- Within a genome, there are various coding and non-coding regions.

- The genomes of eukaryotes and prokaryotes are distinguished by the amount of non-coding regions present.
- The human genome is approximately 3,200 Mb large, and the genome of the most studied organism *E. coli* is 4.6 Mb large. (1 Mb = 1,000,000 bases).
- *Mycoplasma genitalium* has the smallest genome, which contains only 468 genes and is 0.58 Mb large.

Structure of gene:-

- The genes are located on the chromosomes at a specific location called the locus.
- The genes and the DNA are compactly packed in the chromosome.
- Each nucleated cell contains the whole set of the genome.
- In humans, the genome is composed of 23 pairs of linear chromosomes packed with the help of histone proteins.
- 22 pairs are of autosomal chromosomes and 1 pair consists of sex chromosomes.
- In bacteria like *E. coli*, the genome is composed of a single circular chromosome.

A typical Gene consists of:

1. **Promoter sequence:** It is a sequence of DNA to which the enzyme binds which initiates the process of gene expression. It is present at the start of the gene.
2. **Coding region:** It is a stretch of DNA that codes for proteins or RNA. The coding region is composed of introns and exons. Exons are the regions which are protein-coding sequences and intron sequences do not code for any protein. It is also called Cistron. Cistron consists of Muton (the part of a gene that undergoes mutation) and Recon (the part of a gene that undergoes recombination).
3. **Terminator sequence:** It is the sequence of DNA that brings about the termination of the gene expression. It is present at the end of a gene.

The prokaryotic gene consists of :-

- A single promoter
- Coding region
- A single terminator

The gene in which a single promoter and terminator control the expression of many genes is known as the Poly-cistronic gene OR The gene which codes for one or more proteins is known as the polycistronic gene.

Promoter

- A promoter sequence is present in the upstream region of the gene (near 5`end of the gene). -35 (TTGACA) and -10 (TATAAT) are known promoter sequences that initiate the process of transcription by interaction with the RNA polymerase.
- -35 and -10 regions are consensus sequences, which means that they are conserved sequences in man organisms.
- The -10 region is also known as the Pribnow box.

Coding region

- This region starts with the initiator sequence and ends with the terminator sequence.

- The coding region is responsible for the formation of proteins by subsequent steps of transcription (formation of mRNA from DNA template) and translation (formation of the amino acid polypeptide chain and further into folded proteins from mRNA strand as a template).
- The prokaryotic gene is continuous, which means it does not contain introns (the non-coding region in a gene).

Termination region

- This region signals the RNA polymerase to terminate the transcription process.
- The termination can be of two types Rho (ρ) dependent or Rho (ρ) independent termination.

Examples

The genome of *E.coli* is well characterized and consists of 4,267 genes. The genome exists as circular, double-stranded DNA.

The genome of *Mycoplasma genitalium* contains only 468 genes.

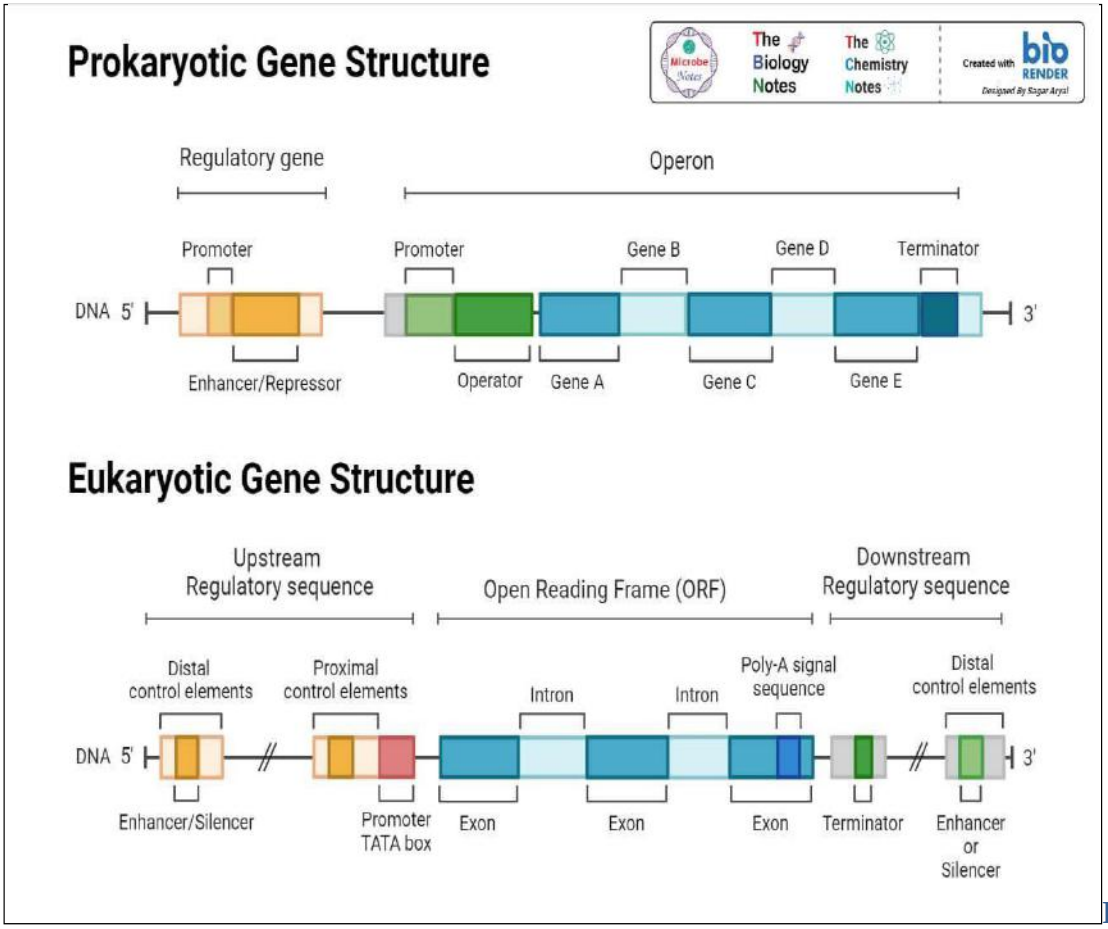


Figure: Prokaryotic and Eukaryotic Gene Structure.

Eukaryotic gene structure

The eukaryotic gene consists of –

- Exons
- Introns
- Promoter sequence
- Termination sequence

Exons

- The term exon was coined by Walter Gilbert in 1978.
- These are the coding sequences that are first transcribed and then translated which leads to the formation of proteins.
- The numbers of exons vary in an organism.

Introns

- Introns were discovered by Richard Roberts and Phil Sharp. Their experiments showed that the eukaryotic genes contain interruptions, called introns.
- These interruptions or introns do not code for any protein and hence, are also known as non-coding regions or junk segments of DNA.
- The introns are removed from the mRNA segment before it is translated into a protein by the process known as splicing.
- Introns are important as they are responsible for regulatory sequences of the RNA and regulate gene expression.
- Exon shuffling, in which introns facilitate the recombination of exons in different genes, is evolutionarily important.

Promoter sequences

- This is the region where the process of transcription is initiated.
- In eukaryotes, the promoter contains three distinct regions known as a core promoter, proximal promoter, and distal promoter.
- The core promoter is the site recognized by the RNA polymerase, and 0this region is located just before the start site. TATA box is the site that contains the sequence 5`-TATAA-3` and also has sites for histone binding and transcription factors.
- The proximal promoter site is located upstream of the core promoter and usually has binding sites for primary regulatory elements for the transcription process.
- A distal promoter is present upstream of the proximal promoter, and this promoter also has binding sites for transcription factors but mainly contains regulatory elements.

Termination sequence

- The RNA polymerase recognizes the particular sequence on the mRNA, which indicates the termination of the transcription process.
- In bacteria, the termination can be carried out in two ways. P (rho) dependent and ρ (rho) independent termination.
- In ρ-dependent termination, the ρ enzyme is required. It binds to a Rut (Rho utilization site) site. This enzyme binds to a specific sequence which is C rich region. This binding cleaves the RNA from the template.
- In the ρ independent termination, a few nucleotides upstream of the termination site a G-C rich region is present and near the termination site also a G-C rich region is present. These two sites are complementary to each other. These sites form a hairpin loop structure and this formation of a hairpin loop drags the RNA from the template, and termination is achieved.

- In the case of the process of translation, the termination codons present on the mRNA indicate the termination. The termination codons are UAA, UGA, and UAG.

Regulation of gene expression

Gene expression is regulated for proper functioning and differentiation of the cells. Every cell contains a different set of proteins which are coded by the genes. Hence the regulation of gene expression is important for the organism.

Prokaryotic gene expression regulation

- In prokaryotes, the processes of transcription and translation occur almost simultaneously. When a particular protein is no longer required, the process of transcription stops, as the protein in excess amount signals the stop of the transcription process.
- Hence the expression of a gene in prokaryotes is mostly regulated at the transcriptional level.
- Three kinds of proteins regulate the genes. Inducers, Repressors, and Activators.
- Repressor proteins bind to the operator region and block the binding capacity of the RNA polymerase.
- In the case of activator proteins, they bind to the inducer region of the gene and enhance the binding capacity of the RNA polymerase.
- Inducer molecules bind to the DNA and activate or repress the gene based on the needs of the cell and the availability of substrate.
- In prokaryotes, the genes required for a particular protein are assembled next to each other, and this arrangement is called an operon.
- For example – The genes required for the use of lactose are arranged into lac operon. Trp (tryptophan) operon is a repressible operon.
- Bacteria require certain amino acids for survival, and these amino acids are produced in the cell with the help of these operons. Tryptophan is one of the essential amino acids required by bacteria. 5 genes are required for synthesizing tryptophan, and these genes are placed next to each other.
- If tryptophan is not available in the environment, bacteria synthesize tryptophan using these genes.
- When the concentration of tryptophan in the cell is high, two molecules of tryptophan bind to the repressor protein on the operator site and inhibit the transcription of RNA hence genes required for the synthesis of tryptophan are blocked.
- Trp operon is negatively regulated by tryptophan molecule.
- Another example of gene regulation in prokaryotes is the lac operon. This is an inducible operon.
- When the glucose concentration in a cell is less or glucose is absent, then bacteria can utilize lactose as a source of energy. Lac Z gene in the lac operon produces β-galactosidase, which breaks down lactose into galactose and glucose.
- When lactose is present, its isomer allolactose binds to the repressor protein and changes its structure so that it cannot bind to the lac operator site and prevent transcription.
- The presence of lactose induces the operon to code for proteins and enzymes and so it is an inducible operon.
- The absence of glucose and the presence of lactose are the important conditions required for a functional lac operon.

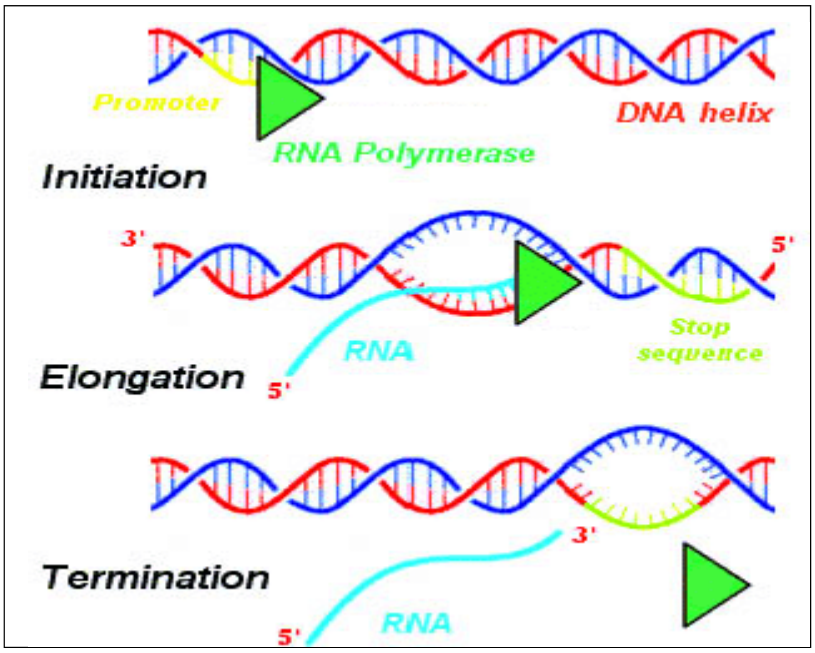
DNA replication, transcription and translation

Both DNA Replication and Transcription involve the generation of a new copy of the DNA in a cell. DNA transcription is involved in replicating the DNA into RNA, while DNA replication makes another copy of DNA. Both processes are involved in the production of new nucleic acids- DNA or RNA.

