VU Medical Zone

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Basic I-Biology

BIO101 Midterm Merge ppt

Lecture 1 to 6

Biology lecture # 1

Levels of Life

(From Atom to Biosphere)

WHAT IS LIFE?

Anything is living if:

- It can acquire energy from the environment, e.g., plants acquire energy using sunlight and carbon dioxide and animals gain energy by eating plants like goats eat plants.
- It is capable of reproducing itself, e.g., all animals produce young ones like lions produce cubs. Plants also reproduce seeds to give rise to new plants.
- Mutating / changing itself: all organisms have a property of mutations, i.e., their heredity material – DNA changes itself during division or other times and the result is change in any characteristic of the organism. This characteristic may be beneficial or harmful; organisms survive better if mutation is beneficial and may die if it is harmful.

BIOLOGY – THE STUDY OF LIFE

Biology (Bio – life; logos – study, reasoning); biology is hence the study of life or living organisms. Biology is about exploring the living part of the world, e.g., studying about animals, plants and even microorganisms is biology.

Biology have many subdivisions; for example, anatomy – the study of structures, physiology – the study of functions, microbiology – the study of microorganisms and many more.

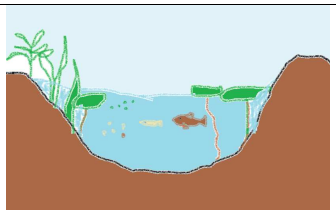
The exploration of life helps in understanding the phenomena of nature and effective utilization and management of natural resources. We can find solutions to various problems for example treatment for various diseases could be discovered, methods for energy production from biological materials may be found, e.g., few bacteria can produce fuel from grasses.

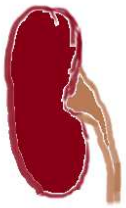
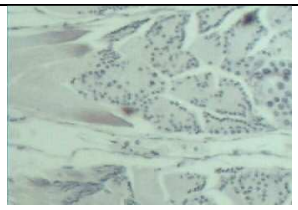
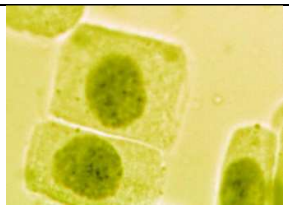
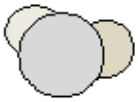
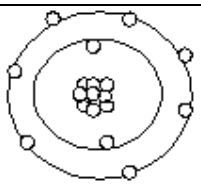
LEVELS OF ORGANIZATION IN LIFE

- Atoms
- Molecules
    - Micromolecules
    - Macromolecules

- Cells
- Tissues
- Organs
- Organ-systems
- Organisms
- Populations
- Communities
- Ecosystems
- Biosphere

Diagram below:

Biosphere	
Ecosystem	
Community	
Population	
Organisms	

Organ systems	
Organs	
Tissues	
Cells	
Molecules	
Atoms	

LEVELS OF ORGANIZATION IN LIFE – MORE DETAILS

Atoms

Greek: a, not; tom, to cut: The smallest component of an element that have all the properties of that element. In nature, 92 kinds of elements are present, out of which only 16 make the living organisms, called **bioelements**. Bioelements are Oxygen (O), Carbon (C), Hydrogen

(H), Nitrogen (N), Calcium (Ca), and Phosphorus (P). These elements make 99% of living mass. Others ten elements make 1 % of total living mass named Potassium (K), Sulfur (S), Chloride (Cl), Sodium (Na), Magnesium (Mg), Iron (Fe), Copper (Cu), Manganese (Mn), Zinc (Nz), and Iodine (I).

Atoms

All living things consist of atoms, like all other forms of matter. Atoms consist of "subatomic particles"; charged or not charged. These include electrons which are negatively charged particles, protons which are positively charged and neutrons which have no charge. Protons and neutrons are present inside the center and the electrons revolve around these in orbits.

Atoms do not live in isolation but join together to make molecules (compounds).

Molecules

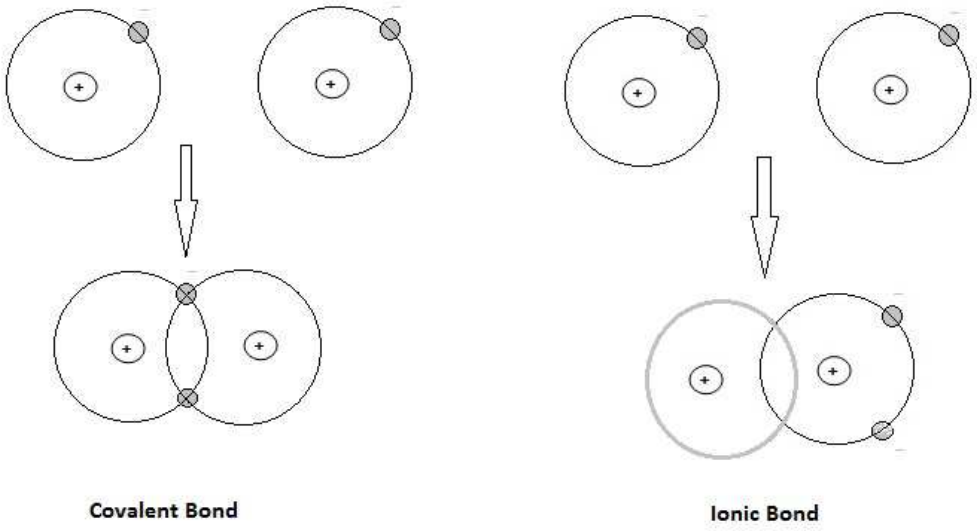
Atoms join together by a process called "bonding" to each other to construct molecules. Bonding is of two types.

- ionic bonds
- covalent bonds

In **inonic bonding** one atom gives one or more of its electron to the other atom which is called a donor and the other receive the electron called recipient. The donor atom then becomes positively charged and the recipient becomes negatively charged. In **covalent bonding**, however, the atoms share one or more of their electrons and these electrons revolve in the orbit of both atoms. Covalent bonding is more strong form of bonding.

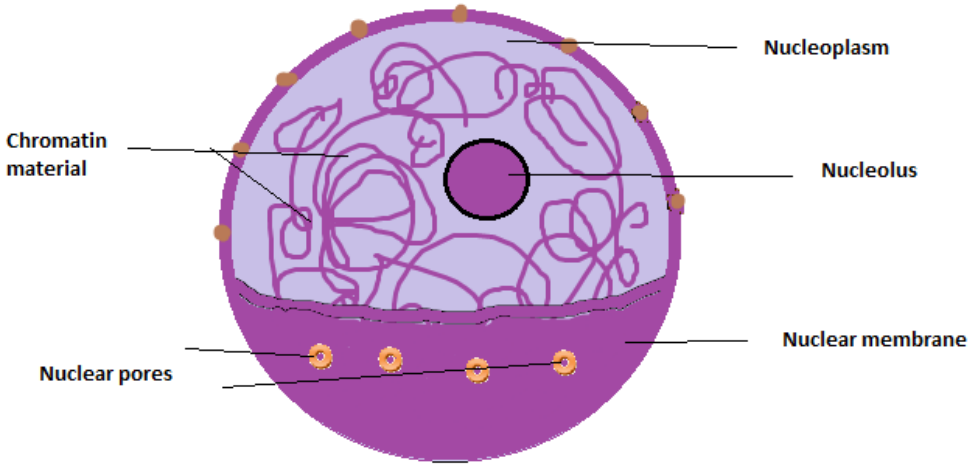
On the bsis of their size molecules are categorized into micromolecules and macromolecules. Micromolecules are the molecules with low molecular weight, e.g., glucose, water. Macromolecules are the molecules with high molecular weight, e.g., proteins, carbohydrates and lipids.

An organism consists of enormous number of biomolecules different types. Though some organisms are unicellular, i.e., consist of one cell only. Many other organisms are multicellular, i.e., these consist of many cells.



Organelles

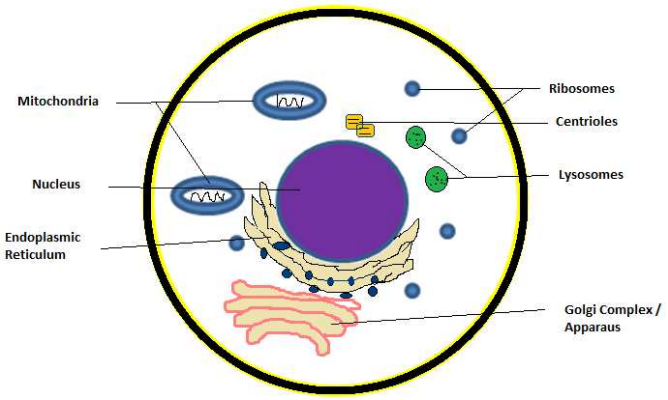
Molecules make organelles. Organelles are sub-cellular structures, assemble together to make cells – the units of life, e.g., mitochondria, lysosomes, Golgi bodies, nucleus. For example, mitochondria of a cell (Singular: mitochondrion) is called "powerhouse" of the cell. This organelle is present in the cytoplasm of the cells and makes energy for the cells hence called "power house". These are found in both plants and animals. Another example is nucleus present in almost all cells.



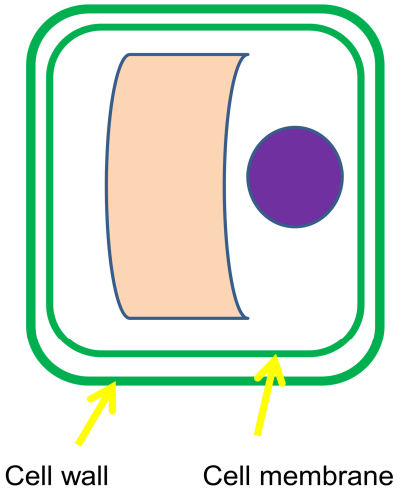
Organelle: nucleus.

