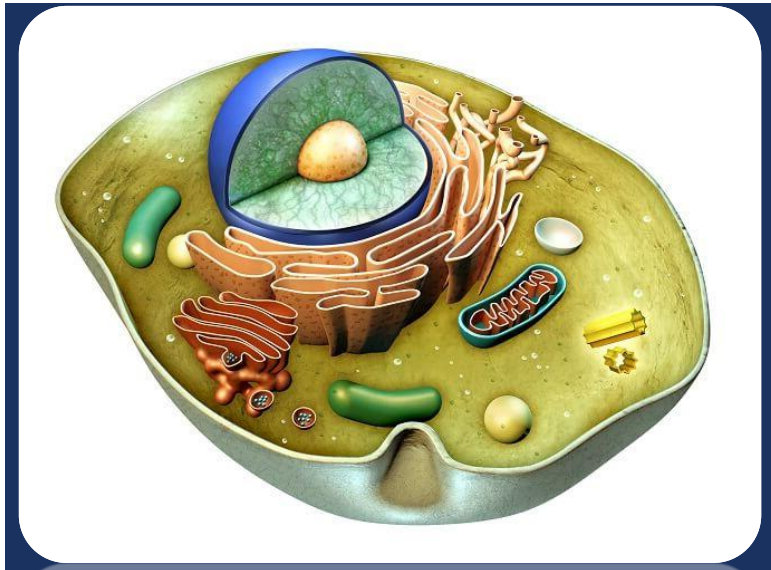
CELL BIOLOGY 1

LECTURE 1



2020-2021

Dr. Hiba A. Jasim

Collage of Education for Pure Sciences

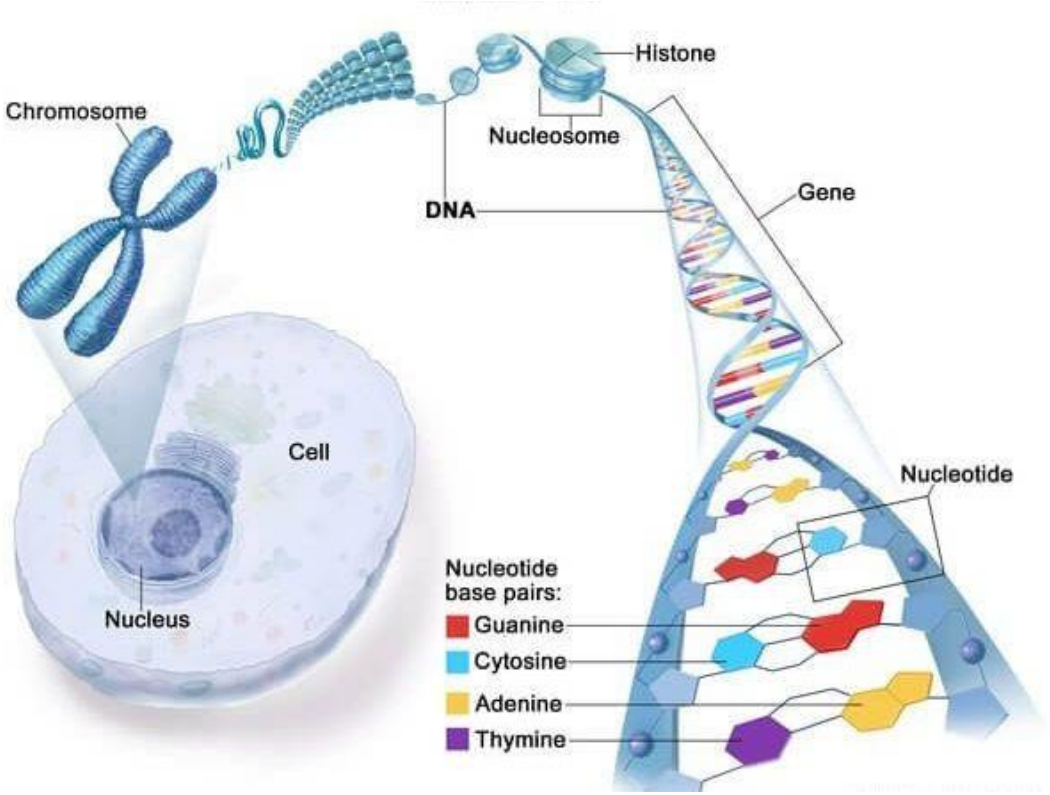
Department of Biology

Level 1

DEFINITION OF CELL BIOLOGY

- **The** cell is the basic unit of organization or structure of all living matter
- **Cell biology** (also **cellular biology** or **cytology**) is a branch of biology that studies the structure, function and behavior of cells.
- The biological science which deals with the study of structure, function, molecular organization, growth, reproduction and genetics of the cells, is called **cytology** or **cell biology**

CYTOLOGY VERSUS CELL BIOLOGY



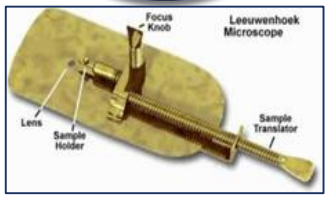
- The cell biology has been studied by the following three avenues: **classical cytology** dealt with only light microscopically visible structure of the cell; **cell physiology** studied biochemistry, biophysics, and functions of the cell; and **cell biology** interpreted the cell in terms of molecules (macromolecules such as nucleic acids and proteins). In recent years distinction between classical cytology, cell physiology and cell biology has become blurred and outmoded and now two terms cytology and cell biology are used as the synonyms

Year	Scientist	Contribution
1595	Zacharias Jensen	Jensen creates the first compound microscope.
1655	Robert Hooke	Hooke, using a microscope that he devised, viewed the cell walls of cork for the first time. He coined the term 'cell' still used in biology today.
1670	Antonie van Leeuwenhoek	van Leeuwenhoek observes the first living cells in pond water using lenses that he created for his microscope.
1833	Robert Brown	Brown discovers the nucleus in plant cells and suggests its importance in cell creation.
1838	Matthias Jakob Schleiden	Schleiden proposes that all plant tissues are composed of cells.
1839	Theodor Schwann	Schwann concludes that not just plant tissue, but animal tissues, as well, are composed of one or more cells. He also states that the cell is the basic unit for all organisms.
1845	Carl Heinrich Braun	Braun restates the second part of the cell theory proposing that cells are the basic unit of life.
1855	Rudolf Virchow	Virchow adds the third part to the cell theory stating that cells only come from other living cells.