Difference between DNA replication transcription and translation:-

DNA replication occurs in preparation for cell division, while transcription happens in preparation for protein translation. DNA replication is important for properly regulating the growth and division of cells

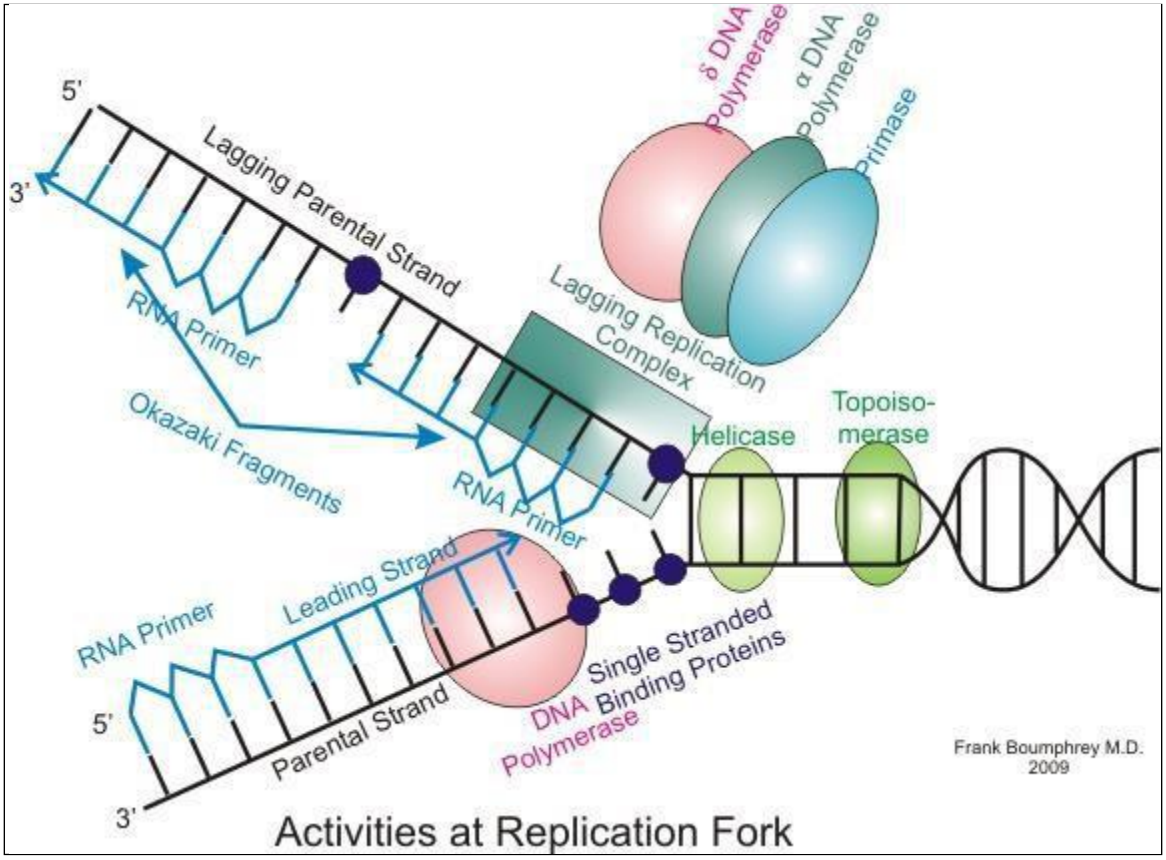
The 3 stages of replication translation and transcription:-



The process of DNA transcription can be split into 3 main stages: initiation, elongation & termination. These steps are also involved in DNA replication.

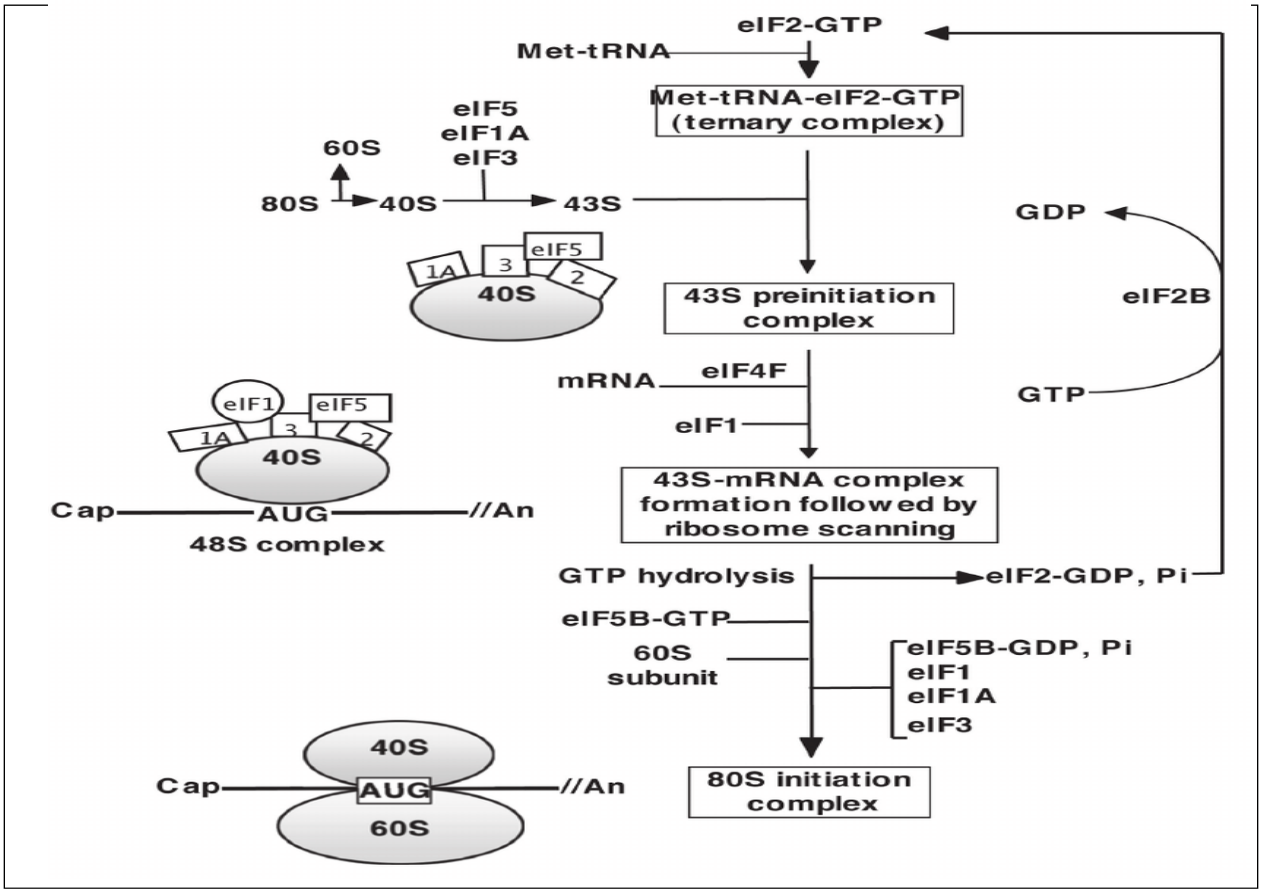
DNA replication:-

The mechanism of eukaryotic DNA replication is similar to that of prokaryotic DNA replication. However, eukaryotic DNA replication requires special consideration due to differences in DNA sizes, unique linear DNA end structures called telomeres, and distinctive DNA packaging that involves complexes with histones.

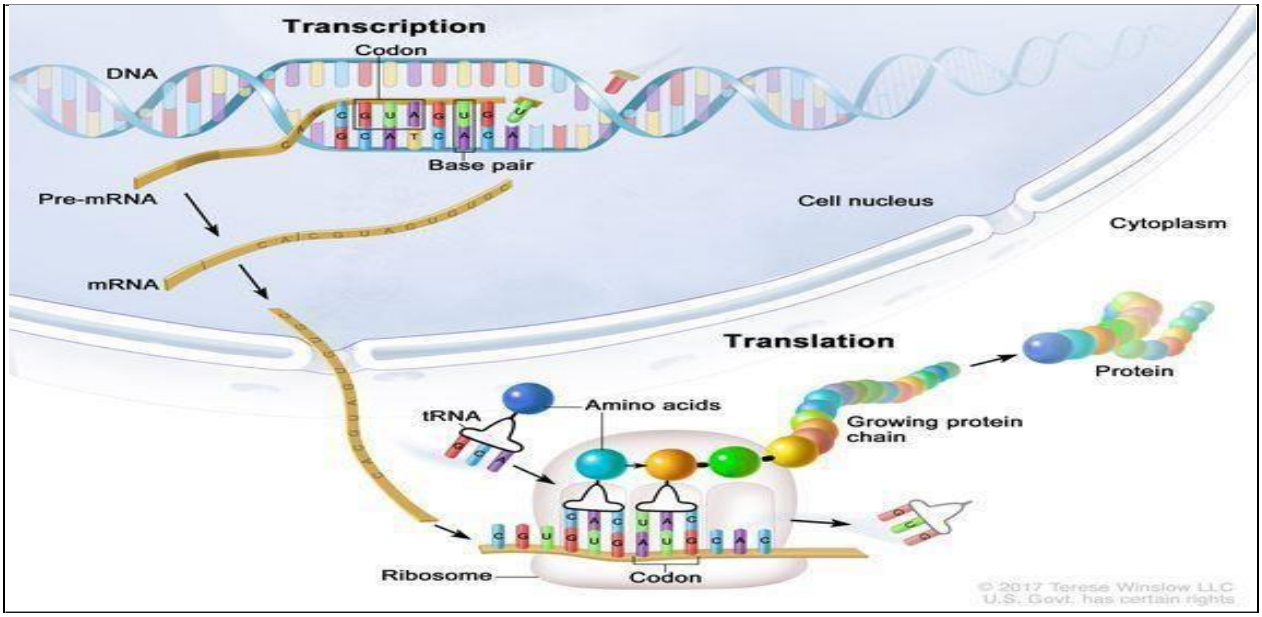


Eukaryotic translation:-

Eukaryotic translation is **the biological process by which messenger RNA is translated into proteins in eukaryotes**. It consists of four phases: initiation,



Translation and translation in DNA:-



Listen to pronunciation. (trans-LAY-shun) In biology, the process by which a cell makes proteins using the genetic information carried in messenger RNA (mRNA). The mRNA is made by copying DNA, and the information it carries tells the cell how to link amino acids together to form proteins.