Cells – the basic unit of life

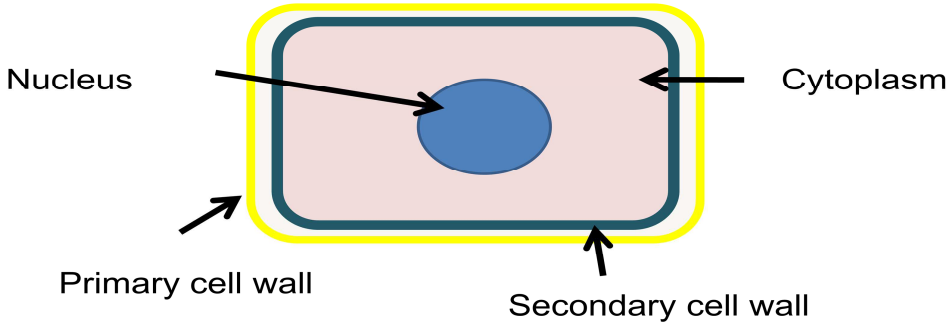
All the living organisms consist of cells. Cells are called the basic units of life. Cells are specialized in their structure and functions. There are different types of cells present in the bodies of multicellular organisms. But some organisms like amoeba consist of only one cell. Cells are categorized based upon the placement of their nuclear material into prokaryotic and eukaryotic cells. Prkaryotic (Pro: old, Karyotic: related to nucleus) cells are those cells that do not have a true nucleus – it means that their nuclear material is not covered by a membrane. While eukaryotic cells have a true nucleus, i.e., their nuclear material is covered by a membrane called nuclear membrane. Sometimes a cell makes a whole unicellular organism, like Prokaryotes and Protists. A variety of cells makes a single, multi-cellular organism.



Animals Cell



Plant Cell



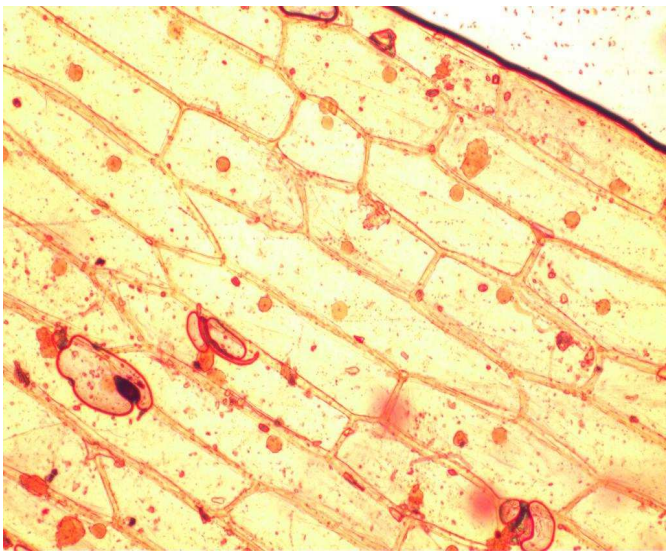
Bacterial Cell

Stem Cells

These are the undifferentiated cells in which most of the genes are switched on and these have a potential to make almost all cells of the body. These cells are present in a few places in adult organism or present in the embryos. These are useful for human beings because these can be used in making organs of any type which may be damaged by for example a disease.

Tissues

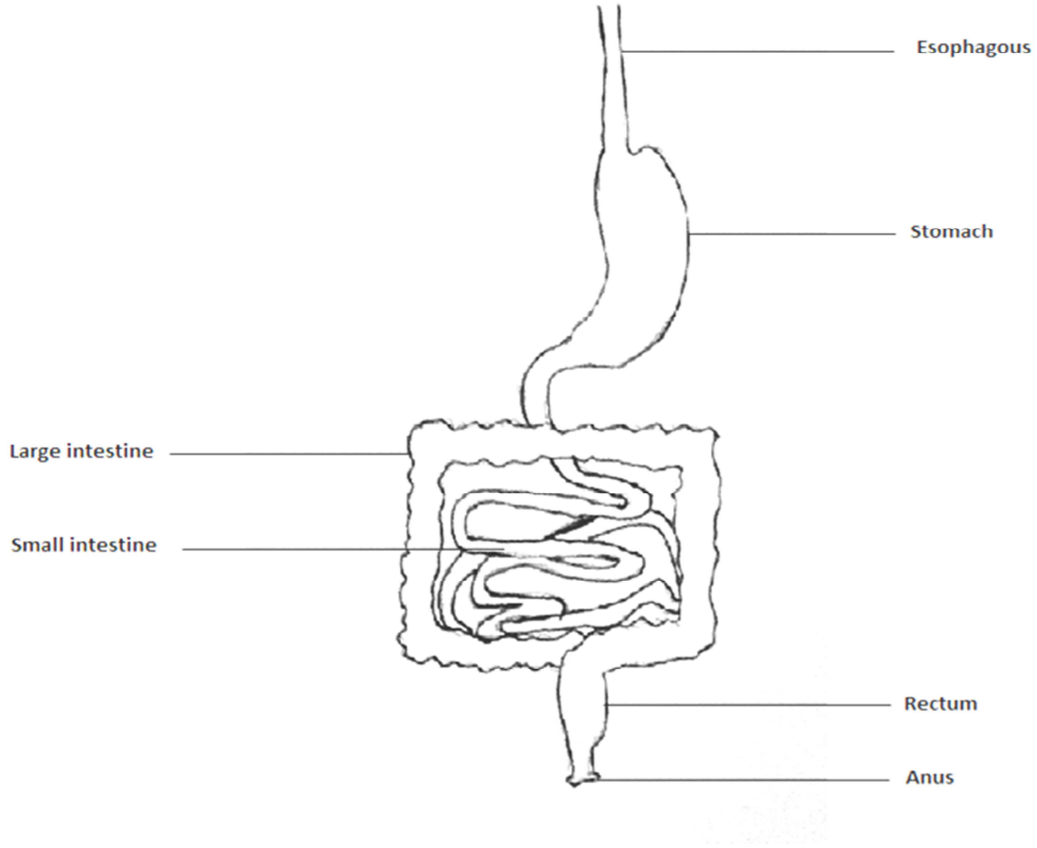
These are the groups of similar kind of cells which perform a same function. The tissues perform a common function, specialized to the tissue. For example, epithelial tissue that makes the skin.



Onion Epidermis (tissue)

Organs and organ systems

Tissues group and work together to make a unit called organ. Different tissues in an organ work differently to perform collective function of the organ. For example in stomach, there are muscle tissues that contract and relax for grinding and there are secretory cells which secrete gastric juices to digest the food. Collective action is the secretion of gastric juices and its mixing.



Digestive system in humans

In the simple to complex organisms, many organ-systems are present, for example, in humans digestive system, cardiovascular system, respiratory system and many more are present that work for a specific purpose. Digestive system consists of oral cavity, esophagus, stomach, intestine, pancreas, liver and rectum. Cardiovascular system consists of heart, vessels and blood.

Organism

Organ-systems join together to constructs organisms. In an organism, the organs and organ-systems coordinate to perform the activities of the whole organism. For example, in humans brain control the activities of most of the organs and organ-systems. If a person is running;

cardiovascular system provides it oxygen and nutrients, muscles contract and relax for movement and nervous system coordinate all of these functions.

Population

All organisms of a species living in an area at a particular time are called population, like all deer in a forest. Biologists study populations to explore the interactions between organisms. For example, interactions between male-male, female to female or else.

Ducks in a local park

Community & Ecosystem

Different populations living in an area in a particular time, for example, in a forest plants, animals, algae, fungi live together are called a **community**. Populations interact with each other and also to the abiotic factors of the area to make Ecosystem, for example, a lake ecosystem.

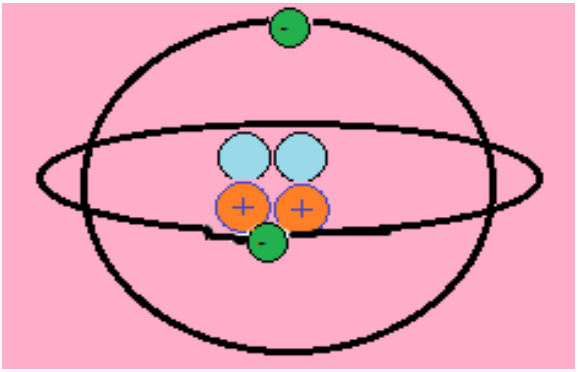
Plant community in a forest

Biosphere

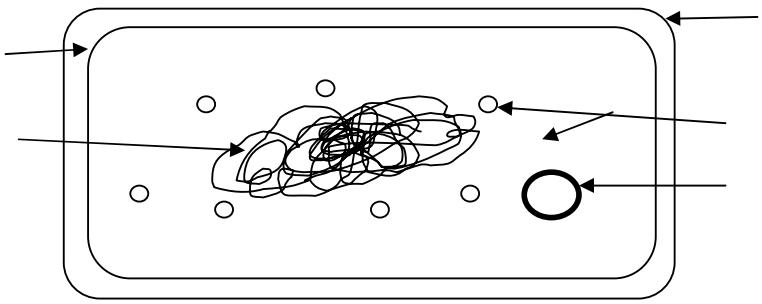
The part of the world covered or inhabited by the living organisms is called biosphere. This is also called zone of life on Earth. Biosphere includes all ecosystems, like forests, lakes, oceans and valleys where biotic components exist.

Exercise

1. Draw a flow chart to demonstrate the levels of organization in life.
2. Label various parts of atom in the following diagram:



3. Label various parts of a bacterial cell in the following diagram:



Lecture No.2

Branches of Biology

Microbiology

This division of biology deals with the study of microorganisms such as bacteria, viruses, fungi etc.