1590م
Janssen

1665م
Robert Hook

1674م
Leeuwen hoek



1886م
Abbe & Zeiss

1897م
Greenough

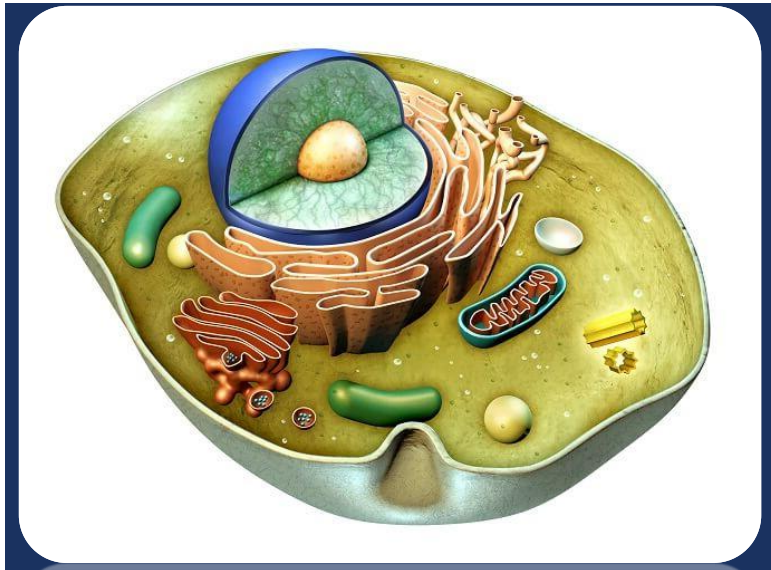
1932م
Knoll &Ruska

CELL THEORY

- The modern version of cell theory states that (1) All living organisms (animals, plants and
- microbes) are made up of one or more cells and cell products. (2) All metabolic reactions in unicellular
- and multicellular organisms take place in cells. (3) Cells originate only from other cells, *i*.e., no cell
- can originate spontaneously or *de novo*, but comes into being only by division and duplication of
- already existing cells. (4) The smallest clearly defined unit of life is the cell.

CELL BIOLOGY 1

LECTURE 2



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:MICROSCOPE

- The human eyes have limited distinguishing or resolving power.
- The ability of an observational instrument such as a human eye or a microscope to reveal details of structure is expressed in terms of **limit of resolution** (*l*) which is defined as *the smallest distance that may separate two points on an object and stillpermit their observation as distinct separate points*

- **Magnification**, *the increase in size of optical image over the size of the object being viewed*, is of no use unless the observational system can resolve the various parts of the structure eing examined. Increased magnification without improved resolution results only in a large blurred image. The human eye has no power of magnification, so magnifying glasses ay e used to magnify images up to about 10 times. A light compound microscope in which many lenses are combined together has a useful magnification of about 1,500 times. The imit of resolution (*l*) of any optical instrument (*i.e.*, eye or microscope) is given approximately by the Abbe's relationships :

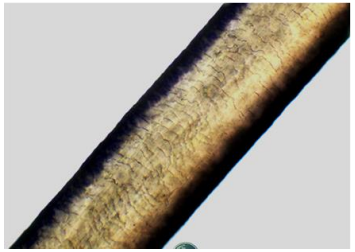
$$\text{Resolution } (l) = \frac{\text{wavelength } (\lambda)}{\text{numerical aperture } (n \sin \alpha)}$$

- where λ (lambda) is the wavelength ("colour") of the illumination or radiation used to form the image, *n* is refractive index (a function of density) of the material (*i.e.*, mostly air or water) between the specimen and the first lens (or objective lens), and *sin* α is sine of the semi-angle of aperture of the first lens as viewed from the specimen. The quantity "*n sin* α" is often called the **numerical aperture** (NA).

TYPES OF MICROSCOPES

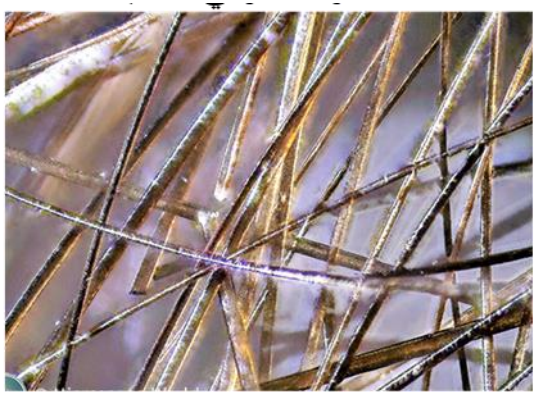
- **Optical microscopes:**

Compound light microscope



Simple light microscope

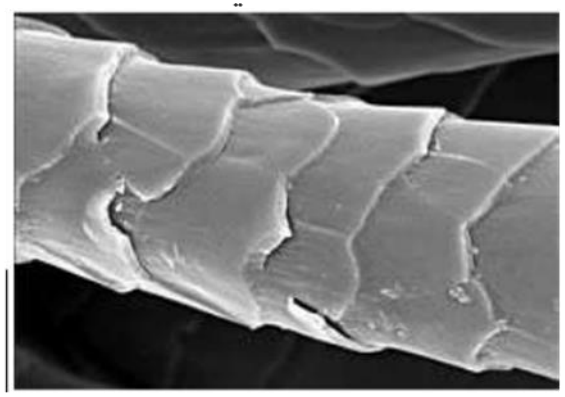
: STEREO OR DISSECTING MICROSCOPE



- Dark field microscope or Ultramicroscope.
- Phase contrast microscope
- Polarization microscope.