DNA transcription:-

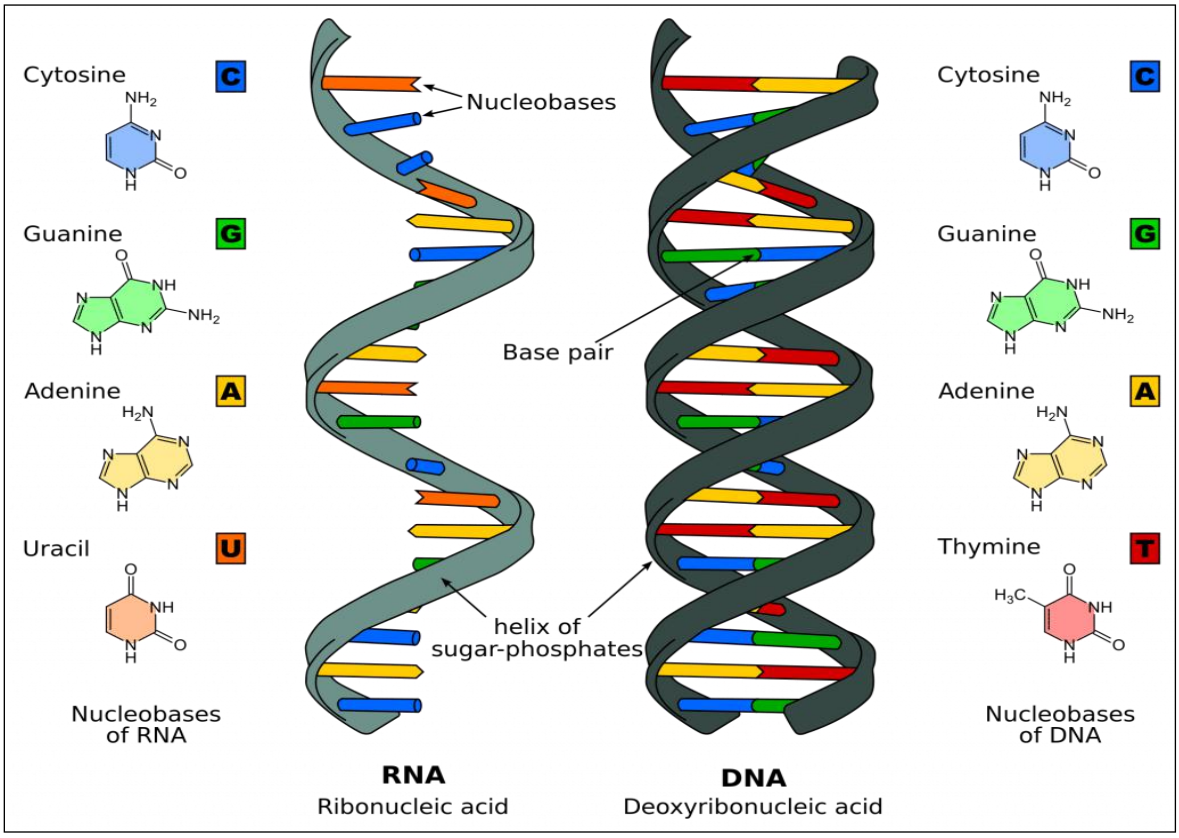
DNA transcription is the process by which the genetic information contained within DNA is re-written into **messenger RNA** (mRNA) by **RNA polymerase**. This mRNA then exits the nucleus, where it acts as the basis for the **translation** of DNA. By controlling the production of mRNA within the **nucleus,** the cell regulates the rate of gene expression.

In this article, we will look at the process of DNA transcription, including the post-transcriptional modification of mRNA and its importance.

RNA Vs DNA

RNA, like DNA, is a polymer of three subunits joined by **phosphodiester bonds**. However, as detailed in the table below, there are key differences in the monomer units for each compound.

DNA	RNA	
Sugar	Deoxyribose	Ribose
Bases	Adenine, guanine, cytosine, thymine	Adenine, guanine, cytosine, uracil
Structure	Double-stranded helix	Single-stranded helix

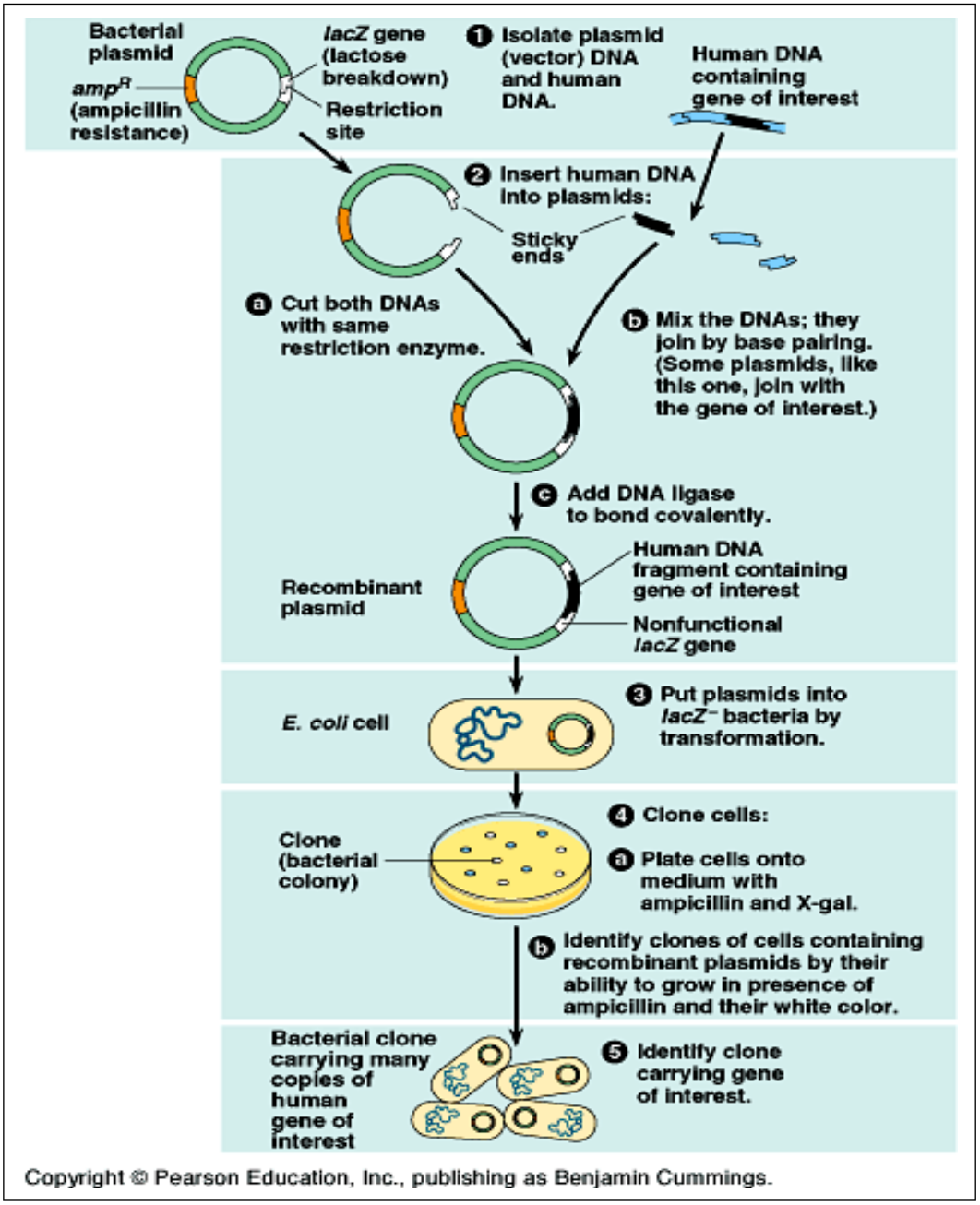


Gene cloning

- Gene cloning involves separation of specific gene or DNA fragments from a donor cell, attaching it to small carrier molecule called vector and then replicating this recombinant vector into a host cell.

Steps involved in gene cloning

1. Isolation of donor DNA fragment or gene
2. Selection of suitable vector
3. Incorporation of donor DNA fragment into the vector
4. Transformation of recombinant vector into a suitable host cell
5. Isolation of recombinant host cell



1. Isolation of donor DNA fragment or gene

- At first a donor DNA fragment should be isolated. There are two method for isolation of desired gene or DNA fragment.
- Using restriction endonuclease enzyme: the enzyme restriction endonuclease is a key enzyme in molecular gene cloning. It has specific restriction site for its action. The enzyme RE generates a DNA fragment either with blunt end or with sticky end
- Using reverse transcriptase enzyme: reverse transcriptase enzyme Synthesizes complementary DNA strand of the desired gene using its mRNA.

2. Selection of suitable cloning vector:

- When donor DNA fragment is incorporated into a host cell, it will not replicates because the isolated gene do not have the capacity to replicated itself. So before introduction of donor fragment into host, a suitable vector should be selected.
- Cloning vector is the DNA molecule capable of self-replication inside the host cell. the main function of cloning vector is to replicates the inserted DNA fragment inside the host cell.
- Examples of cloning vectors: Plasmid, BAC, YAC, Λ-bacteriophase, expression vectors etc.

1. It must be self-replicating inside host cell
2. It must possess restriction site for RE enzymes
3. Introduction of donor DNA fragment must not interfere with replication property of the vector
4. It must possess some marker gene such that it can be used for later identification of recombinant cell.

3. Incorporation of donor DNA fragment with Plasmid vector:

- The plasmid vector is cut open by the same RE enzyme used for isolation of donor DNA fragment
- The mixture of donor DNA fragment and plasmid vector are mixed together.
- In the presence of DNA ligase, base pairing of donor DNA fragment and plasmid vector occurs forming recombinant vector in the mixture

4. Transformation of recombinant vector into suitable host:

- The recombinant vector is transformed into suitable host cell. ie bacterial cell
- Some bacteria are naturally transformable, they take up the recombinant vector automatically. For examples: *Bacillus, Haemophillus, Helicobacter pylori*, are naturally competent
- Some other bacteria are not naturally competent, in those bacteria recombinant vector are incorporated by artificial method such as Ca++ ion treatment, electroporation etc

5. Isolation of recombinant cell:

- The recombinant host cell is then grown in culture media but the culture may contains colonies both recombinant cell and non-recombinant cell.
- For isolation of recombinant cell from non-recombinant cell, marker gene of plasmid vector is employed.
- For examples, PBR322 plasmid vector contains different marker gene (Ampicillin resistant gene and Tetracycline resistant gene. When pst1 RE is used it knock out Ampicillin resistant gene from the plasmid, so that the recombinant cell become sensitive to Ampicillin.

UNIT-V
APPLICASTION OF BIOLOGY

==========

Industrial production of enzymes

Enzymes used for industrial applications are produced by controlled and contained fermentation in large closed fermentation tanks, using a well-defined production strain. These production strains grow under very specific conditions to maximize the amount of enzyme that they produce.

Industrial applications of enzymes introduction:-

Some Examples Of Industrial Uses Of Enzymes: Rennin for coagulation of milk to make cheese. Invertase from yeast and lactase in the food industry. Cellulase and amylase to remove waxes, oils, and starch coatings on fabrics and to improve the look of the final product.

The general methods for industry production of enzymes:-

Enzyme production methods

Submerged fermentations (SmF) and solid-state fermentations (SSF) are the two methods widely employed for the production of Enzymes. Submerged fermentation: SmF is a traditional method for enzyme production from microorganisms which has been used for a longer period of time.