Hydrobiology

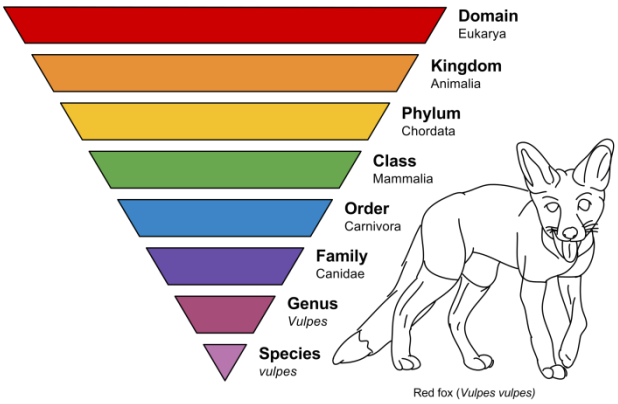
The study of life in water environment.

Cell Biology

The study of structures and functions of cells and cell organelles is called cell biology. This branch also deals with the study of cell division.

Taxonomy

Taxonomy is the science of naming, describing and classifying organisms and includes all plants, animals and microorganisms of the world.



Paleontology

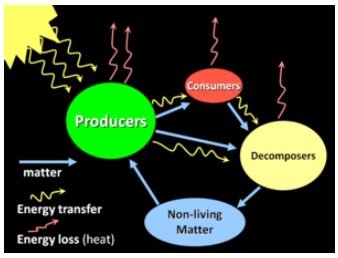
It is the study of fossils, which are the remains of extinct organisms.

Botany

This division of biology deals with the study of plants .The study of plants is vital because they underpin almost all animal life on Earth. They generate a large proportion of the oxygen and food.

Ecology

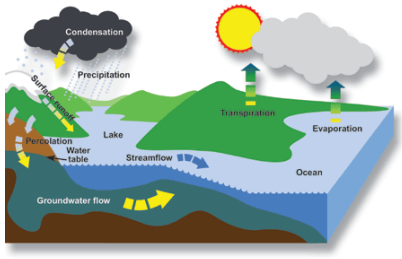
Ecology is the study of the relationships between living organisms, including humans, and their physical environment; it seeks to understand the vital connections between plants and animals and the world around them. Ecology also provides information about the benefits of ecosystems and how we can use Earth's resources in ways that leave the environment healthy for future generations.



Limnology

Limnology **i**s the study of inland waters - lakes (both freshwater and saline), reservoirs, rivers, streams, wetlands, and groundwater - as ecological systems interacting with their drainage basins and the atmosphere. The limnological discipline integrates the functional relationships of growth, adaptation, nutrient cycles, and biological productivity with species

composition, and describes and evaluates how physical, chemical, and biological environments regulate these relationships.



Marine Biology

Marine biology is the scientific study of organisms in the *ocean* or other marine or brackish bodies of water.

Zoology

Zoology is basically the branch of biology that deals with the scientific study of animals.

Entomology

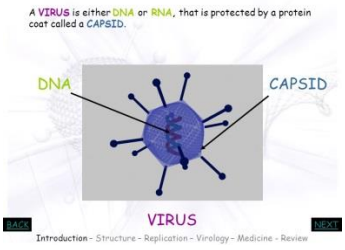
Entomology is the study of insects and their relationship to humans, the environment, and other organisms. Entomologists make great contributions to such diverse fields as agriculture, chemistry, biology, human/animal health, molecular science, criminology, and forensics.

Bacteriology

The science and study of bacteria and their relation to medicine and to other areas such as agriculture (e.g., farm animals) and industry. Bacteria are single-celled microorganisms which can live as independent organisms or, dependently, as parasites.

Virology

Virology is a branch of the sciences which focuses on the study of viruses and organisms which behave like viruses, such as prions and viroids.



Mycology

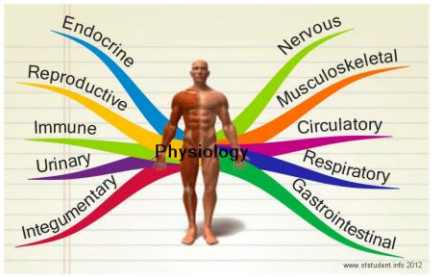
Mycology is the branch of biology concerned with the study of fungi, including their genetic and biochemical properties, their taxonomy and their use to humans as a source for tinder, medicine, food, and entheogens, as well as their dangers, such as poisoning or infection**.**

Parasitology

Parasitology is the study of parasites, their hosts, and the relationship between them.

Physiology

This branch deals with the study of the functions of different parts of living organisms.



Genetics

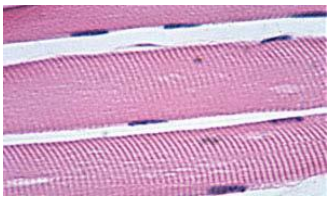
The study of genes and their roles in inheritance is called genetics. Inheritance means the transmission of characters from one generation to another.

Biotechnology

It deals with the practical application of living organisms for make substances for the welfare of mankind.

Histology

Histology is the study of the microscopic anatomy of Cells and tissues of plants and animals.

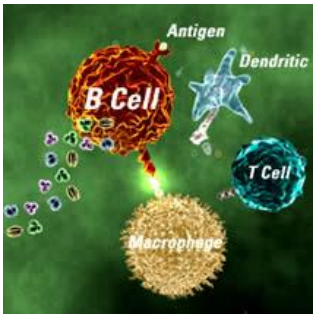


Pharmacology

It is the study of drugs and their effects on the systems of human body.

Immunology

It is the study of immune system of animals, which defend the body again invading organisms. It deals with the physiological functioning of the immune system in states of both health and diseases.



Biology lecture # 3

CELL ORGANELLES

WHAT IS CELL THEORY?

- Cell theory in its modern form states:
    - All living organisms are composed of one or more cells.
    - Cells are the smallest living things, the basic unit of all living organisms.
    - Cells arise only by division in pre-existing cells.

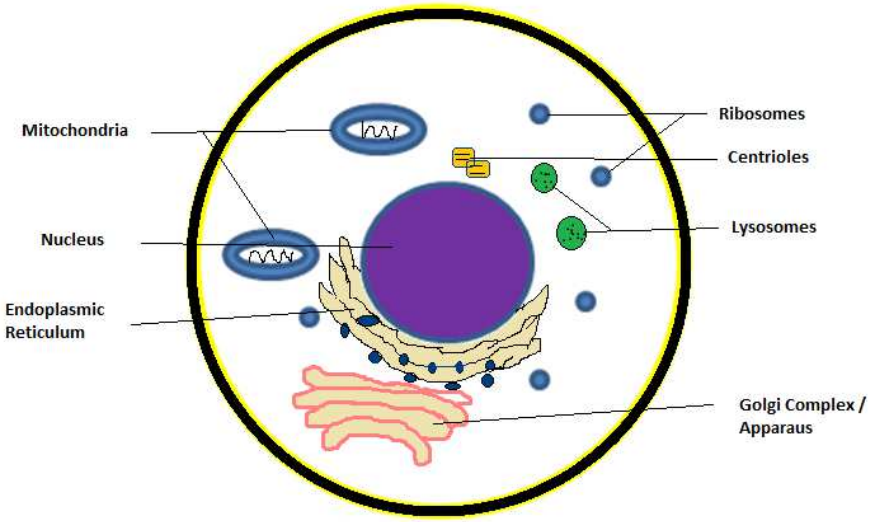
HOW CELL THEORY DEVELOPED?

- Cells were first described by Robert Hooke (Curator for instruments of Royal Society of London) in 1665.
- Leeuwenhoek (Textile Merchant) observed tiny organisms in pond's water, called them animalcules.
- In 1809, de-Lamark proposed that nobody can have life if its parts are not cellular tissues.
- Robert Brown discovered nucleus in the cell.
- In 1838, Schleiden stated that all plants are aggregates of individual cells.
- In 1839, Schwann stated that all animal tissues consist of cells.
- In 1855, Virchow proposed that cells arise from pre-existing cells.
- In 1862, Pasteur provided experimental proof for the above.

CELLULAR COMPONENTS

Cells consist of several components. Some important and common ones are discussed below:

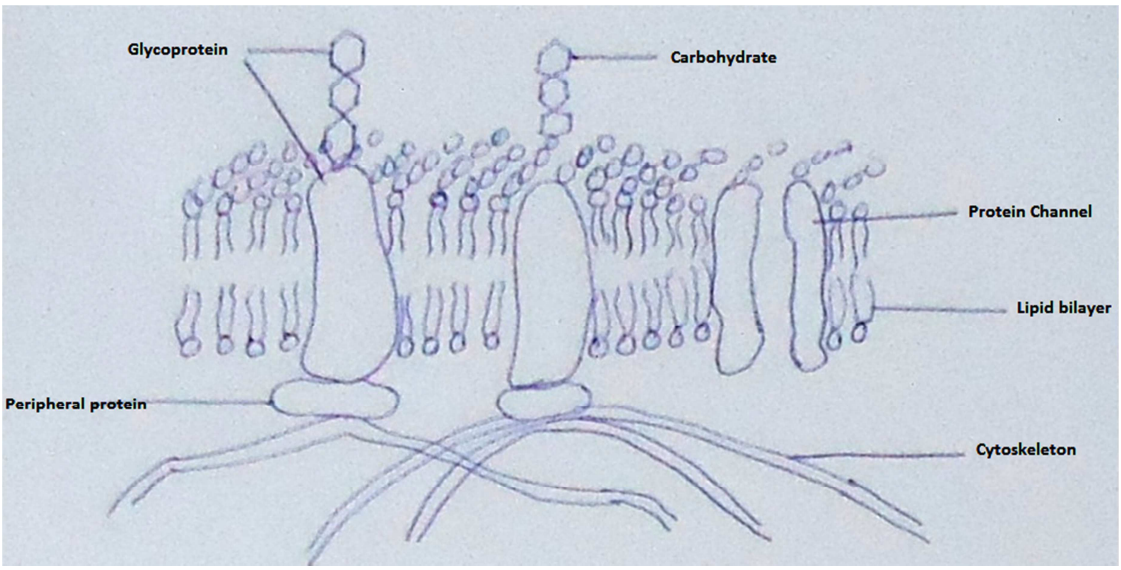
- Cell membrane
- Cell wall
- Cytoplasm
- Cytoskeleton
- Organelles (e.g. nucleus, ribosomes)



A typical animal cell

Cell Membrane

- Cell membrane is the external most layer that covers the cell from outside.
- Functions of the cell membrane are:
  - It acts as a barrier, i.e., it separates the cell from environment.
  - It provides protection to the inner parts of the cells including all the organelles.
  - Another important function of cell membrane is transport of materials. Cell membrane manages the transport in and out of the cell.