:ELECTRONIC MICROSCOPE

- In the electron microscope electromagnetic coils (*i.e.*, magnetic "lenses") are used to control and focus a beam of electrons ccelerated from a heated metal wire by high voltages, in the range of 20,000 to 100,000 volts
- The electrons of the beam are scattered by a specimen placed in he path of the beam

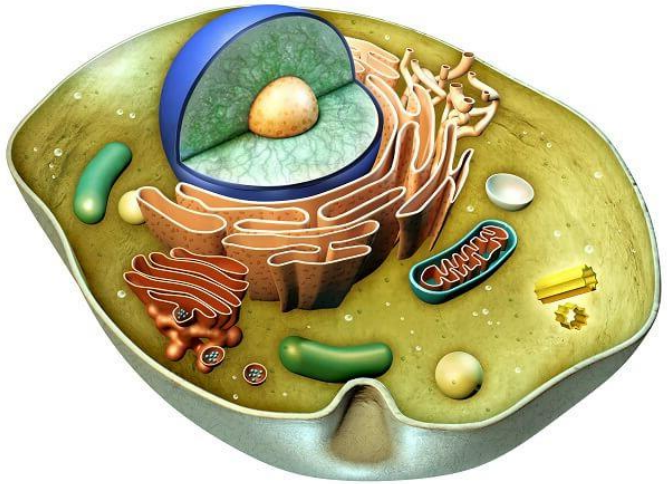


- Transmission electronic microscope
- Scanning electronic microscope
- Scanning transmission electronic microscope
- Reflection electronic microscope

CELL BIOLOGY 1

LECTURE 3

HIERARCHY LEVEL OF BIOLOGICAL ORGANISATION



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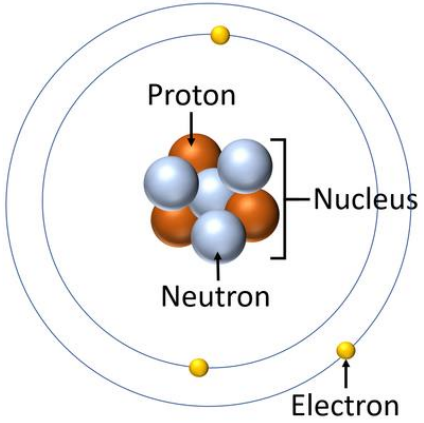
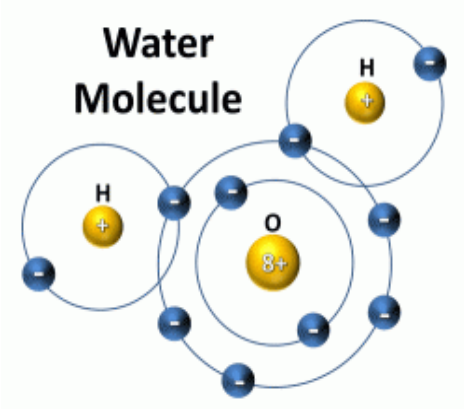
ATOM

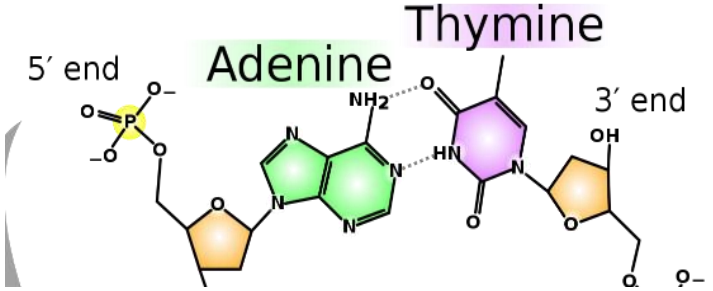
- Are defined as the smallest unit of an element that still maintains the property of that element.
- Such as: Carbon, Hydrogen, Oxygen