The characteristics of industrial enzymes:-

The special characteristics of enzymes are exploited for their commercial interest and industrial applications, which include: thermotolerance, thermophilic nature, tolerance to a varied range of pH, stability of enzyme activity over a range of temperature and pH, and other harsh reaction conditions
Important enzymes:- Lipases; Pectinases

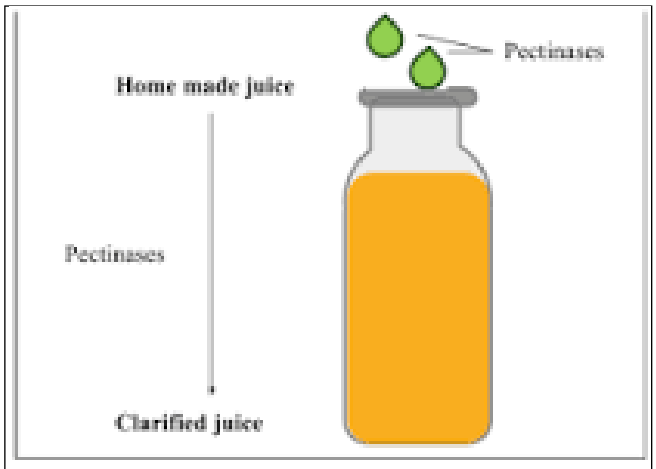


Fig: Use of pectinases

.

What is industrial application of enzyme catalysis:-

The pharmaceutical, food and beverage, detergent, and biofuel industries have reaped the advantages of enzyme catalysis in commercial-scale applications, while other industries, such as natural gas conversion and fine chemical production, are only recently considering their use

Production of enzymes amylase:-

Amylase is one of the most widely used enzymes in the industry. It hydrolyses starch and is used commercially for the production of sugar syrups from starch which consist of glucose, maltose, and higher oligosaccharides

majority of the industrial enzymes produced from:-

The majority of the enzymes used in the industry are of microbial origin because microbial enzymes are relatively more stable than the corre- sponding enzymes derived from plants and animals. With the recent advent of biotechnology, there has been a growing interest and demand for enzymes with novel properties.

The industrial enzyme for food:-

Most enzymes applied in the food processing are glucoamylase and then followed by protease, lipase, esterase, oxidoreductase and isomerase.

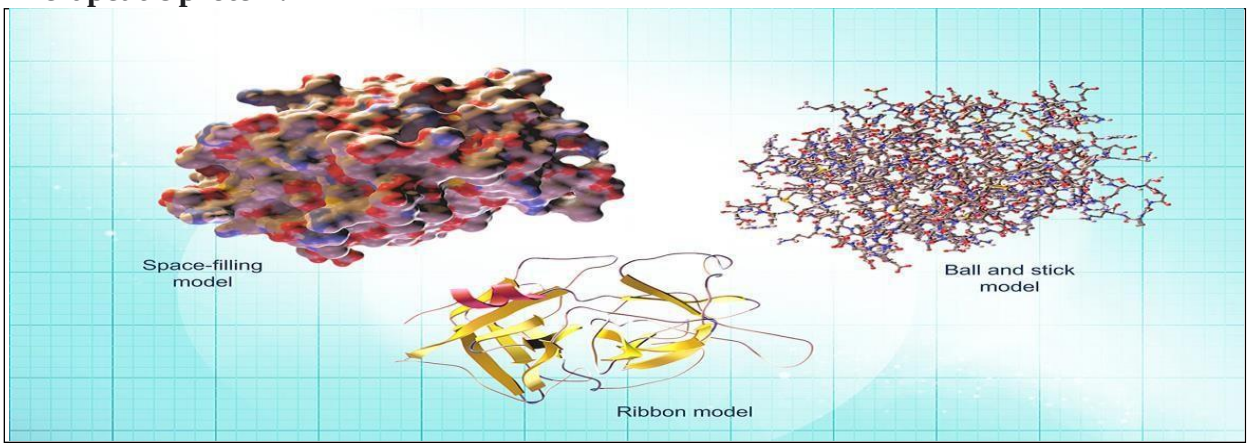
Recombinant protein pharmaceutical products

Recombinant proteins are commonly used to produce pharmaceutical products, protein-based polymers for drug delivery, antibodies and enzymes for disease treatment, protein scaffolds for tissue engineering, as well as for a myriad of other uses.

Example of recombinant pharmaceuticals:-

Activase is a recombinant pharmaceutical that is administered intravenously. Approved by the FDA on November 13, 1987, it contains tissue plasminogen activator (tPA), an enzyme that helps dissolve blood clots.

Therapeutic protein:-



The term therapeutic protein was first used to describe medicines that are genetically engineered versions of naturally occurring human proteins. The complex structure of proteins can be represented in several different ways to help scientists study larger or smaller details of the molecule.

Uses of therapeutic proteins:-

Therapeutic proteins are extensively used in the treatment of cancer, HIV, and other diseases. Monoclonal antibodies, IFNs, and cytokines are examples of some of the macromolecular therapeutic proteins.

Therapeutics examples:-

Examples of therapeutics include drug therapy, medical devices, nutrition therapy and stem-cell therapies. Therapeutics can be used in patients with active disease – to treat the disease itself or its signs and symptoms – in preventive medicine, or as palliative care.

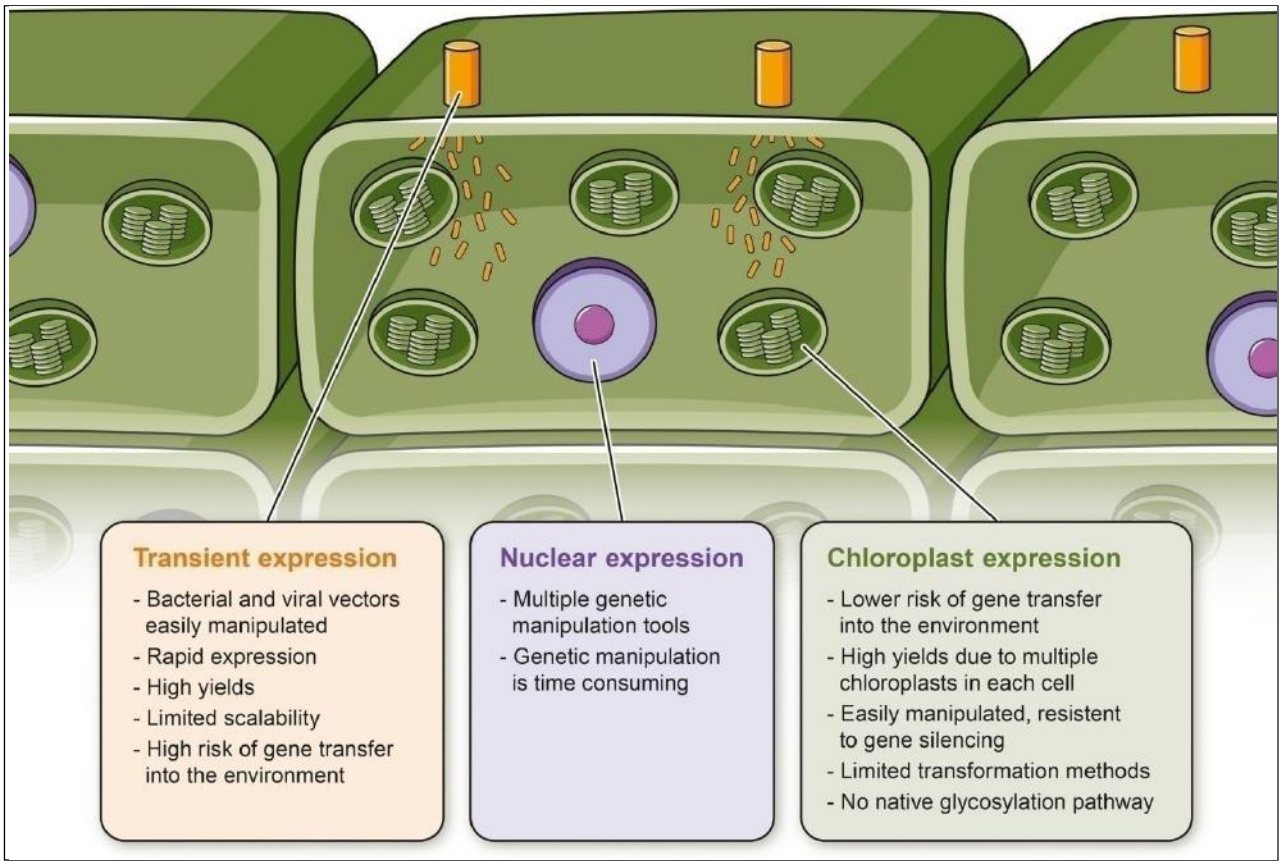
The function of therapeutic:-

therapeutics, treatment and care of a patient for the purpose of both preventing and combating disease or alleviating pain or injury. The term comes from the Greek therapeutikos, which means "inclined to serve."

Applications of therapeutics:-

Therapeutic Applications means applications comprised of prevention, treatment or prophylaxsis of human disease. Therapeutic Applications means applications for preventing, treating or mitigating a disease or condition in humans and animals.

Recombinant therapeutic proteins:-



Therapeutic recombinant proteins are exogenous proteins that are expressed in a production organism and used for the treatment or prevention of disease in humans or animals

4. What are biosensor and its classification and characteristics?

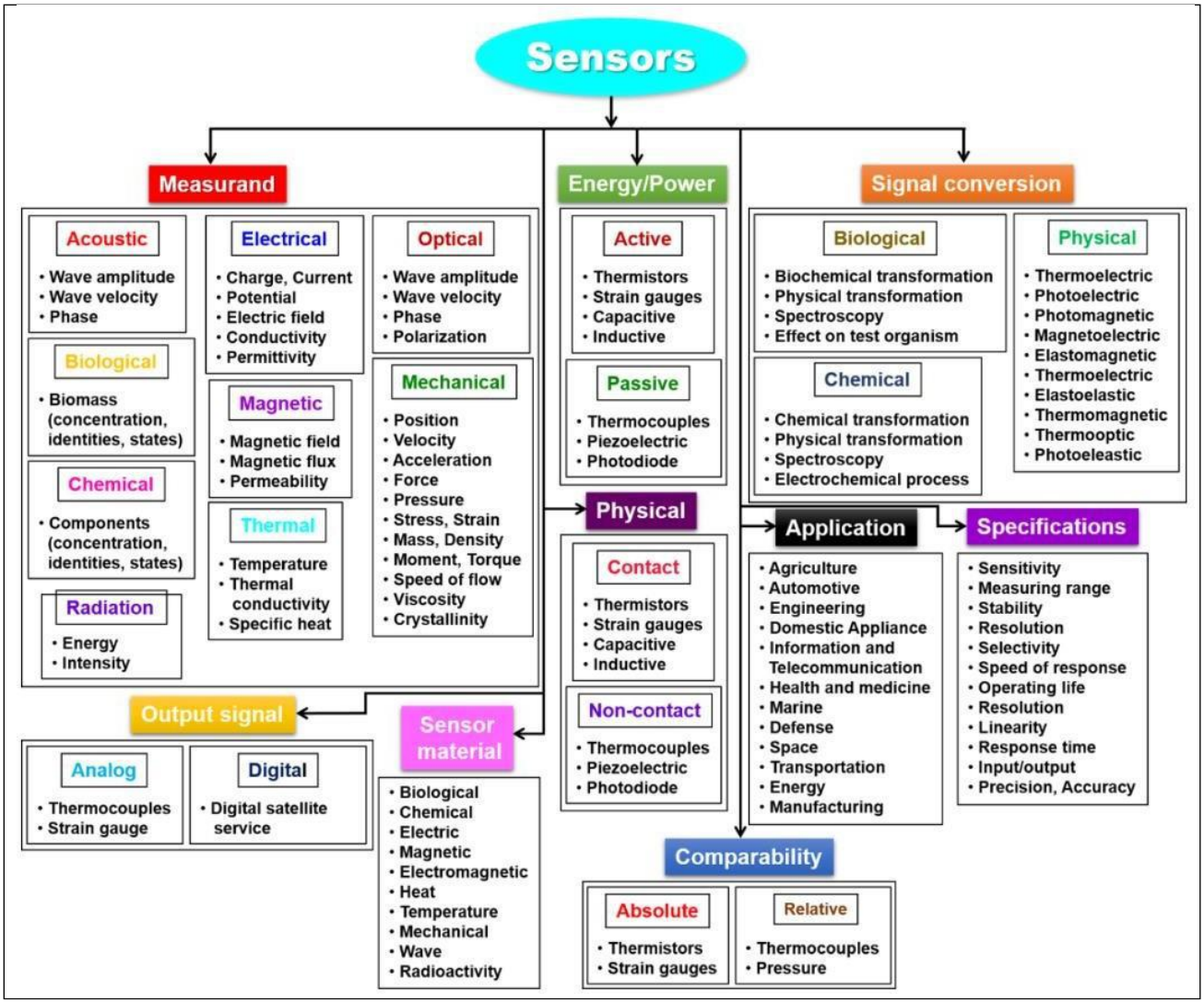
A. Biosensors are devices comprising a biological element and a physiochemical detector that are used to detect analytes. These instruments have a wide range of applications ranging from clinical through to environmental and agricultural. The devices are also used in the food industry.