Structure of plasma membrane

Structure and Functions of Cell Membrane

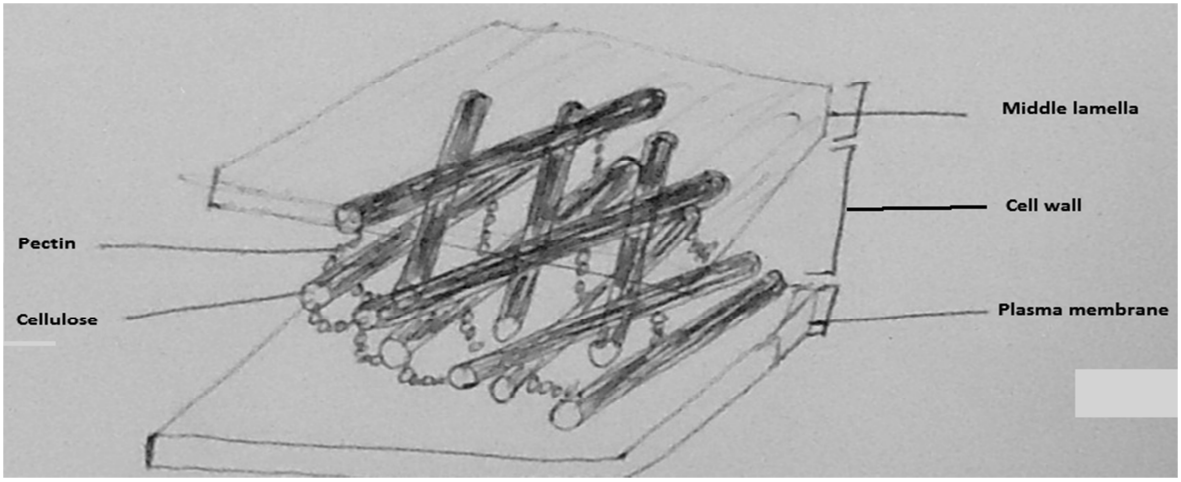
Structure of cell membrane is described by Fluid Mosaic Modal. It consists of lipid bilayer, proteins and carbohydrates. Lipid bilayer provides it with fluidity, flexibility and transport of lipid like substances. Proteins are integrated inside the membrane or present on its peripheries called **integrated proteins** and **peripheral proteins**, respectively. Some proteins are transmembrane, i.e., these are integrated and their ends (domains) are exposed from both intracellular and extracellular side of the membrane. These make channels for transport of materials, e.g., aquaporins are the protein channels for transport of water. Proteins and glycoproteins (carbohydrates attached to proteins) make receptors for message transmission. Cells carry out their message transmission with other cells or environment with the help of these glycoproteins mostly, we call these **receptors**.

Movements across Cell Membrane

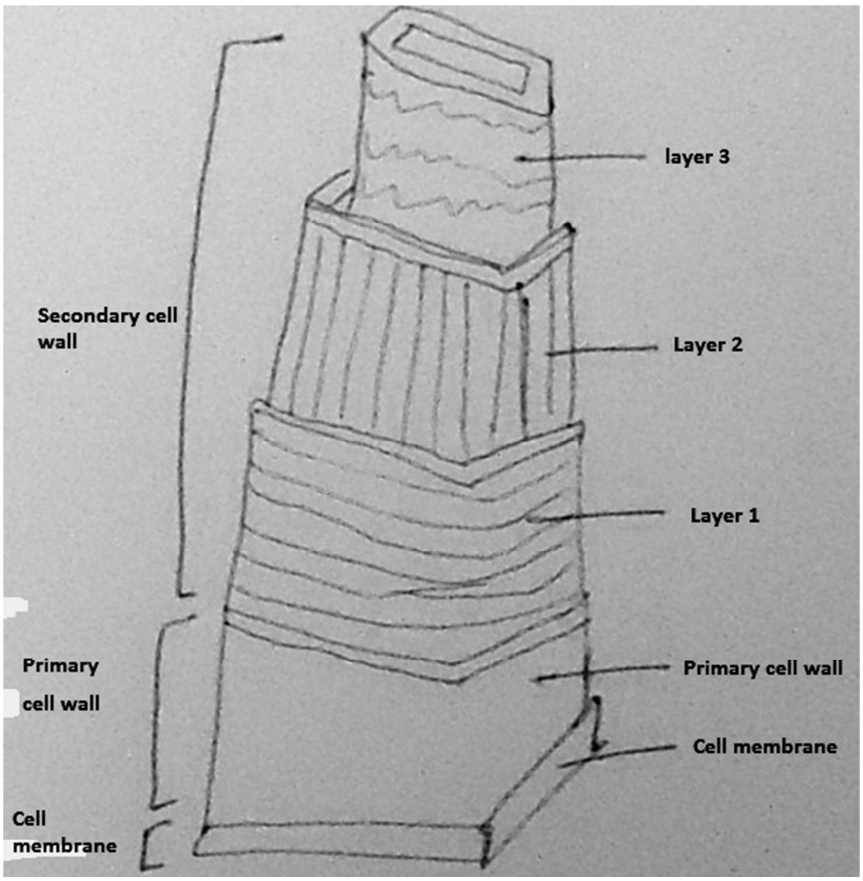
- Some molecules can pass directly e.g. few lipids.
- Other molecules need channels to pass through; channels are made up of proteins.
- There are different types of channels for different molecules like water channels and ion channels (Sodium channels, Calcium channels).

Cell Wall

It is the outermost covering in many organisms surrounding the cell membrane. Prokaryotic cells, fungi and plant cells have a cell wall around their cell membrane. Cell wall makes the outermost covering in these organisms. Cell wall is tough in comparison to cell membrane; it is a rigid structure. Cell wall in plants consists of **cellulose**, **hemicellulose**, and **pectin**. Fungal cell walls consist of a long polymer called, **chitin**. Prokaryotic cell wall consists of a polymer, called **peptidoglycan**. Functions of the cell wall are protection, shape, strength and support. Plant cells have 2 types of cell wall, primary cell wall and secondary cell wall. Primary wall consists of mainly cellulose, hemicellulose and pectin. Secondary cell wall contains cellulose and some other molecules like lignin which make it stronger structure.



Primary cell wall



Secondary cell wall

Cytoplasm

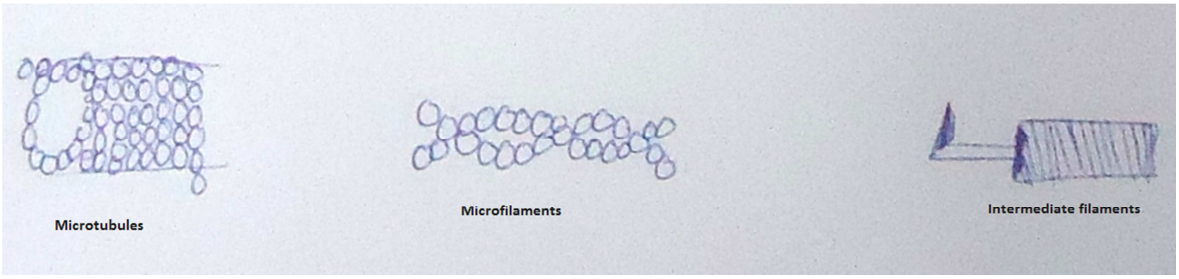
Cytoplasm is a semi transparent substance present between plasma membrane and the nucleus. It contains water in which organic (e.g. proteins, carbohydrates) and inorganic materials (e.g. salts), which are partially or fully dissolved in this solution. Cytoplasm provides space for metabolic reactions (e.g. glycolysis). It also provides space for functioning of organelles and metabolic reactions.

Cytoskeleton

Cytoskeleton is the skeletal framework of the cell – a network of filaments and tubules. There are three types of cytoskeletal elements called microfilaments, intermediate filaments and microtubules.

Microfilaments are the smallest in their diameter. These help in movement of organelles and the cell. These consist of helical chains of a protein called actin e.g. in muscle cells these are highly modified. **Intermediate filaments** are intermediate in size. These consis of different

proteins belong to a protein family called keratins. These filaments help in maintaining shape and placement of the cell and its various parts. These also provide protection to various parts of the cell particularly to the nucleus. **Microtubules** are largest in diameter, these filaments consist of a protein called tubulin which makes dimers and then long and large hollow tubes. These help in movement of the organelles inside the cells and also in movement of the cell itself. Cilia and flagella consist of microtubules. These filaments help in maintaining shapes of organelles and cell. For example these make the nuclear lamina, a layer that maintain the shape of the nucleus and give it support.



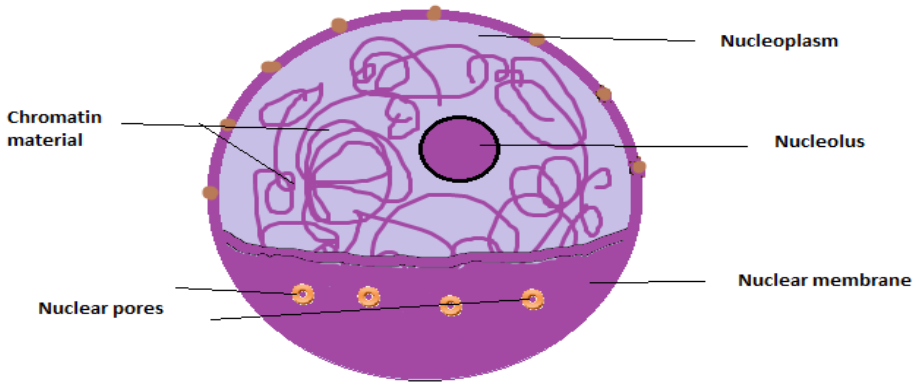
Cytoskeletal fibers

Cell Organelles

These are sub-cellular structures that perform a particular function. These include nucleus, mitochondria, endoplasmic reticulum and many more.