MOLECULES

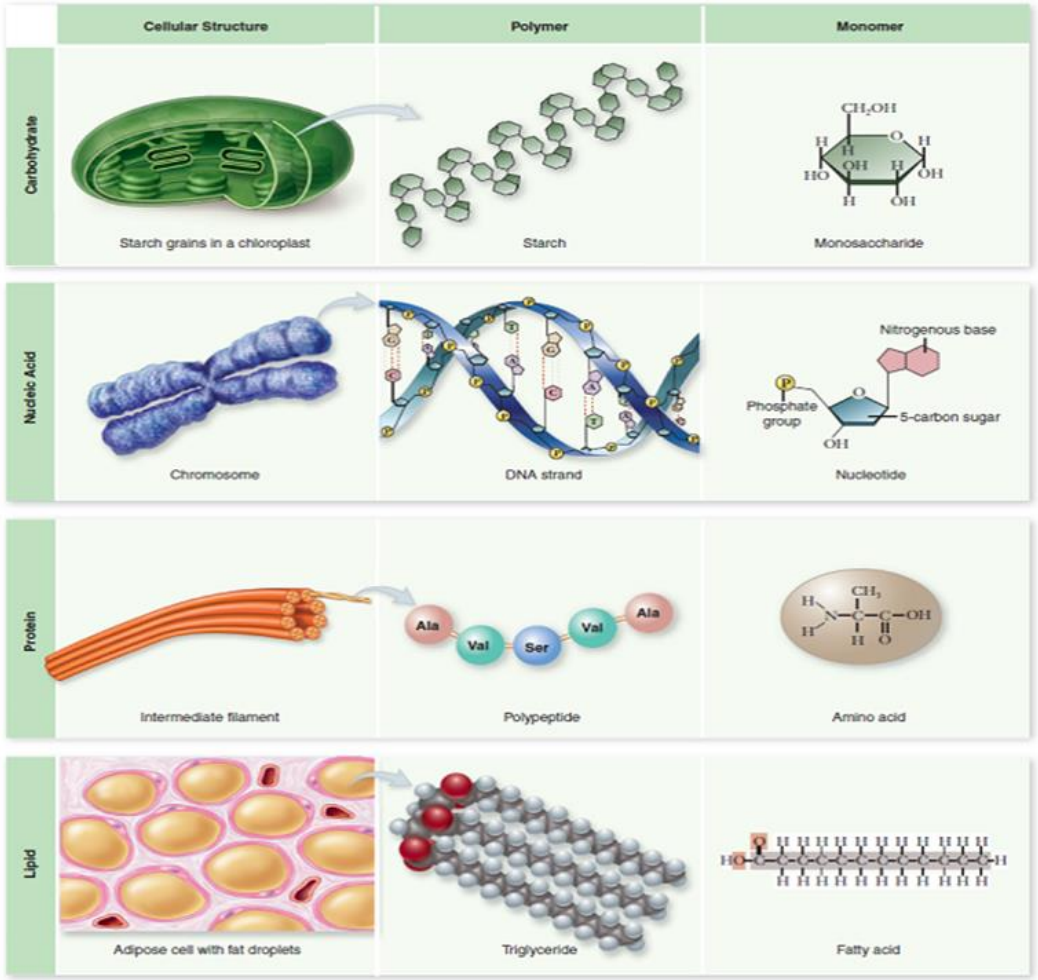
- Atoms combine to form molecules which can have entirely different properties than the atoms they contain.
- Such as: Water, DNA. Corbohydrates





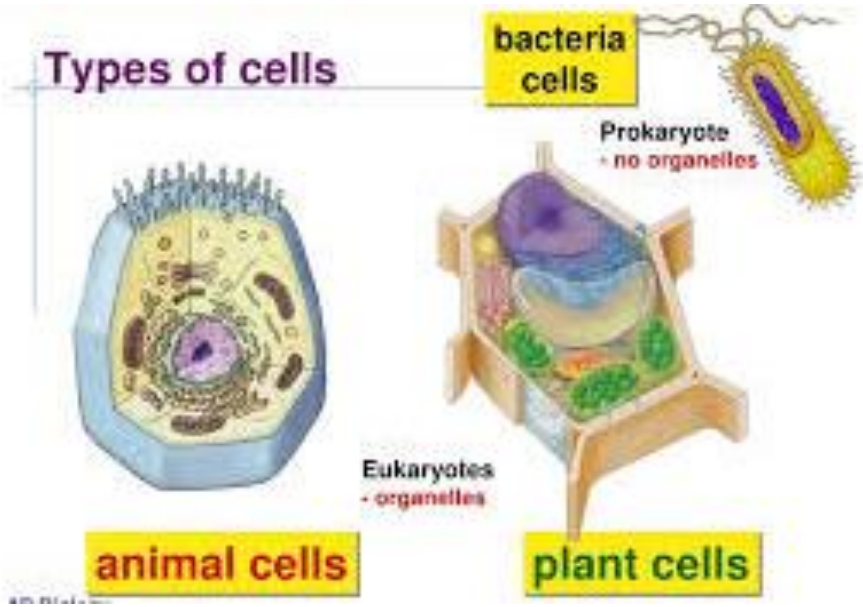
3. العضيات Organelles: ارتباط مجموعة جزيئات مع بعضها تشكل العضيات، كل عضية لها وظائف خاصة بها و هي تشمل:

اسم العضي	الوظيفة
النواة Nucleus	تحتوي على الـDNA ، التحكم في فعالية الخلية
البلاستيدات plastids	مركز بناء الكربوهدرات والافعال الايضية
جهاز كولجي Golgi apparatus	مركز تعديل ، معالجة ، تركيز وتعبئة النواتج الافرازية
مايتوكوندريا Mitochondria	انتاج الطاقة من خلال اكسدة المواد الغذائية
الحويصلات Vacuole	خزن الماء
الجسم المركزي Centrsome	تثبيت الهيكل الخلوي ، تكوين الخيوط المغزلية خلال انقسام الخلية
الاجسام الحالة Lysosome	تحطيم الجزاءات الكبيرة و المواد الغريبة
النوية Nucleolus	انتاج الرايبوسوم
الرايبوسومات Ribosome	ترجمة الـRNA الى بروتينات