Classification of biosensors:-

Based on the biological recognition element, biosensors have been classified into enzymatic, protein receptor-based, immunosensors, DNA biosensors, and whole-cell biosensors.

Characteristics of biosensors:-

Biosensors required for measurement should have rapid detection, be accurate, be easy to operate, have a low response time, and be low-cost, highly sensitive, and reliable. Biosensors can be further classified into electrochemical, optical, piezoelectric, and thermal sensors based on the type of transducer

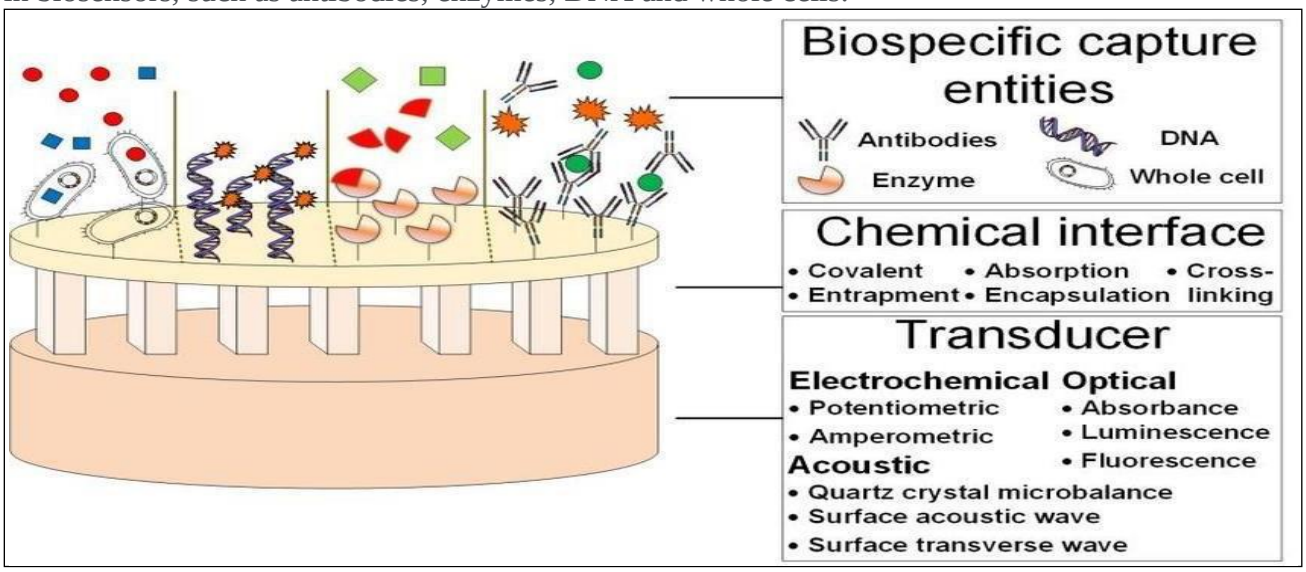


The father of biosensor:-

Considered the "father of biosensors," Leland C. Clark Jr. invented the first device to rapidly determine the amount of glucose in blood. Today many of the 18.2 million Americans with diabetes rely on Clark's original glucose sensor concept for self-monitoring.

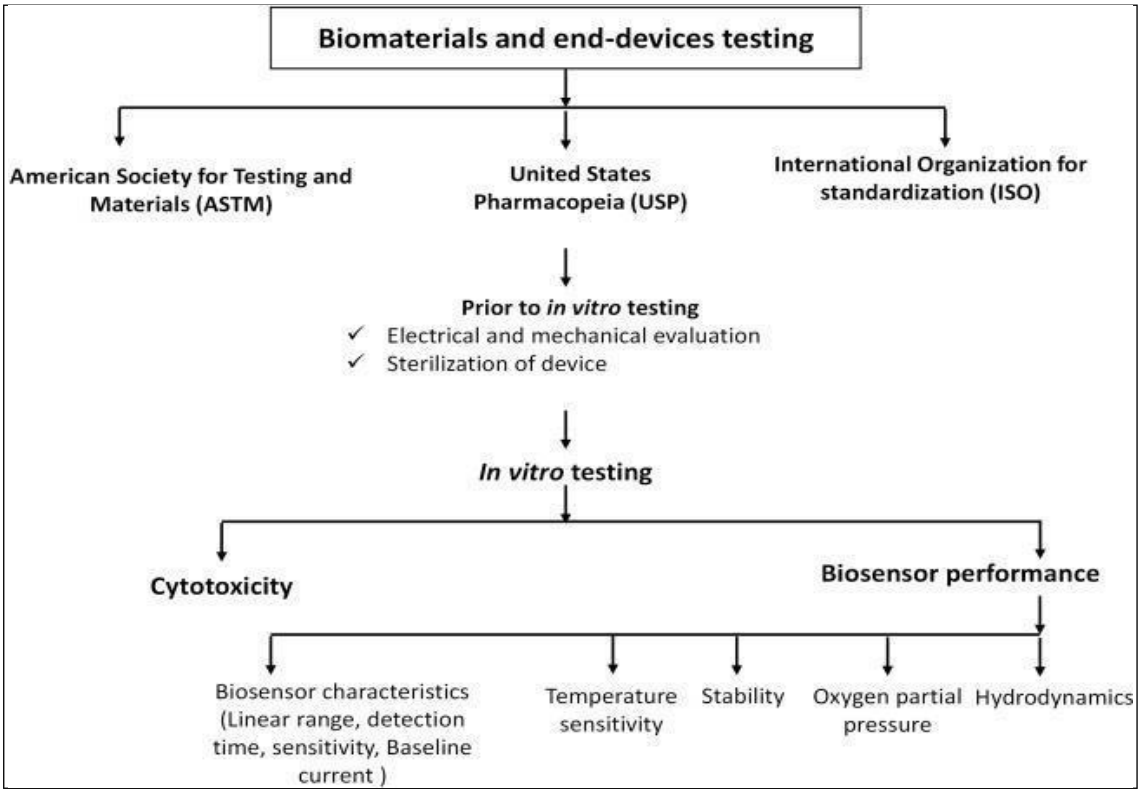
The structure of a biosensor:-

A Biosensor consists of three components: biospecific capture entity, chemical interface and transducer. A variety of biospecific capture entities are used for the biodetection of the target analyte in biosensors, such as antibodies, enzymes, DNA and whole cells.



The advantages of biosensors:-

The main components of biosensors are biological recognition elements and physical/chemical transducers. Due to these biorecognition components, biosensors have significant advantages such as high sensitivity, high selectivity, and the ability for high-throughput processing



Vaccine definition and types

Definition:-A vaccine is a biological preparation that improves immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing microorganism, and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins.

(OR)
Vaccines by definition are biological agents that elicit an immune response to a specific antigen derived from an infectious disease-causing pathogen. Edward Jenner developed the first vaccine in 1796 using cowpox to inoculate against smallpox

A preparation that is used to stimulate the body's immune response against diseases. Vaccines are usually administered through needle injections, but some can be administered by mouth or sprayed into the nose.

Introduction or discovered vaccine:-

Dr Edward Jenner created the world's first successful vaccine. He found out that people infected with cowpox were immune to smallpox. In May 1796, English physician Edward Jenner expands on this discovery and inoculates 8-year-old James Phipps with matter collected from a cowpox sore on the hand of a milkmaid.

The study of vaccines called:-

In addition, a new field of microbiology and immunology has evolved, called "vaccinology," that comprises not only vaccine development but also the use of vaccines and their effects on public health

Classification of vaccines:-

Classification of Vaccines. There are two basic types of vaccines: Live, attenuated, and. Inactivated.

The function of vaccine:-

Vaccines help your immune system fight infections faster and more effectively. When you get a vaccine, it sparks your immune response, helping your body fight off and remember the germ so it can attack it if the germ ever invades again.

Vaccine and its importance:-

What is vaccination? Vaccination is a simple, safe, and effective way of protecting you against harmful diseases, before you come into contact with them. It uses your body's natural defenses to build resistance to specific infections and makes your immune system stronger.

Examples of vaccines:-

List of Vaccines Used in United States

- Adenovirus.
- Anthrax. AVA (BioThrax)
- Cholera. Vaxchora.
- Diphtheria. DTaP (Daptacel, Infanrix) ...
- Hepatitis A. HepA (Havrix, Vaqta) ...
- Hepatitis B. HepB (Engerix-B, Recombivax HB, Heplisav-B) ...
- Haemophilus influenzae type b (Hib) Hib (ActHIB, PedvaxHIB, Hiberix) ...
- Human Papillomavirus (HPV)

Vaccine types in India:-

- Novavax. Nuvaxovid. Phase 1. ...
- Biological E Limited. Corbevax. Phase 1. ...
- Serum Institute of India. COVOVAX (Novavax formulation) Phase 1. ...
- University Medical Center Groningen. AKS-452. Phase 1. ...
- Zydus Cadila. ZyCoV-D. Phase 1. ...

- Gennova Biopharmaceuticals Limited. GEMCOVAC-19. Phase 1. ...
- Bharat Biotech. iNCOVACC. Phase 1. ...
- Gamaleya. Sputnik Light.

Vaccine India discovered:-

- COVAXIN® - India's First Indigenous COVID-19 Vaccine. COVAXIN®, India's indigenous COVID-19 vaccine by Bharat Biotech is developed in collaboration with the Indian Council of Medical Research (ICMR) - National Institute of Virology (NIV).

Benefits of vaccinations:-

Vaccination is one of the most successful public health interventions in reducing disease spread, preventing complications and even deaths from vaccine preventable diseases.

Vaccinated diseases:-

Vaccines protect against many different diseases, including:

- cervical cancer.
- cholera.
- COVID-19.
- diphtheria.
- hepatitis B.

- influenza.
- Japanese encephalitis.
- malaria.

The father of vaccination in India:-

India's vaccine inventor: Gursaran Talwar.

The first vaccine in the world:-

Two months later, in July 1796, Jenner took matter from a human smallpox sore and inoculated Phipps with it to test his resistance. Phipps remained in perfect health, the first person to be vaccinated against smallpox. Edward Jenner among patients in the Smallpox and Inoculation, coloured etching after J.

Properties and classification of virus

Definition of virus:- (VY-rus) In medicine, a very simple microorganism that infects cells and may cause disease. Because viruses can multiply only inside infected cells, they are not considered to be alive.