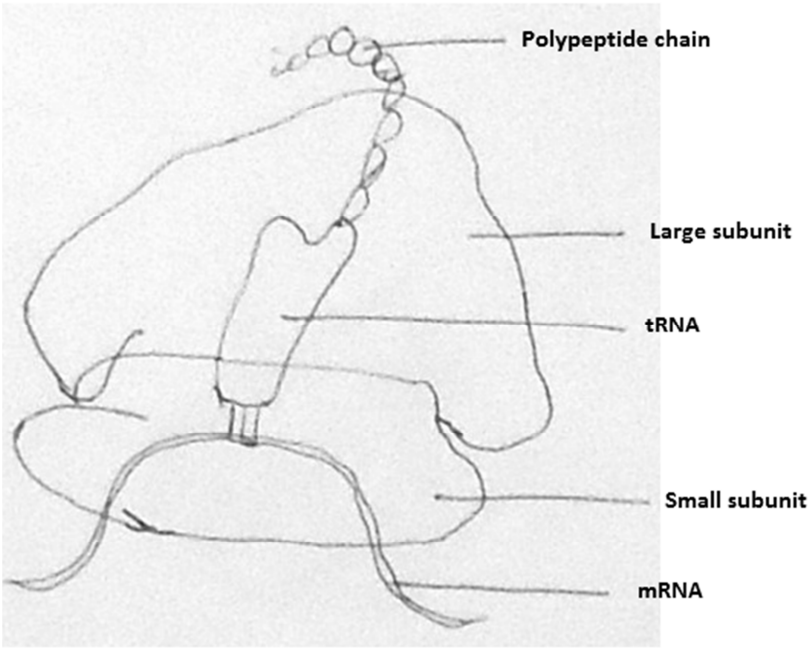
Nucleus

It is the organelle that contains genetic material. It is present in the center in animal cells usually. In plant cells, it is present on a side due to presence of a large vacuole. Nucleus is covered by nuclear membrane with nuclear pores. It is filled with a fluid called nucleoplasm. It also contains a denser body called nucleolus which is involved in ribosomal RNA production. Genetic material is present inside the nucleus in most of the eukaryotic cells, though, some cells have extranuclear DNA. DNA is present in the form of chromosomes, which are visible during cell division.



Ribosomes

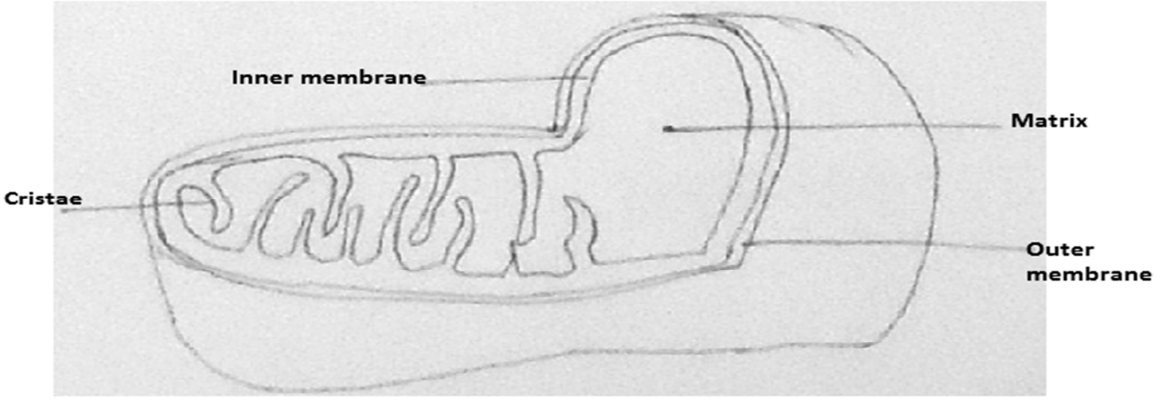
Ribosomes are the protein making machinery of the cells. These are present free in cytoplasm or attached to endoplasmic reticulum. A large number of ribosomes are present in cells. Eukaryotic ribosomes are slightly different than prokaryotic ones in their size.



Structure of a ribosome

Mitochondria

Mitochondria are called power house of the cell. These make energy for the cells in the form of ATP (Adenosine Tri Phosphate). ATP is the biological or chemical form of energy. Mitochondria have a double membrane, one is called outer and the other is inner membrane. Mitochondria are filled with matrix containing circular DNA molecule and other molecules including the enzymes. Mitochondria are self replicating organelles.



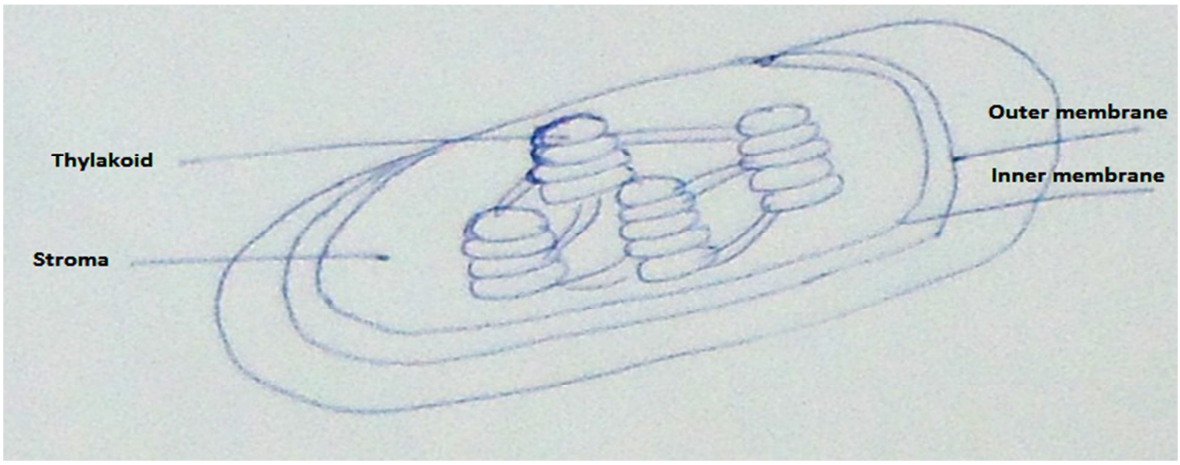
Mitochondria

Plastids

Plastids are the double membrane bound organelles, present in plants and in the other organisms which are producers such as algae. These are of three main types:

- Chloroplasts are present in the green parts of plants. These are green in color and their color is due to chlorophyll, the green pigment. These help in photosynthesis.
- Chromoplasts are the organelles present in the fruits and flowers of the plants. Beautiful colors of fruits and flowers are due to presence of Chromoplasts which contain red, yellow, orange and more colored pigments.
- Lecuoplasts are the plastids present in the roots and tubers. These are colorless pigments and their function is to store various materials in the roots and tubers, e.g., potatoes.

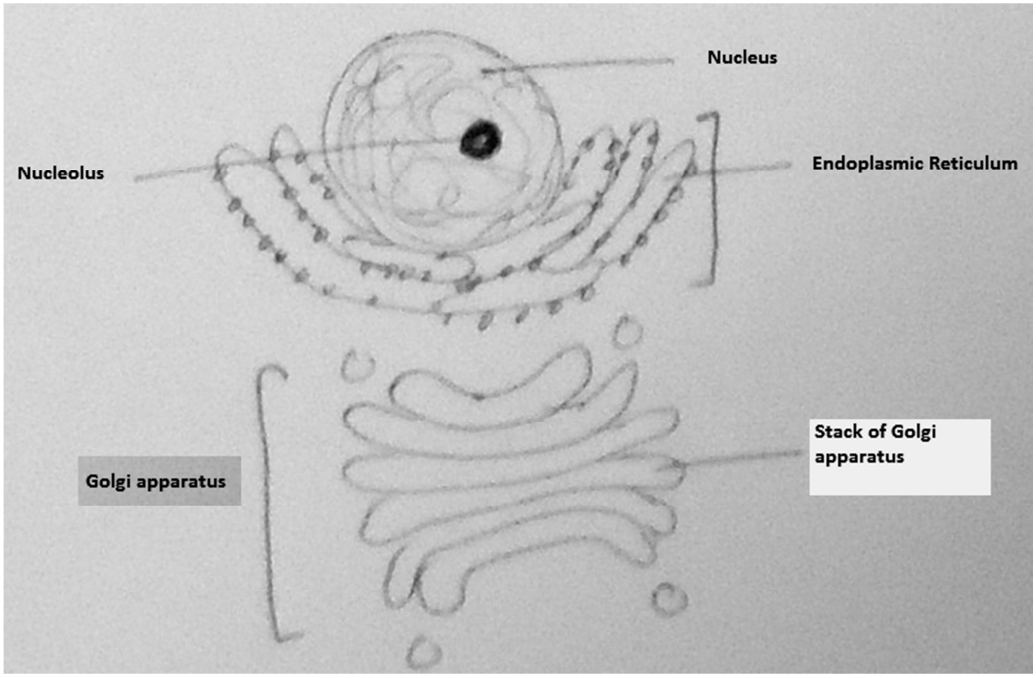
Plastids have a double membrane system. Their membranes are called outer membrane and inner membrane. They have a membrane system called thylakoid. Stacks thylakoids are called grana. They have a matrix inside inner membrane which is called stroma. These organelles like mitochondria have their own circular DNA. These are self replicating organelles.