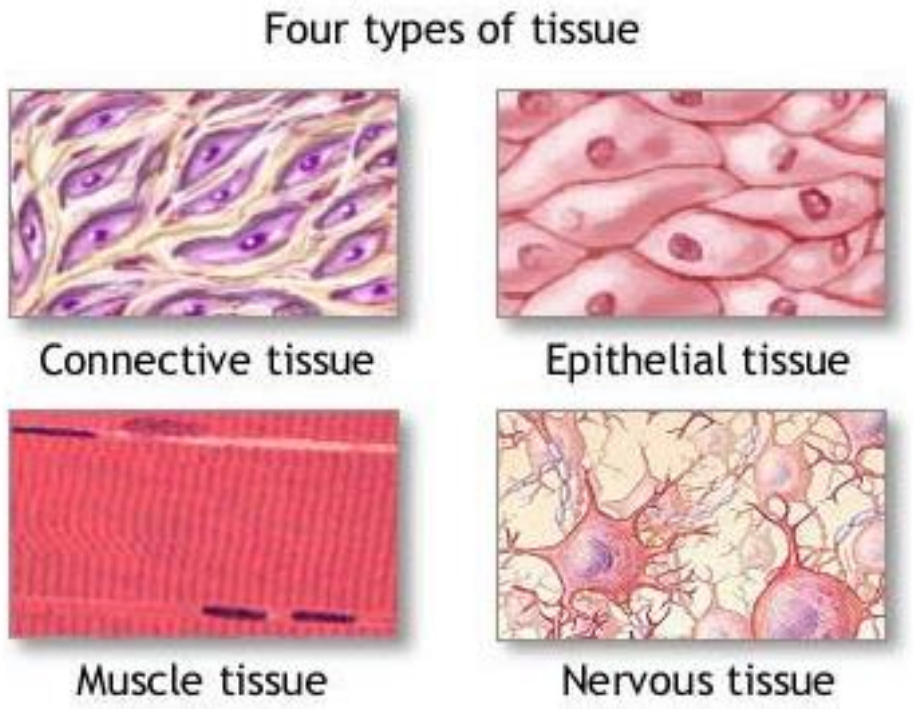
CELL

- Cell is the smallest unit of life. It is enclosed by a membrane or cell wall and in multicellular organisms often perform specific functions. Cells classified to:
- -Prokaryotic. Like: Bactria
- Eukaryotic. Like: animal and plant cells



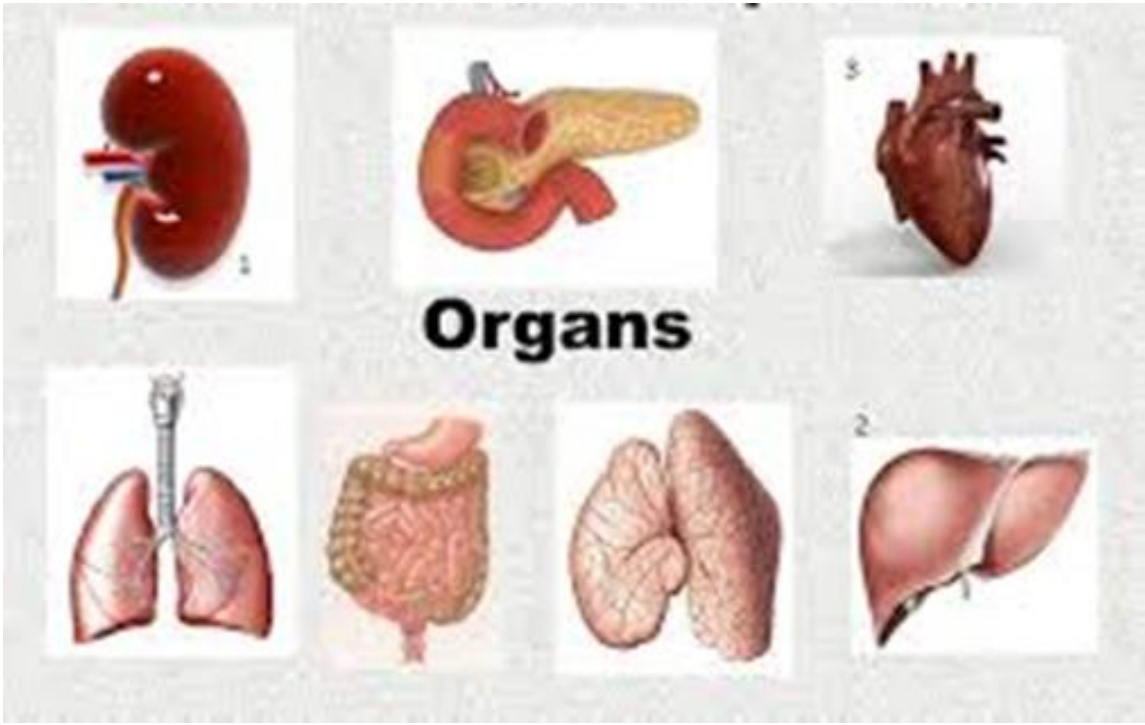
TISSUE

- Tissues are groups of cells with similar function. They classified to:
- 1- Connective tissue
- 2- Muscle tissue
- 3- Nervous tissue
- 4- Epithelial tissue