A virus can be simply defined as an obligate intracellular parasite. Each viral particle, or virion, consists of a single nucleic acid, RNA or DNA, encoding the viral genome surrounded by a protein coat, and is capable of replication only within the living cells of bacteria, animals or plants. Viruses have several common characteristics: they are small, have DNA or RNA genomes, and are obligate intracellular parasites. The virus capsid functions to protect the nucleic acid from the environment, and some viruses surround their capsid with a membrane envelope.

Properties of Viruses:-

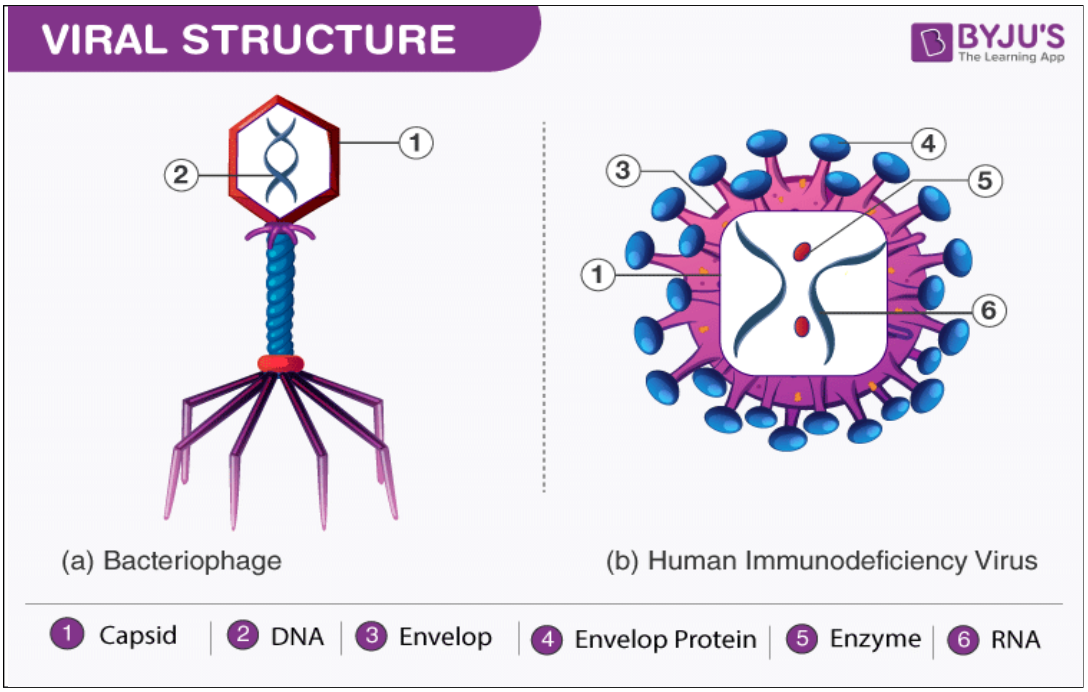
1. They are non-cellular organisms, which is enclosed in a protective envelope.
2. The presence of spikes helps in attaching the viruses to the host cell.
3. These viruses do not grow, neither respire nor metabolize, but they reproduce.
4. They are surrounded by a protein coat – capsid and have a nucleic acid core comprising DNA or RNA.
5. They are considered both as living and non-living things. These viruses are inactive when they are present outside of host cells, but become active within host cells. These viruses cause several infections and reproduce within the host cell by using the enzymes and raw materials.

The classification of viruses:-

Viruses can be classified primarily on their phenotypic characteristics, core content, chemical composition, capsid structure, size, shape, modes of replication and other viral genome structures.

Based on their host, viruses can be classified into three types, namely,
1. Animal viruses,
2. Plant viruses, and
3. Bacteriophages.

Differences of bacteria and virus



Classification based on the presence of nucleic acid

DNA virus

The virus, having DNA as its genetic material. There are two different types of DNA virus

Single-stranded (ss) DNA virus: e.g. Picornaviruses, Parvovirus, etc.

Double-stranded (ds) DNA virus: e.g. Adenovirus, Herpes virus, etc.

RNA virus

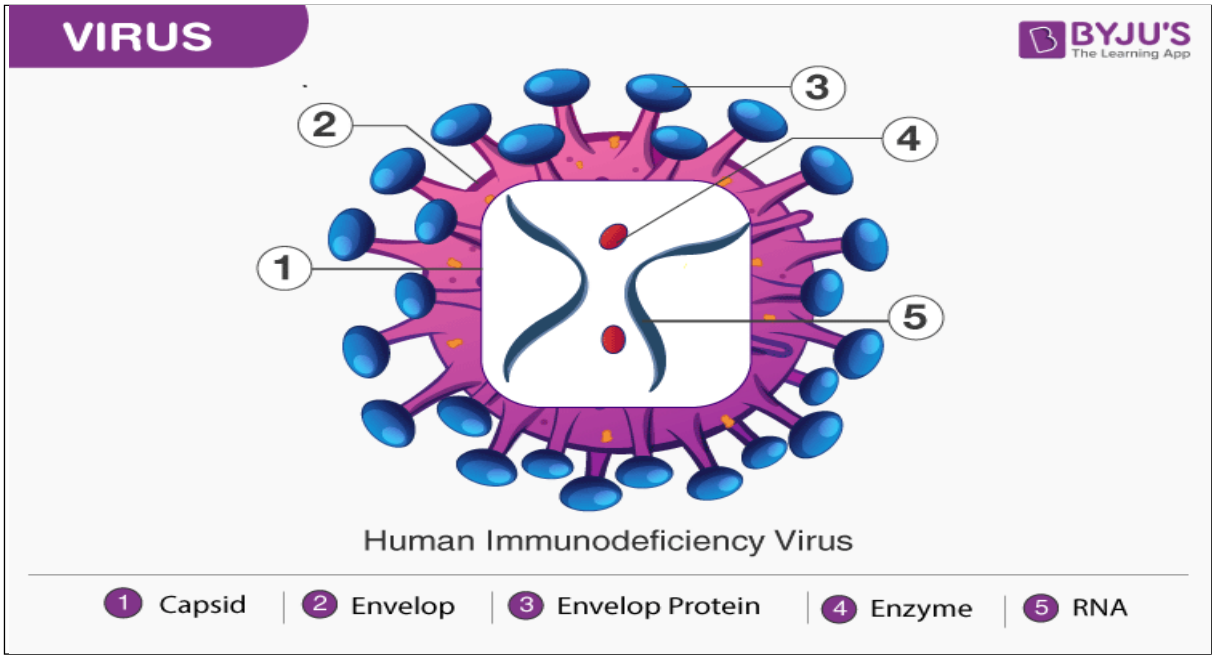
The virus, having RNA as its genetic material. There are two different types of RNA virus

Double-stranded (ds) RNA virus: e.g. Reovirus, etc.

Single-stranded (ss) RNA virus. It is further classified into two Positive sense RNA (+RNA) and negative sense RNA (-RNA). Poliovirus, Hepatitis A, Rabies virus, Influenza virus are examples of single-stranded RNA virus.

What is a Virus:-

Virus is extremely small entities which contain either RNA or DNA as the genetic material. They are also smaller than most bacteria.



HIV

Virus are not fully acknowledged as living organisms as they cannot survive outside a host. Anatomically, a typical virus is girdled by a protein coat that is enclosed by a membrane made of proteins. In some virus, this protein coat is covered by a lipid membrane called the viral envelope.

Characteristics of Virus:-

- Virus lack cellular organelles and cytoplasm.
- They fail to perform metabolic activities.
- Most of the virus contain RNA or DNA, but not both.
- Virus reproduces at a tremendous pace but only inside the cells of the living hosts. Furthermore, most virus have the capability to mutate.

- They make use of the metabolic machinery of the host cells. Virus cannot grow and divide. They produce and assemble new viral components inside the infected host cell.
- Non living structures.
- Non-cellular.
- Contain a protein coat called the capsid.
- Have a nucleic acid core containing DNA or RNA (one or the other - not both)
- Capable of reproducing only when inside a HOST cell.
- They reproduce at a spectacular rate, but only in live host cells.
- They can be transformed.
- They are acellular, i.e., they have no cytoplasm or cellular organelles.
- They do not conduct any metabolism on their own and must replicate using the metabolic machinery of the host cell.

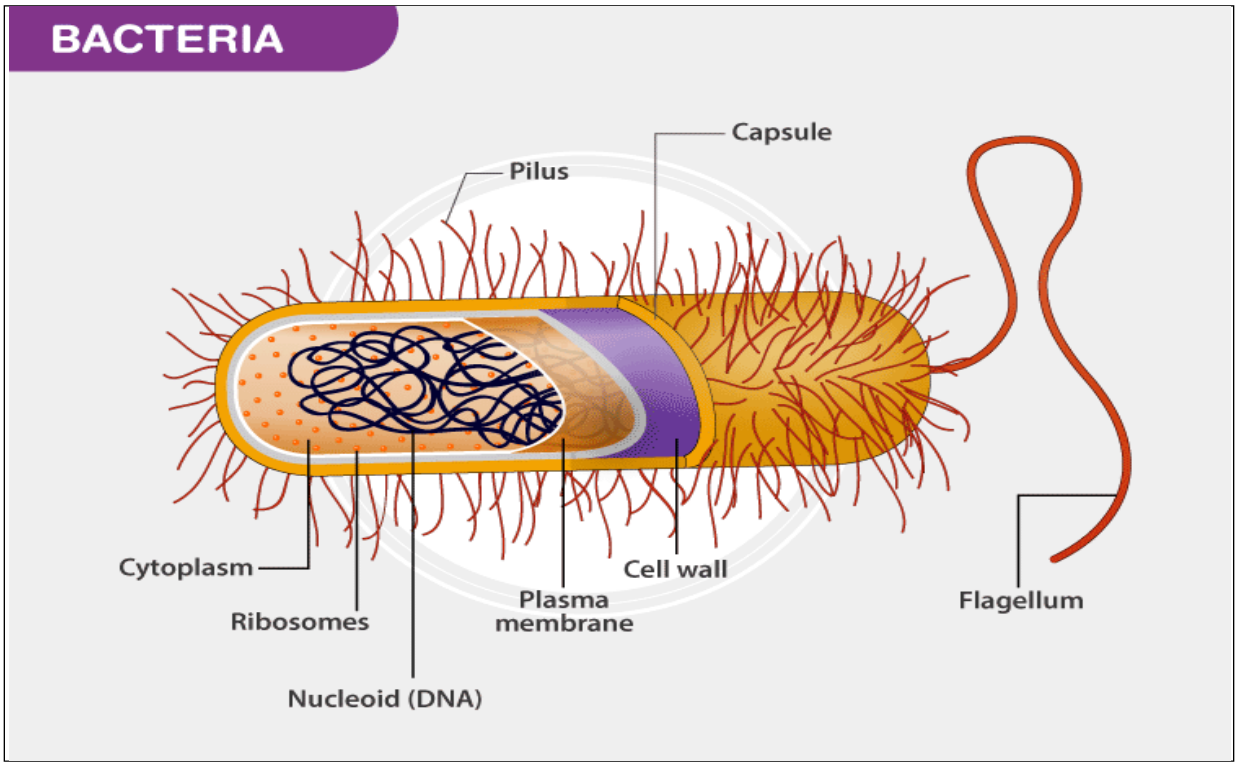
List of Viral Diseases:-

Following is a list of virus diseases that have made a significant socioeconomic impact in the last few decades.

- AIDS (Acquired Immunodeficiency Syndrome)
- Ebola
- Influenza
- SARS (Severe Acute Respiratory Syndrome)
- Chikungunya
- Small Pox (Now eradicated)

What is Bacteria:-

Bacteria are prokaryotic microorganisms. They are found everywhere. They can survive even the harshest of conditions such as hot springs, deep ocean, snow and even in the volcanos. Disease-causing bacteria are known as pathogens.