Structure of a chloroplast (a kind of plastid)

Endoplasmic Reticulum

Endoplasmic reticulum (ER) is a network of interconnected channels present inside the cells. This is of two types: Rough ER and Smooth ER. Rough endoplasmic reticulum is the rough due to the ribosomes present on its surface. This type is involved in protein modification. The other type is free of ribosomes so that shape of this one is smooth giving it its name. SER is involved in metabolism of lipids and carbohydrates.



Endoplasmic reticulum and Golgi apparatus

Golgi Apparatus

This is also called Golgi bodies or Golgi complex. This is also very important organelle of the cells. It was discovered by Camillo Golgi. Golgi apparatus consist of flattened disks called cisternae which are associated with endoplasmic reticulum. These are called the post office of the cell because these pack materials in the form of vesicles. For example the proteins formed by the ribosomes and modified by the endoplasmic reticulum enter in the cisternae and here these are packed in the vesicles and transferred to the part of the cell where these are required or secreted out of cells.

Centrioles

These are hollow and cylindrical bodies present near the nucleus of the animal cells. It is also present in some lower plants. A pair of Centrioles is collectively called centrosome. Their function is during cell division. These make the spindle fiber during cell division in animal cells.

Vacuoles

Vacuoles are membrane bound organelles present in most of the cells. Their major function is storage of various materials including food materials to waste materials. If these store food then these are called food vacuoles. Their size is from small to very large in different cells according to the requirements of the cells. In mature plant cells a single large vacuole is present. Contractile vacuole in unicellular fresh water organisms helps in removal of water from the body.

Lysosomes

Lysosomes are membranous sacs filled with enzymes. Lysosomes are spherical bag like structures that are bound by a single layer membrane. These are found in all eukaryotic cells and act as 'garbage disposal' or the 'digester' of the cell. These act as disposal system of the cell. They break down complex proteins, carbohydrates, lipids and other macromolecules into simpler compounds. These simple compounds are returned to the cytoplasm and are used as new cell building materials. They are used for digestion of cellular waste products, dead cells or extracellular material such as bacteria.

Exercise

1. Draw the structure of an animal cell.
2. Draw structure of a plant cell.
3. Compare mitochondria with chloroplast.

Lecture 4

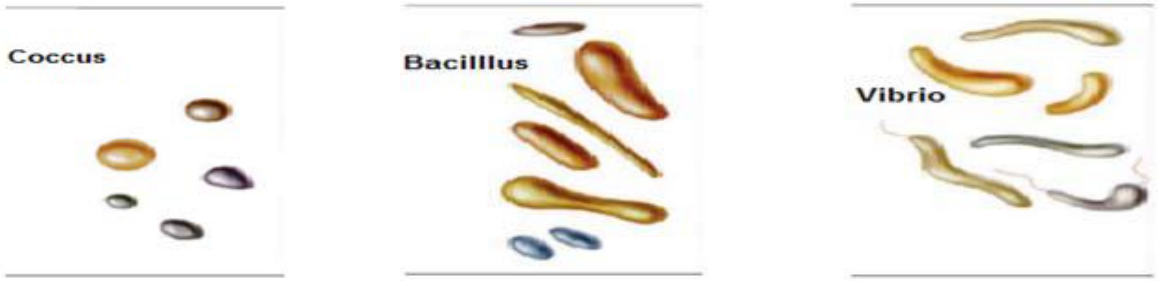
Bacteria and their Structure

Introduction of bacteria

Bacteria are single celled prokaryotic unicellular microorganisms, usually a few micrometers in length that normally exist together in millions. The cell wall of bacteria usually contains peptidoglycan and multiplies by binary fission. The cell structure is simpler than that of other organisms as there is no nucleus or membrane bound organelles. Instead their control Centre containing the genetic information is contained in a single loop of DNA. Some bacteria have an extra circle of genetic material called a plasmid. The plasmid often contains genes that give the bacterium some advantage over other bacteria. For example it may contain a gene that makes the bacterium resistant to a certain antibiotic.

Shapes of bacteria

Most bacteria are 0.2 um in diameter and 2-8 um in length. The three basic bacterial shapes are coccus (spherical), bacillus (rod-shaped), and spiral (vibrio twisted), however pleomorphic bacteria can assume several shapes.



Characteristic Groups

These bacteria can give themselves higher Level structural organizations such as

Cocci

Cocci may be oval, elongated, or flattened on one side. Cocci may remain attached after cell division. These group characteristics are often used to help identify certain cocci.

1) Cocci that remain in pairs after dividing are called diplococci.

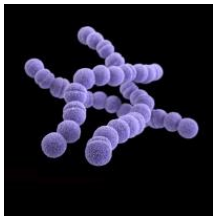
2) Cocci that remain in chains after dividing are called streptococci.

3) Cocci that divide in two planes and remain in groups of four are called tetrads.

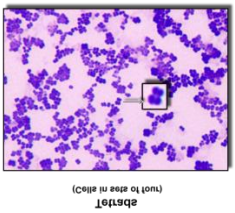
4) Cocci that divide in three planes and remain in groups cube like groups of eight are called sarcinae.

5) Cocci that divide in multiple planes and form grape like clusters or sheets are called staphylococci.

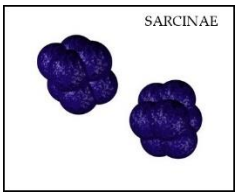
Diplococci



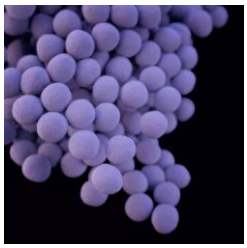
Streptococci



Tetrads



Sarcinae



Staphylococci

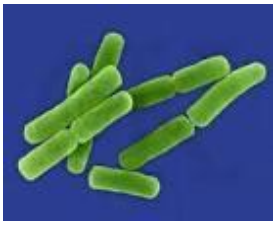
Bacilli

Bacilli only divide across their short axis there are fewer groupings. Bacillus is a shape (rod shaped) but there is also a genus of bacteria with the name *Bacillus*.

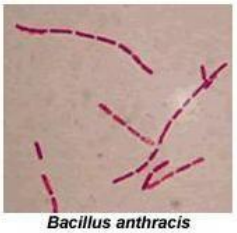
1) Most bacilli appear as single rods. Diplobacilli appear in pairs after division.

2) Streptobacilli appear in chains after division.

3) Some bacilli are so short and fat that they look like cocci and are referred to as coccobacilli.



Diplobacilli



Streptobacilli

Coccobaciili

Spiral bacteria

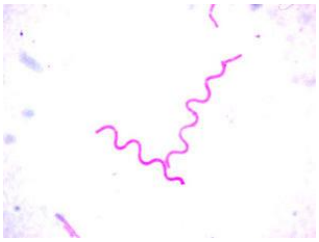
Spiral bacteria have one or more twists.

1) Vibrios look like curved rods.

2) Spirilla have a helical shape and fairly rigid bodies.

3) Spirochetes have a helical shape and flexible bodies. Spirochetes move by means of axial filaments, which look like flagella contained beneath a flexible external sheath.

Vibrio's



Spirilum

Spirochetes

Structure of bacteria

The bacterial structure is composed of following components. These are

1) Cell wall 2) Plasma membrane 3) Cytoplasm
4) Ribosomes 5) Plasmid 6) Flagella
7) Pilli 8) Capsule

1) Cell wall

Cell walls of bacteria are made up of glycoprotein murein.The main function of cell wall is it helps in providing support, mechanical strength and rigidity to cell. It protects cell from bursting in a hypotonic medium.

Two distinct structural types of cell wall known as:

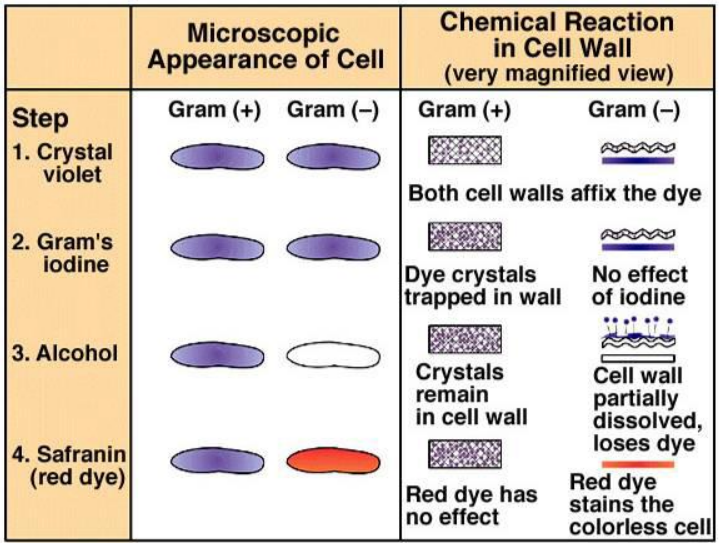
- Gram-negatives
- Gram-positives

Gram negative cell wall

Gram-negative cell walls are thin and unlike the gram-positive cell walls, they contain a thin peptidoglycan layer adjacent to the cytoplasmic membrane. Gram-negative bacteria are stained as pink colour. The chemical structure of the outer membrane's lipopolysaccharides is often unique to specific bacterial sub-species and is responsible for many of the antigenic properties of these strains**.**

Gram positive cell wall

Gram-positive cell walls are thick and the peptidoglycan (also known as *murein*) layer constitutes almost 95% of the cell wall in some gram-positive bacteria and as little as 5-10% of the cell wall in gram-negative bacteria. The gram-positive bacteria take up the crystal violet dye and are stained purple**.**



2) Plasma membrane

It is also known as cytoplasmic membrane (or) cell membrane. It is composed of phospholipids, proteins and carbohydrates, forming a fluid-mosaic. It helps in transportation of substances including removal of wastes from the body .It helps in providing a mechanical barrier to the cell. Plasma membrane acts as a semi permeable membrane, which allows only selected material to move inside and outside of the cell.

3) Cytoplasm

Helps in cellular growth, metabolism and replication. Cytoplasm is the store houses of all the chemicals and components that are used to sustain the life of a bacterium.