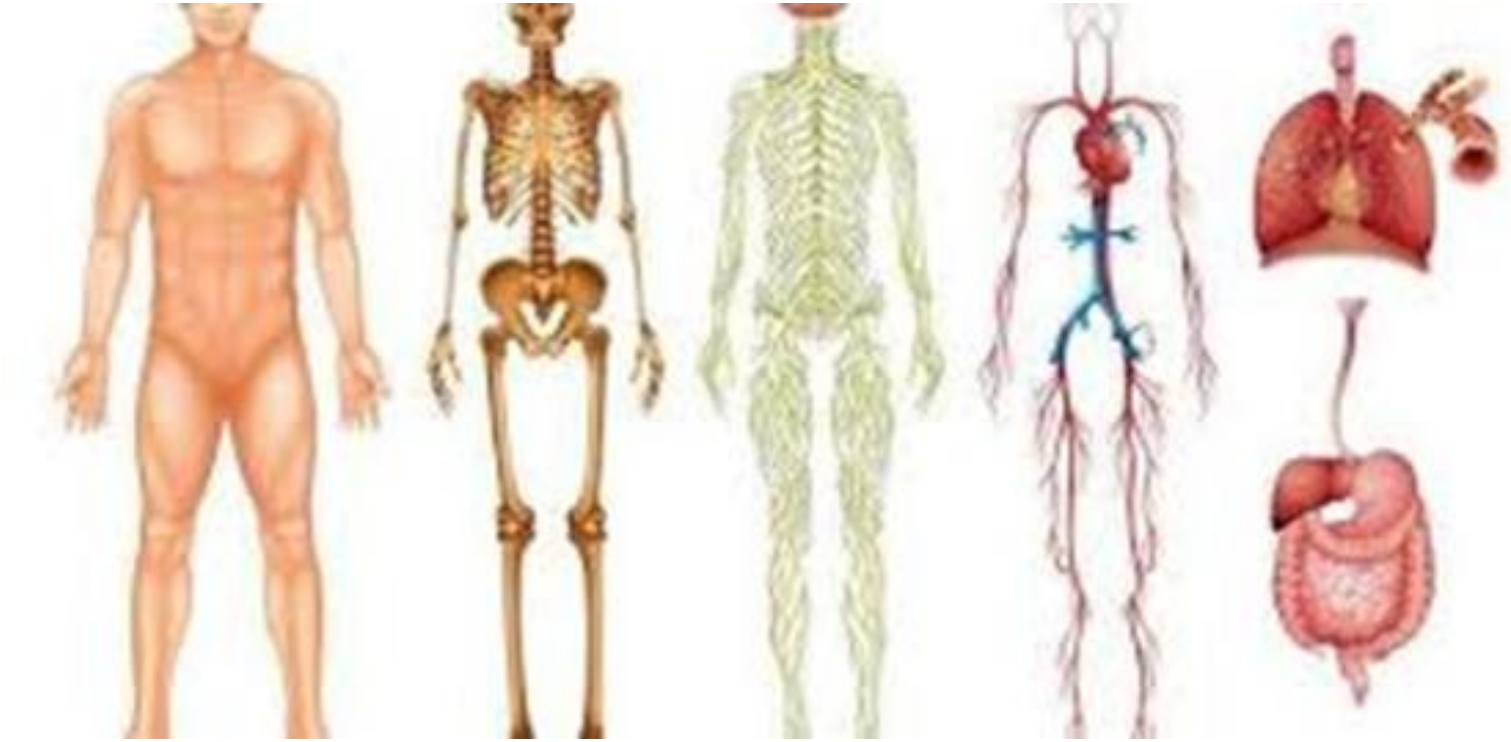
ORGAN

- Organs are two or more types of tissues that work together to complete a specific task. Such as: Heart, Liver, stomach.