A bacteria

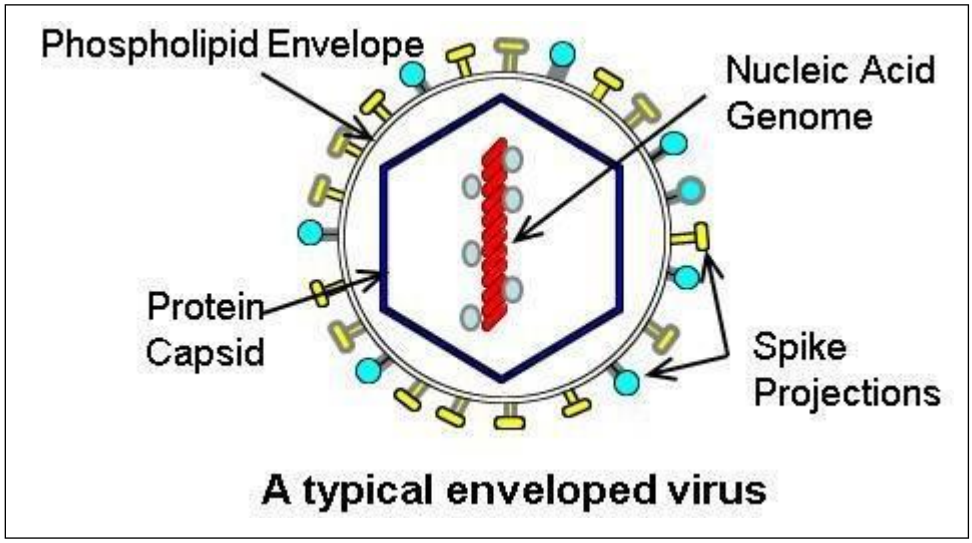
Characteristics Of Bacteria

- Bacteria are unicellular, some of the bacteria form multicellular reproductive structures, e.g. myxobacteria.
- Bacterial cell lacks membrane-bound organelle. Genetic material remains dispersed in nucleoid and the nucleus is absent.
- The bacterial cell has ribosomes, where protein assembly takes place.

Bacteria play a very important role in the ecosystem. They are widely used in the medical and agricultural industries.

The structure and function of a virus:-

Viruses are a unique type of pathogen that lack cytoplasmic membrane, cytosol, or functional organelles and use the metabolic machinery of host cells to produce more viral molecules. They can exist extracellularly as a virion or intracellularly as nucleic acids that induce the host to synthesize viral components.



The function of virus:- A virus is an infectious agent that can only replicate within a host organism. Viruses can infect a variety of living organisms, including bacteria, plants, and animals. Viruses are so small that a microscope is necessary to visualize them, and they have a very simple structure.

Discovered virus:- Beijerinck, in 1898, was the first to call 'virus', the incitant of the tobacco mosaic. He showed that the incitant was able to migrate in an agar gel, therefore being an infectious soluble agent, or a 'contagium vivum fluidum' and definitively not a 'contagium fixum' as would be a bacteria.

The structure of virus:- Viral Structure. In the simpler viruses the virion consists of a single molecule of nucleic acid surrounded by a protein coat, the capsid; the capsid and its enclosed nucleic acid together constitute the nucleocapsid. In some of the more complex viruses the capsid surrounds a protein core

The size of a virus:- Human viruses can vary in size but are generally in the range of 20–200 nm in diameter. In comparison, bacteria are generally 2–3 μM in length, and an average human cell is 10–30 μM.

Disease caused by viruses;- Viruses cause familiar infectious diseases such as the common cold, flu and warts. They also cause severe illnesses such as HIV/AIDS, Ebola, and COVID-19. Viruses are like hijackers. They invade living, normal cells and use those cells to multiply and produce other viruses like themselves

The 2 main components of a virus:- All viruses contain nucleic acid, either DNA or RNA (but not both), and a protein coat, which encases the nucleic acid. Some viruses are also enclosed by an envelope of fat and protein molecules.

Using Vitamins and Minerals to Fight Viruses and Support Immunity

- Vitamin D: Vitamin D, commonly known for its role in bone health, also helps make proteins that kill viruses and bacteria, especially in the respiratory tract. ...

- Vitamin C: ...
- Zinc: ...
- Polyphenols: ...
- Potassium: ...
- Probiotics: ...
- Supplement Wisely.

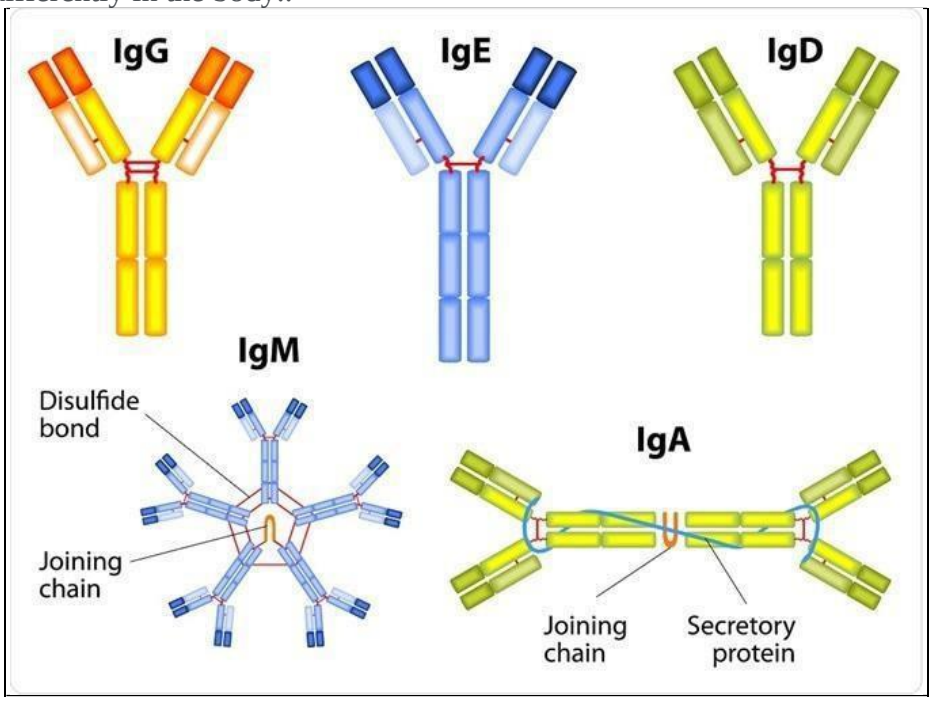
Fights viruses:- One of the most important players in our immune systems is the white blood cell, also called a leukocyte. Leukocytes patrol the blood and tissues throughout the body in search of intruders. When they detect a foreign substance, they send out signals and launch an immune attack.

Viruses harmful in our body:- Viruses make us sick by killing cells or disrupting cell function. Our bodies often respond with fever (heat inactivates many viruses), the secretion of a chemical called interferon (which blocks viruses from reproducing), or by marshaling the immune system's antibodies and other cells to target the invader.

Type and function of antibodies

It's found mainly in blood and tissue fluids. IgG antibodies help protect your body from viral and bacterial infections. Found in your blood and lymph system, IgM antibodies act as the first line of defense against infections. They also play a large role in immune regulation

Types:- There are 5 types of heavy chain constant regions in antibodies (immunoglobulin) and according to these types, they are classified into IgG, IgM, IgA, IgD, and IgE. They are distributed and function differently in the body..



Classes of immunoglobulins
•There are 5 types of antibodies in mammals-IgA, IgG, IgM, IgE, and IgD.

•Each type has its different heavy chain

•Ig A-α

•Ig M-μ

•Ig G-γ

•Ig E-ε

•Ig D-δ

1.IgG
•Most abundant in the serum-80% of the total serum antibodies

•In humans, there are four type of IgG-IgG1, IgG2, IgG3, and IgG4

•Can cross placenta, transferring immunity from mother to fetus.

2.IgE
•Immediate hypersensitivity is mediated by IgEegin asthma
•Produced in Allergic reaction
•Able to bind with mast cells and blood basophils-give rise to allergic menifestation

3.Ig D
•Constitute 0.2% of total serum antibodies

•No biological function has been identified

4.Ig A
•Constitute 10-15% of total serum antibodies

•Present in the secretions-tears, breast milk, saliva, mucus

•Two types-IgA1 and IgA2

•Present in the mother milk-colostrum

•Provide immunity to the new born

•IgA is dimeric

5.IgM

•First produced antibody by B cell

•5-10%

•IgM and IgD: Also found on the B cell surface-serve as BcellReceptors

•Secreted as pentameric molecule

•primary response in allergic reaction

•First produced in the neonate

•Helps in complement activation

Effector functions

•**Opsonization:** antibody together with other complements, covers antigens and prepare it to phagocytosed by phagocytic cells. IgG is the opsonising immunoglobulin

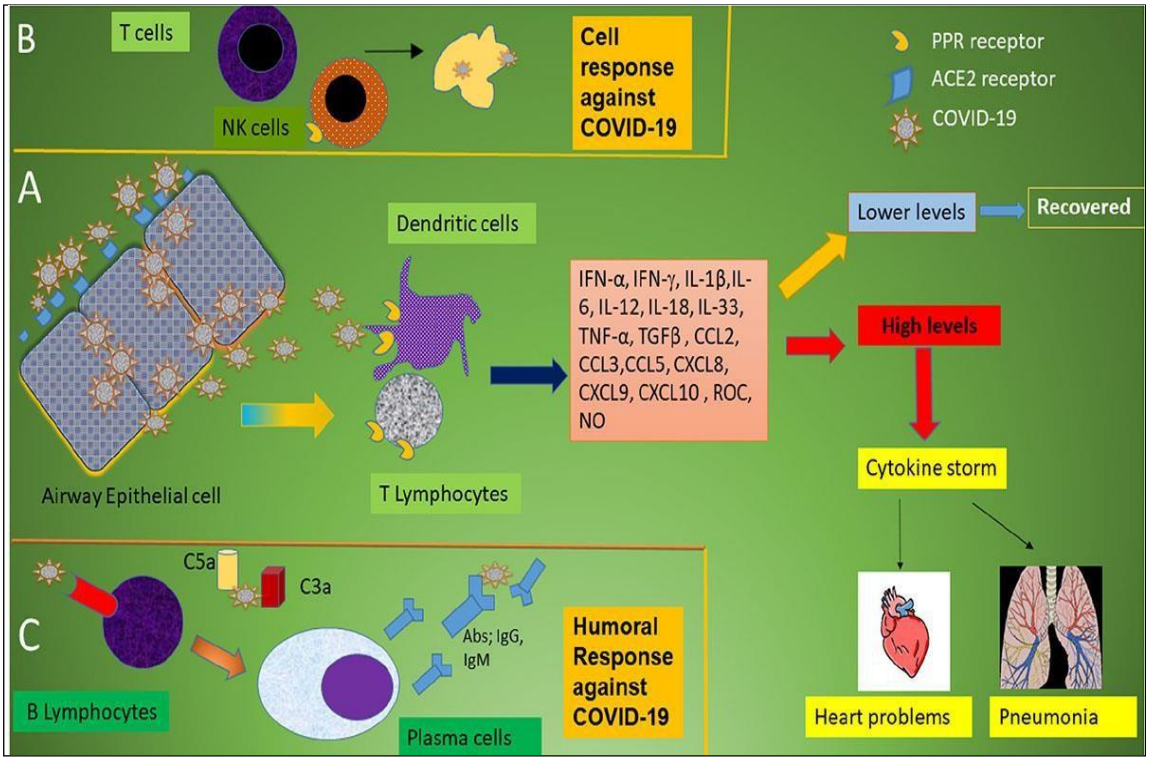
•**Toxin/viral neutralization:** exotoxins secreted by some bacteria can be neutralized by these antibodies. IgM, IgG and IgA are found to neutralize some viral particles.