4) Ribosome

A tiny granule made up of RNA and proteins .They is the site of protein synthesis. They are freely floating structures that help in transferring the genetic code.

5) Plasmid

Plasmids are small circle of DNA. Bacterial cells have many plasmids. Plasmids are used to exchange DNA between the bacterial cells.

6) Flagella

This is a rigid rotating tail. It helps the cell to move in clockwise and anticlockwise, forward and also helps the cell to spin. The rotation is powered by H+ gradient across the cell membrane. Common forms include:

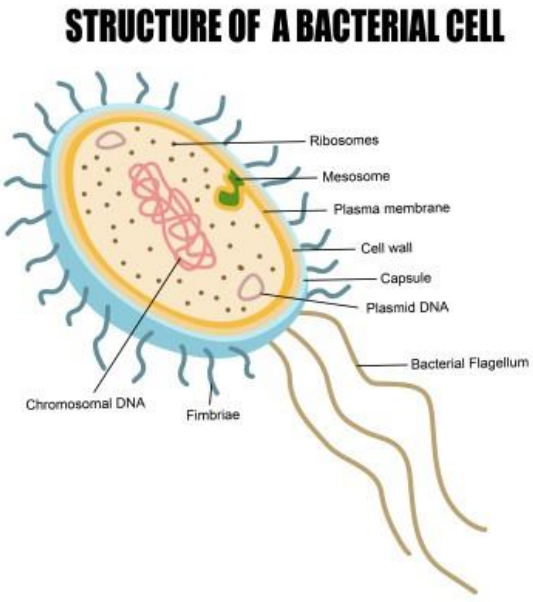
- **Polar *Monotrichous***
  A single flagellum at one or both ends of the cell
- ***Amphitrichous***
  Two or several flagella at one or both ends of the cell
- **Bipolar**
  One flagellum arises predominantly from the both pole of the cell
- ***Monotrichous***
  One flagellum from the each of the cellular pole
- **Peritrichous**
  Random, haphazard arrangement of flagella scattered around the bacterial cell

7) Pilli

Pilli are protein tubes that extend out from the outer membrane in many members of the *Proteobacteria*. They are generally short in length and present in high numbers about the entire bacterial cell surface. Fimbriae usually function to facilitate the attachment of a bacterium to a surface (e.g. to form a biofilm) or to other cells (e.g. animal cells during pathogenesis).

8) **Capsule**

Capsule is a kind of slime layer, which covers the outside of the cell wall. They are composed of a thick polysaccharide. It is used to stick cells together and works as a food reserve. It protects the cell from dryness and from chemicals.



Lecture 5

Bacterial Taxonomy

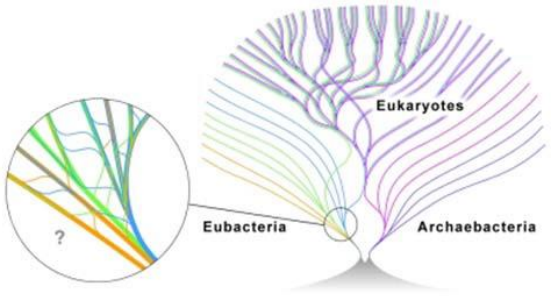
Bacterial Taxonomy

The classification, nomenclature, and identification of bacteria; sometimes used as a term to indicate the theory of classification. The bacteria are members of the kingdom Prokaryote, which is defined in terms of the unique structural and biochemical properties of their cells; Formal system originated by Carl von Linnaeus (1701-1778). Each organism placed into a specific cluster based on selected criteria.

Phenetic based Classification

In the past, the classification scheme has been based mostly on characteristics such as:

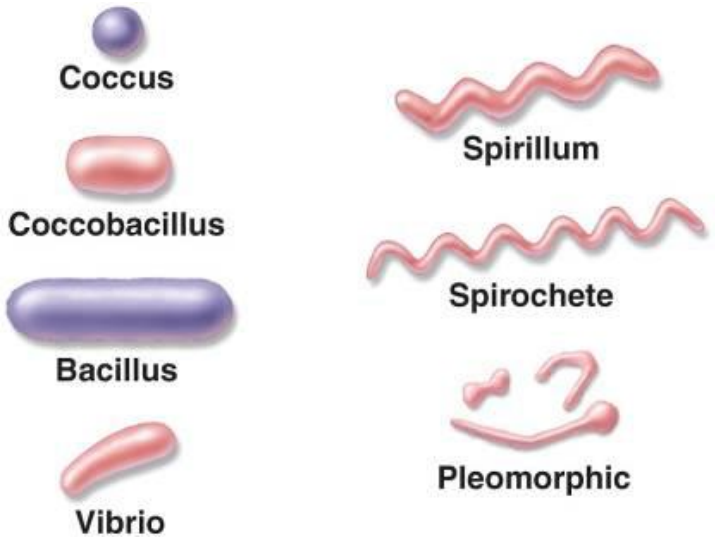
- Structural features
- Staining characteristics
- Gram Staining
- Acid Fast Staining
- Metabolic properties



Classification based upon structural Features

Shapes of bacteria

Most bacteria are 0.2 um in diameter and 2-8 um in length. The three basic bacterial shapes are coccus (spherical), bacillus (rod-shaped), and spirillum (vibrio twisted, spirochete), however pleomorphic bacteria can assume several shapes.



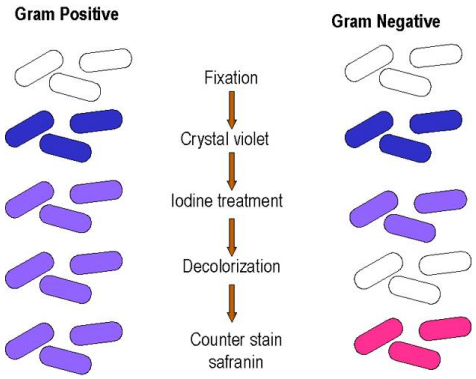
Using Staining procedure to Identify Prokaryotes

Gram Stain

The Gram stain is a differential stain that distinguishes between Gram-positive and Gram-negative bacteria. This relatively rapid test narrows the possible identities of an organism by excluding numerous others and provides suggestive information that can be helpful in the identification process.

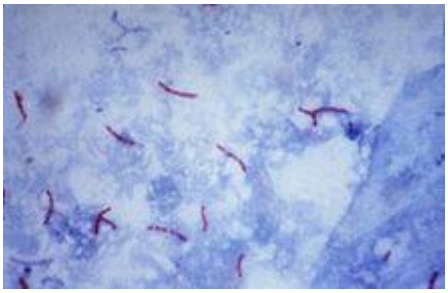
- **Gram-positive** bacteria tend to obtain blue color while don't survive with antibiotics. E.g. *Actinobacteria.* Gram-positive cell walls are thick and the peptidoglycan (also known as *murein*) layer constitutes almost 95% of the cell wall in some gram-positive bacteria and as little as 5-10% of the cell wall in gram-negative bacteria

- **Gram-negative** bacteria stained red and are more resistant to antibiotics. E.g. *proteobacteria.* The chemical structure of the outer membrane's lipopolysaccharides is often unique to specific bacterial sub-species and is responsible for many of the antigenic properties of these strains**.**



Differential Stains: Acid-Fast Stain

Acid-fast organisms are difficult to characterize using standard microbiological techniques. For example gram stain. Acid fast organisms like Mycobacterium contain large amounts of lipid substances within their cell walls called mycolic acids. These acids resist staining by ordinary methods such as a Gram stains. It can also be used to stain a few other bacteria, such as Nocardia. The reagents used are Ziehl–Neelsen carbol fuchsin, acid alcohol, and methylene blue. Acid-fast bacilli will be bright red after staining.



Classification based upon Metabolism

- **Heterotrophic**
  Saprobes
  Parasites
- **Autotrophic**
  Photosynthetic bacteria
  Cyanobacteria
  Purple sulfur bacteria
- **Chemoautotrophic**

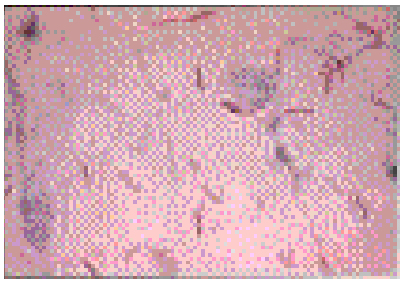
Nutrition of bacteria

They exhibits different modes of nutrition level such as-

- **Autotrophic bacteria*:*** These bacteria are able to synthesize their own food. For e.g.: Photosynthetic bacteria use a special type of chlorophyll called bacteriochlorophyll. E.g. *Rhodospirillum* O2 is not released in bacterial photosynthesis.

- **Heterotrophic bacteria*:*** These bacteria are unable to synthesize their own food, hence they depends on other organic materials.

- May feed on the remains of dead plants and animals called **Saprobes**.
- Those live on or in the organism and cause disease are called **Parasites**. For example, *Mycobacterium tuberculosis.*

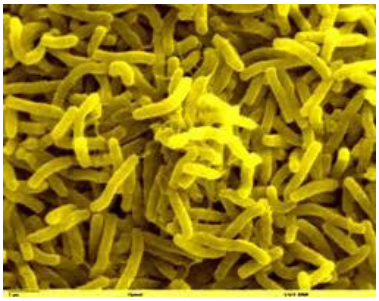


- **Symbiotic bacteria*:*** These bacteria have a mutual benefit from other organisms. For e.g.: nitrogen fixing bacteria (or) rhizobium.

- **Parasitic bacteria*:*** These bacteria are present in plants, animals and human beings. These bacteria feeds on host cells and causes harm to the host.

Chemoautotrophs

Chemoautotroph – an organism that uses the energy of environmentally available chemical reactions to fix raw materials into energy rich compounds.
Bacteria that produce organic matter by the use of energy obtained by oxidation of certain chemicals with carbon dioxide as the carbon source.