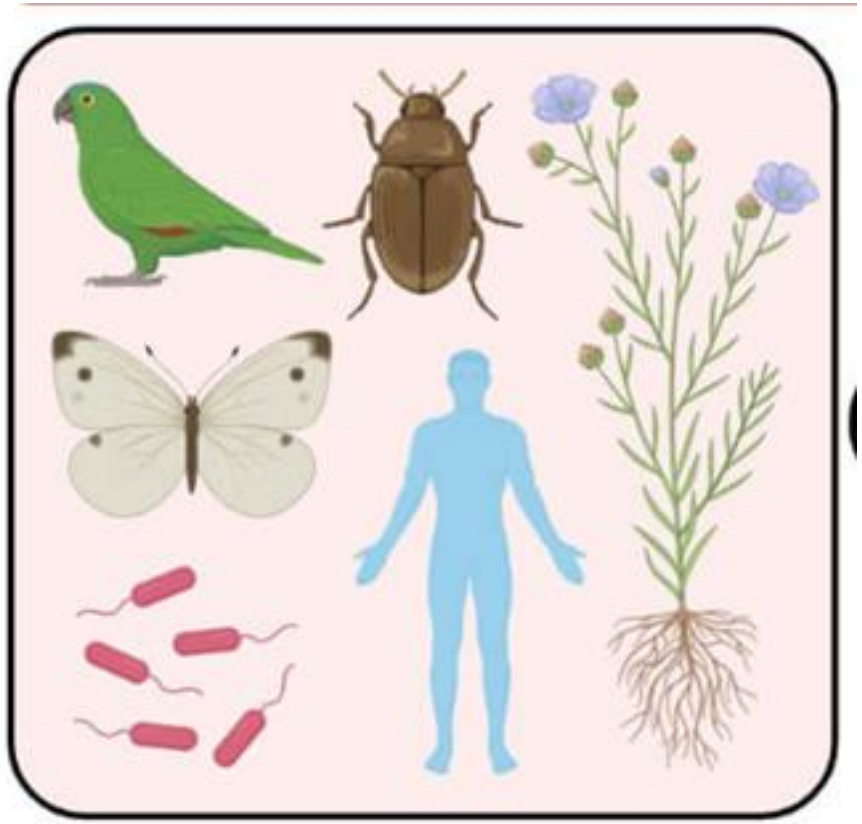
SYSTEM

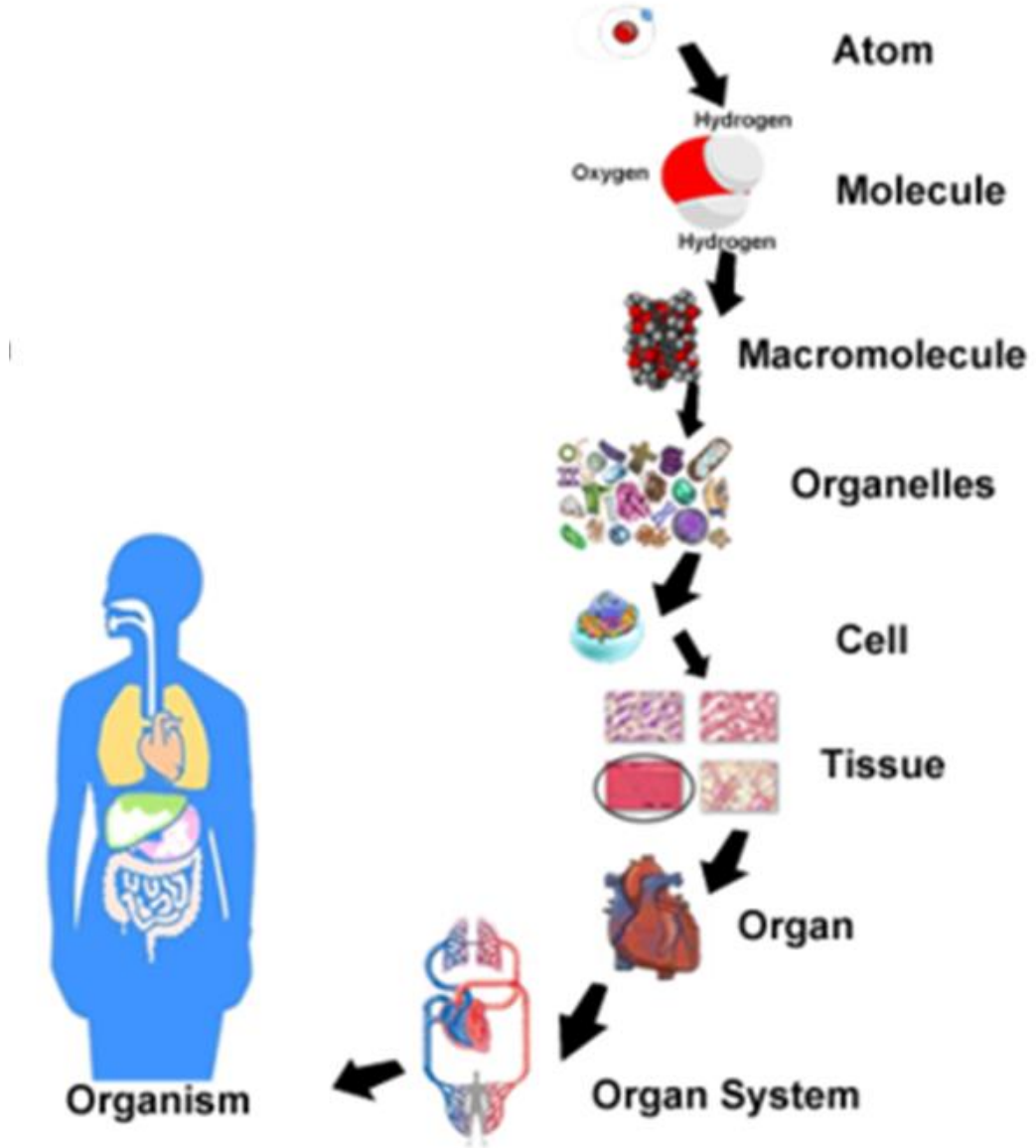
- An organ system is group of organs that carries out more generalised set of functions. Such as Circulatory system, Respiratory system.



ORGANISM

- An organism has several organ systems that function together

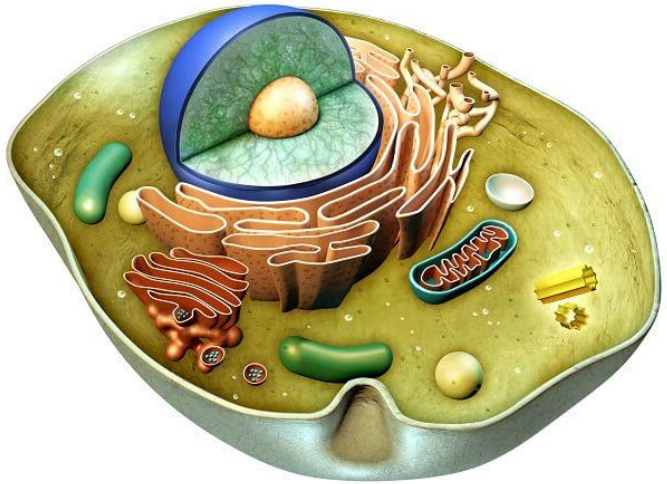



Atom
Hydrogen
Oxygen
Molecule
Hydrogen
Macromolecule
Organelles
Cell
Tissue
Organ
Organ System
Organism

CELL BIOLOGY 1

LECTURE 4

CELL BIOLOGY AND OTHER BIOLOGICAL SCIENCES



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Level -1

CELL BIOLOGY AND OTHER BIOLOGICAL SCIENCES

- The cell biology has helped the biologists to understand various complicated life activities such as metabolism, growth, differentiation, heredity and evolution at the cellular and molecular levels. Due to its wide application in various branches of biological science, many new hybrid biological sciences, have sprung up. Some of them are as follows:
- **1. Cytotaxonomy** (Cytology and Taxonomy). Each plant and animal species has a definite number of chromosomes in its cells and the chromosomes of the individuals of a species resemble closely with one another in shape and size. These characteristics of the chromosomes help a taxonomist in determining the taxonomical position of a species. Further, cell biology furnishes strong support to the manner of origin of certain taxonomic units. Therefore, the cytotaxonomy can be defined as a cytological science which provides cytological support to the taxonomic position of any species.

2. Cytogenetics (Cytology and Genetics). Cytogenetics is that branch of cell biology which is concerned with the cytological and molecular bases of heredity, variation, mutation, phylogeny , morphogenesis and evolution of organisms. The Weismann's germ plasm theory, Mendel's laws of inheritance and the concept of gene could be well understood only after the application of cytological concept to the genetics.