•**Complement activation**: it's a series of enzymatic events that can be initiated by antigens or binding to the antibodies. IgM and IgG are able to start complement system.

•**Antibody dependent cell mediated toxicity: ADCC:** natural killer cells recognise infected cells and malignant cells by antibodies bound on the surface of these cells.

The immune response to COVID vaccine

Immune Response Against Coronavirus. In patients with COVID-19, the white blood cell count can vary between leukopenia, leukocytosis, and lymphopenia, although lymphopenia appears to be more common (1, 72). Importantly, the lymphocyte count is associated with increased disease severity in COVID-19



Immune system respond to COVID-19:-

They found that nearly 90% of patients showed positive T cell immunity to one or more of five proteins associated with SARS-CoV-2. 4 That would suggest that immunity will be long lasting, because T cells contribute to long term adaptive immunity.

What is the immune response to coronavirus vaccine

The magnitude and quality of a key immune cell's response to vaccination with two doses of the Pfizer-BioNTech COVID-19 vaccine were considerably lower in people with prior SARS-CoV-2 infection compared to people without prior infection, a study has found.

What is a protective immune response

The protective immune response to a vaccine may be due to the presence of circulating antibody (humoral immunity), the actions of sensitized T-lymphocytes (cell-mediated immunity), the presence of secretory IgA on mucosal surfaces (mucosal immunity), or a combination of these factors.

What is COVID-19:-

COVID-19 is the disease caused by a coronavirus called SARS-CoV-2. WHO first learned of this new virus on 31 December 2019, following a report of a cluster of cases of so-called viral pneumonia in Wuhan, People's Republic of China.

Corona virus disease (COVID-19)

WHO is continuously monitoring and responding to this pandemic. This questions and answers page will be updated as more is known about COVID-19, how it spreads and how it is affecting people worldwide. For more information, regularly check the WHO coronavirus pages.

What are the symptoms of COVID-19

The most common symptoms of COVID-19 are

- fever
- chills
- sore throat.

Other symptoms that are less common and may affect some patients include:

- muscle aches
- severe fatigue or tiredness
- runny or blocked nose, or sneezing
- headache
- sore eyes
- dizziness
- new and persistent cough
- tight chest or chest pain
- shortness of breath
- hoarse voice
- heavy arms/legs
- numbness/tingling
- nausea, vomiting, abdominal pain/ belly ache, or diarrhoea
- appetite loss
- loss or change of sense of taste or smell
- difficulty sleeping.

Symptoms of severe COVID-19 disease which need immediate medical attention include:

- difficulty in breathing, especially at rest, or unable to speak in sentences
- confusion
- drowsiness or loss of consciousness

- persistent pain or pressure in the chest
- skin being cold or clammy, or turning pale or a bluish colour
- loss of speech or movement.

If possible, call your health care provider, hotline or health facility first, so you can be directed to the right clinic.

People who have pre-existing health problems are at higher risk when they have COVID-19; they should seek medical help early if worried about their condition. These include, but are not limited to: those taking immunosuppressive medication; those with chronic heart, lung, liver or rheumatological problems; those with HIV, diabetes, cancer or dementia

Who is most at risk of severe illness from COVID-19:-

People aged 60 years and over, and those with underlying medical problems like high blood pressure, diabetes, other chronic health problems (for example those affecting the heart, lungs, kidneys, and brain), low immune function / immunosuppression (including HIV), obesity, cancer, and unvaccinated people are most at risk of severe illness.

However, anyone at any age can get sick with COVID-19 and become seriously ill or die.

What test should I get to see if I have COVID-19

There are two main types of tests that can confirm whether you are infected with SARS-CoV-2, the virus that causes COVID-19. Molecular tests, such as polymerase chain reaction (PCR), are the most accurate tests for diagnosing SARS-CoV-2 infection. Molecular tests detect virus in the sample by amplifying viral genetic material to detectable levels. Rapid antigen tests (sometimes known as rapid diagnostic tests or RDTs) detect viral proteins (known as antigens). RDTs are a simpler and faster option than molecular tests and are available for testing by trained operators or by the individual themselves (sometimes called self-tests). They perform best when there is more virus circulating in the community and when sampled from an individual during the time they are most infectious, generally within the first 5–7 days following symptom onset. Samples for both types of tests are collected from the nose and/or throat with a swab.

The concept of a pandemic and with suitable examples

A pandemic is the worldwide spread of a new disease. Viral respiratory diseases, such as those caused by a new influenza virus or the corona virus COVID-19, are the most likely to turn into a pandemic. A pandemic is not the same as an epidemic.

What is a pandemic:-

A pandemic is the worldwide spread of a new disease. Viral respiratory diseases, such as those caused by a new influenza virus or the coronavirus COVID-19, are the most likely to turn into a pandemic.

A pandemic is *not* the same as an epidemic. In an epidemic, many more cases of a health condition occur than would normally develop in a community or region, but the condition does not spread further.

In the past, there have been numerous influenza pandemics. Pandemic influenzas often have their origin in animal influenza viruses and are not the same as seasonal influenza. Few people, if any, will have immunity against a pandemic influenza virus — even if they have had seasonal flu or **a seasonal flu vaccination**.

How is a pandemic declared:-

The World Health Organization (WHO) is responsible for declaring when a global pandemic is occurring. The WHO does this by monitoring outbreaks of a disease and taking advice from international health experts. Australia and other countries are, however, likely to take steps to reduce the impact of an pandemic before the WHO makes a formal declaration.

How does Australia respond to influenza pandemics:-

1. The Australian Government has in place a health management plan to minimise the impact of an influenza pandemic on Australians' health and the healthcare system.

2. To control infection, health authorities may provide information about the importance of good hand and cough hygiene — hand washing and coughing or sneezing into the elbow — to minimise the chance of transmitting the virus. They may also issue personal protective equipment (PPE), such as masks, to healthcare providers and workers who come into close contact with infected individuals.

3. Travellers — aboard flights or ships — may receive information about the pandemic, while other sources of information, such as the Smartraveller website may advise on high-risk destinations. At entry points into Australia, travellers may find healthcare staff doing screening checks, such as checking temperatures with hand-held scanners.

4. State education departments may decide to close schools or provide remote learning. Businesses may be encouraged to let staff work from home and mass gatherings may be cancelled. In some cases, people confirmed with having the infection — and people who have come into contact with confirmed cases — may be asked to self-isolate.

5. Commonwealth biosecurity laws and state and territory public health and emergency response laws allow these measures to be enforced. However, generally people are asked to comply with measures voluntarily.

6. Healthcare is managed by state and territory authorities so different states may have different policies, such as those regarding school closures.

How do I self-isolate during a pandemic:-

You may need to isolate yourself at home during a pandemic if you are experiencing symptoms, or even if you have no symptoms but are confirmed to be infected.

If you need to isolate yourself, you should:

- Stay home for the recommended timeframe or as advised by your doctor, except to get medical care. Do not go to work, school, or visit public areas, and do not use public transport or taxis.
- Call before visiting the doctor and tell them you may have been exposed to the virus or you are being tested for it.
- Remain separate from other people in your home; stay in a different room and use a separate bathroom, if available.
- Make sure shared spaces have good air flow — for example, weather permitting, open a window.
- Keep away from elderly people and those with compromised immune systems or chronic health conditions, such as heart, lung or kidney conditions, and diabetes. Restrict other visitors who do not need to be in the home.
- Wear a surgical face mask if you need to be around other people. If you cannot wear a mask, then the people around you should wear a surgical face mask.
- Cough or sneeze into your elbow. Throw used tissues in a lined bin, and immediately wash your hands with soap and water for at least 20 seconds.
- Use an alcohol-based hand sanitiser if soap and water are not available and if your hands are not visibly dirty. Avoid touching eyes, nose and mouth with unwashed hands.
- Do not share dishes, cups, eating utensils, towels, bedding or other items. Wash these items thoroughly with soap and water after use.

Examples:-

- The Flu of 1918.
- Tuberculosis.

- H1N1 Flu of 2009.

The burden of SARS-CoV-2, HCV, and HIV co-pandemics and their associations with specific sociodemographic disparities, clinical presentations, and outcomes suggest that urban EDs should consider implementing integrated screening and linkage-to-care programs for these 3 infections.

Pandemic diseases in India

Since then India has ridden out a host of lesser epidemics, from cholera to chikungunya, from the "Asian flu" of 1957 to the swine flu of 2009, without mortality on anything like 1918's apocalyptic scale.

What is a epidemic

An outbreak is a sudden rise in the number of cases of a disease more than normal expectancy in a community or geographical area. An outbreak can be declared an epidemic when the disease spreads rapidly to many people

What is epidemic disease causes

Disease outbreaks are usually caused by an infection, transmitted through person-to-person contact, animal-to-person contact, or from the environment or other media. Outbreaks may also occur following exposure to chemicals or to radioactive materials. For example, Minamata disease is caused by exposure to mercury.

What are the 4 types of diseases

There are four main types of disease:
1.infectious diseases,
2.deficiency diseases,
3.hereditary diseases (including both genetic diseases and non-genetic hereditary diseases),
4.physiological diseases. Diseases can also be classified in other ways, such as communicable versus non-communicable diseases.

What are the most common epidemic diseases

Examples of major epidemics include cholera and diarrhoeal diseases, measles, malaria, and dengue fever. A pandemic is an epidemic of infec- tious disease that spreads through human popula- tions across a large region, multiple continents or globally. These are diseases that infect humans and can spread easily.

The difference between epidemic and pandemic

If the disease is limited to an isolated region, epidemiologists may refer to it as an outbreak. When it is actively spreading or growing out of control, they may refer to it as an epidemic. Once the disease affects large populations across borders, it is regarded as a pandemic.

What is outbreak of disease example

Disease outbreaks are usually caused by an infection, transmitted through person-to-person contact, animal-to-person contact, or from the environment or other media. Outbreaks may also occur following exposure to chemicals or to radioactive materials. For example, Minamata disease is caused by exposure to mercury.

What causes a disease outbreak

Disease outbreaks are caused by bacteria, viruses or other organisms such as parasites. They can happen when people consume contaminated food or water, when a contagious disease is spread from person to person, or from the bite of an infected insect like a mosquito that causes West Nile Virus disease.

How do you control an outbreak of disease?

Outbreak control measures

1. Recalling the food.
2. Warning people not to eat or sell the food.
3. Telling people how to make the food safe to eat (such as cooking to a certain temperature)
4. Temporarily closing restaurants or processing plants.
5. Improving practices to prevent contamination during food production or harvesting.

Prevention of Pandemic Disease:-

Wash hands, utensils, and surfaces often when preparing any food, especially raw meat. Always wash fruits and vegetables. Cook and keep foods at proper temperatures. Don't leave food out – refrigerate promptly.

How to prevent pandemic?

In addition to basic health and hygiene practices, like handwashing, CDC recommends some prevention actions at all COVID-19 Community Levels, which include:

1. Staying Up to Date with COVID-19 Vaccines.
2. Improving Ventilation.
3. Getting Tested for COVID-19 If Needed.

Learn these healthy habits to protect yourself from disease and prevent germs and infectious diseases from spreading.

- Handle & Prepare Food Safely. ...
- Wash Hands Often. ...

- Clean & Disinfect Commonly Used Surfaces. ...
- Cough & Sneeze Into Your Sleeve. ...
- Don't Share Personal Items. ...
- Get Vaccinated. ...
- Avoid Touching Wild Animals.

Getting preventive care reduces the risk for diseases, disabilities, and death — yet millions of people in the United States don't get recommended preventive health care services. Healthy People 2030 focus on increasing preventive care for people of all ages.