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Lecture 6

Structure of Viruses

Viruses

A virus is a small infectious agent that replicates only inside the living cells of other organisms. Viruses can infect all types of life forms, from animals and plants to microorganisms, including bacteria and archaea.

Virology

Virology is the study of viruses – submicroscopic, parasitic particles of genetic material contained in a protein coat.

Virologists

Virologists study viruses that affect humans, animals, insects, bacteria, fungi, and plants in community, clinical, agricultural, and natural environments.

Viruses as Living

Living characteristics of viruses

1) Viruses have genetic material (DNA or RNA).

2) They can be mutated.

3) They can be transmitted from one host to another.

4) They are capable of multiplication within a host.

5) They are able to infect and cause disease to living beings.

6) The DNA and proteins of viruses are similar in composition and structure to those of higher organisms.

Viruses as Non-living

Nonliving characteristics of viruses

1) Viruses can replicate and multiply inside the host but cannot grow.
2) Viral replication is different from reproduction of other living organisms.

3) There is no cell wall, membrane or cytoplasm.

4) There are no cell organelles and there is no metabolism.

5) They use the host cell's metabolic machinery.

General Features of viruses

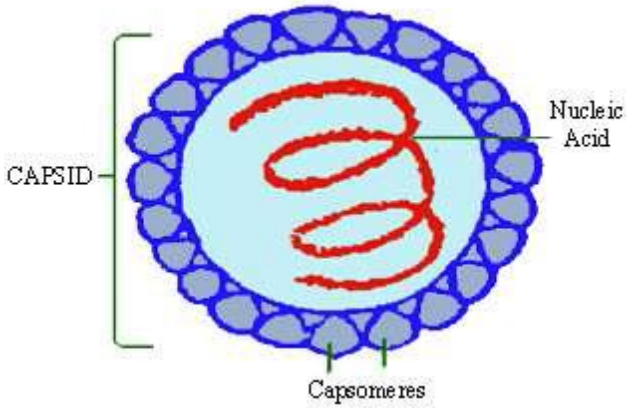
1) Obligate intracellular parasite.

2) Contain either DNA or RNA never both.

3) Can affect humans, animals, insects, bacteria and plants.

4) They do not respond to antibiotic.

5) Some viruses also surrounded by a membrane-like envelope



Structure of Viruses

Viruses come in an amazing variety of shapes and sizes. They are very small and are measured in nanometers, which is one-billionth of a meter. Viruses can range in the size between 20to750nm, which is 45,000times smaller than the width of a human hair. The majority of viruses cannot be seen with a light microscope because the resolution of a light microscope is limited to about 200nm, so a scanning electron microscope is required to view most viruses.

The three major viral components are

1. Nucleic acid **2.Capsid** **3.Viral Envelope**

1. Nucleic acid

The viral nucleic acid carries the genetic information in either DNA or RNA which is considered as the finger prints of the virus.

2. **Capsid (Protein coat)**

Capsid is the protein shells which enclose the nucleic acid. It is formed of small unis called capsomeres. Capsomeres are arranged in a precise and highly repetitive pattern around the nucleic acid. A single type of capsomeres or several chemically distinct types may make up the capsid. The combination of genome and capsid is called the viral nucleocapsid**.**

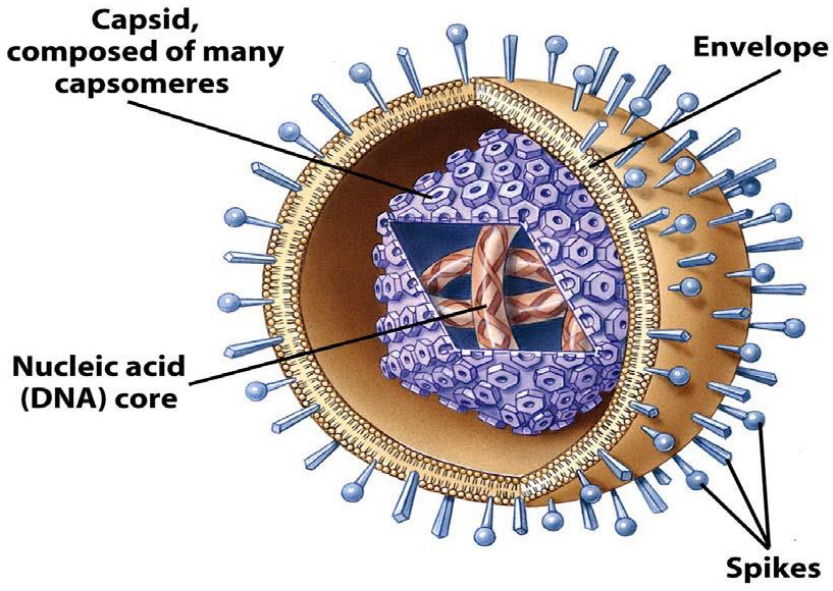
Functions of the capsid

1) Protects the viral genome against extracellular environments.

2) It carries he viral attachment proteins (VAP) which are glycoproteins that attach the virus to a specific receptor on the target cell.

3) Determine the antigenic characters of the virus.

4) It is responsible for the symmetry of the virus



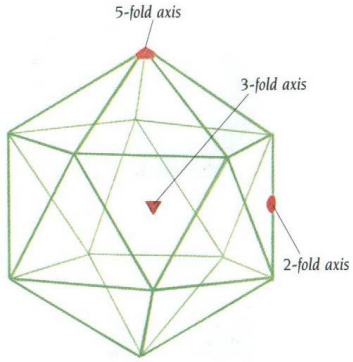
3. Viral Envelopes

A number of kinds of viruses contain envelopes. An envelope is a membrane like structure that encloses the nucleocapsid and is obtained from a host cell during the replication

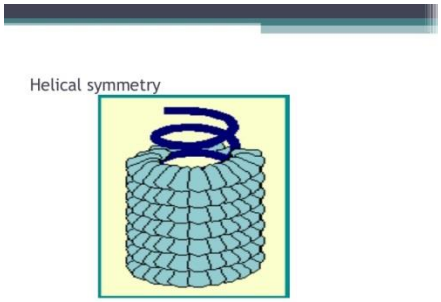
process. The envelope contains viral-specified proteins that make it unique. Among the envelope viruses are those of herpes simplex, chickenpox, and infectious mononucleosis.

The nucleocapsids of viruses are constructed according to certain symmetrical patterns. The virus that causes tobacco mosaic disease, for example, has helical symmetry**.** In this case, the nucleocapsid is wound like a tightly coiled spiral. The rabies virus also has helical symmetry. Other viruses take the shape of an icosahedron, and they are said to have icosahedral symmetry**.**

In an icosahedron, the capsid is composed of 20 faces, each shaped as an equilateral triangle 12 vertices, 5-3-2 symmetry axes, 60 identical subunits in identical environments can form icosahedral shell.



Icosahedral symmetry



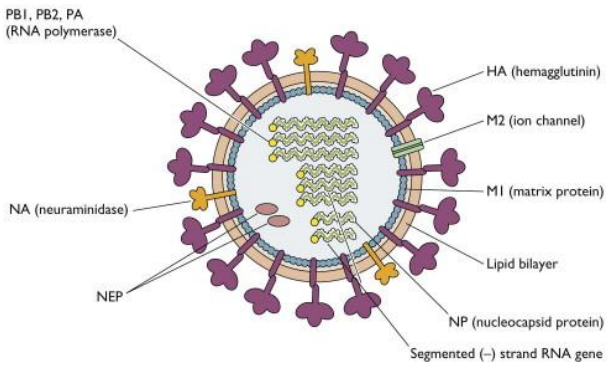
helical symmetry

Envelope Glycoproteins

Found in the envelope bilayer. This is aided by domains of host membrane proteins called *spanners.* They can generate spikes or other structures on the outside of the virion to anchor a host cell.

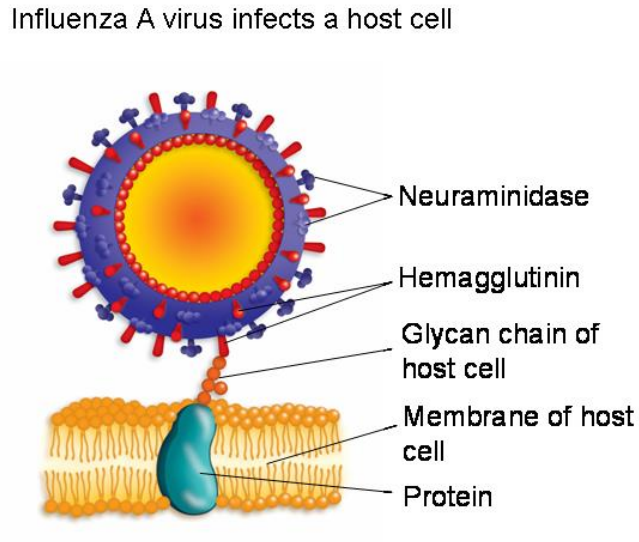
4. Influenza virus

The influenza virion (as the infectious particle is called) is roughly spherical. It is an enveloped virus – that is, the outer layer is a lipid membrane which is taken from the host cell in which the virus multiplies. Inserted into the lipid membrane are ‘spikes’, which are proteins – actually glycoproteins, because they consist of protein linked to sugars – known as HA (hemagglutinin) and NA (neuraminidase). These are the proteins that determine the subtype of influenza virus.



Influenza Hemagglutinin

Hemagglutinin (BE) is an antigenic glycoprotein found on the surface of the influenza viruses. It is responsible for binding the virus to the cell that is being infected. The name "hemagglutinin" comes from the protein's ability to cause red blood cells (erythrocytes) to clump together ("agglutinate") in vitro. The process is like this: Hemagglutinin (HA) binds to the monosaccharide sialic acid which is present on the surface of its target host cells. The cell membrane then engulfs the virus through endocytosis and forms endosome. The cell then attempts to begin digesting the contents of the endosome by acidifying its interior and transforming it into a lysosome. The HA spikes extend like a spring during infection.



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