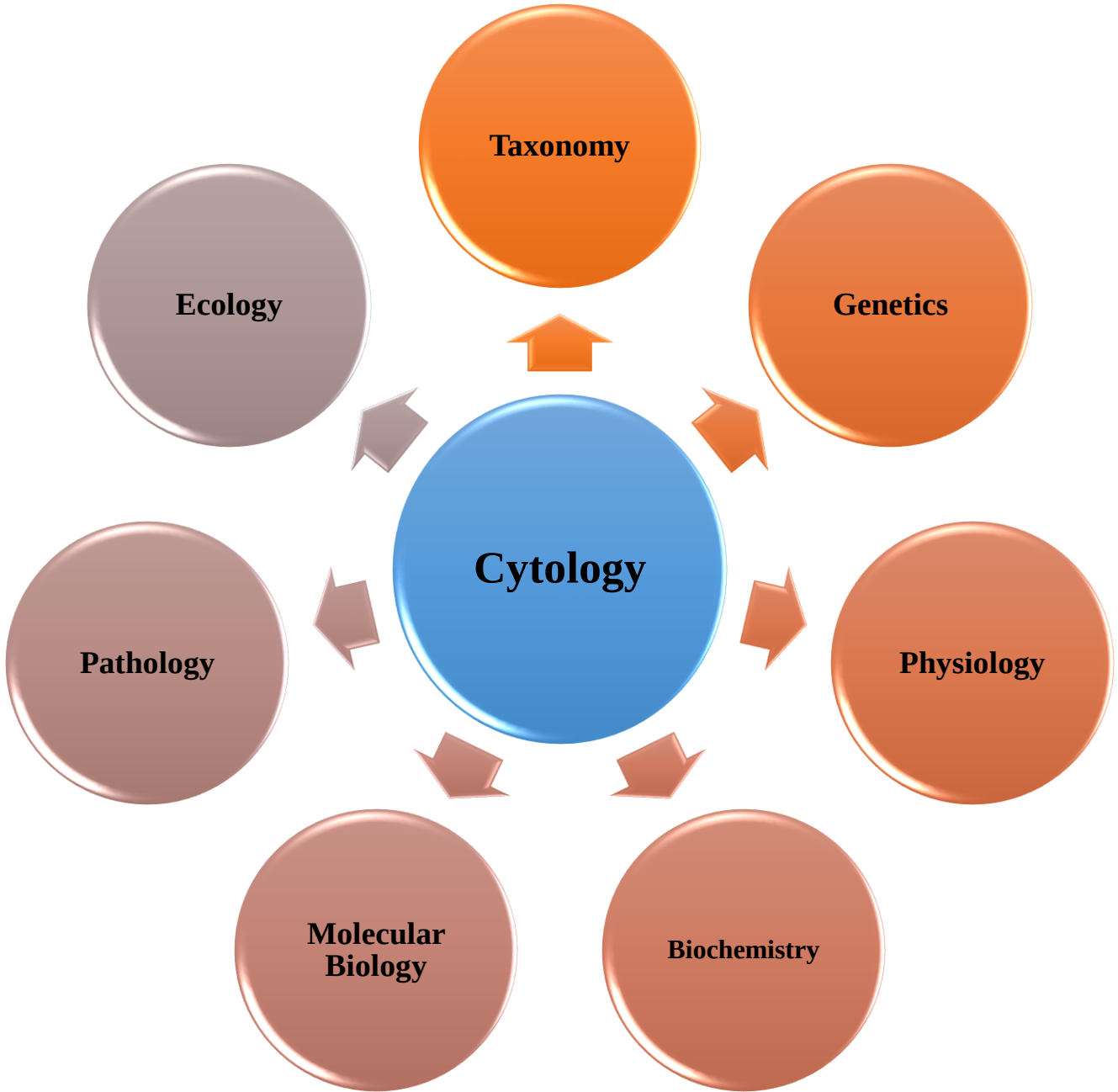
3. Cell Physiology (Cytology and Physiology). The cell physiology is the study of life activities, nutrition, metabolism, excitability, growth, reproduction or cell division and differentiation of the cell. The cell physiology has helped in understanding various complicated physiological activities at cellular level.

4. Cytochemistry (Cytology and Biochemistry). The cytochemistry is that branch of cytology which deals with the chemical and physico-chemical analysis of living matter. For example, the cytochemical analysis has revealed the presence of carbohydrates, lipids, proteins, nucleic acids and other organic and inorganic chemical compounds in the cells.

5. Ultrastructure and Molecular Biology. These are the most modern branches of biology in which the merging of cytology with biochemistry, physico-chemistry and especially macromolecular and colloidal chemistry become increasingly complex. Knowledge of the submicroscopic organization or ultrastructure of the cell is of fundamental importance because practically all the functional and physicochemical transformations take place with the molecular architecture of the cell and at a molecular level

6. Cytopathology (Cytology and Pathology). The application of molecular biology to pathological science has helped in understanding various human diseases at molecular level. Because most diseases are caused due to disorder of genetic codes in DNA molecule which alter the synthetic process of enzymes and ultimately disturb metabolic activities of the cell.

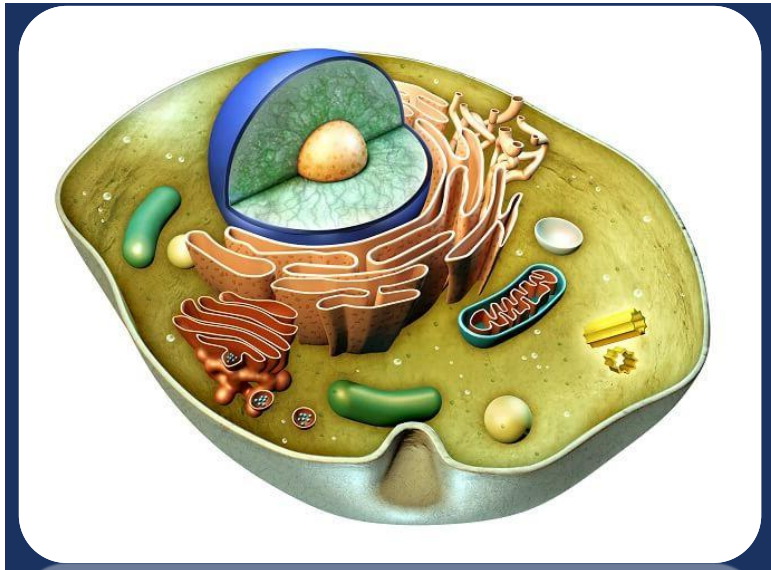
7. Cytoecology (Cytology and Ecology). The cytoecology is the science in which one studies the effects of ecological changes on the chromosome number of the cell. The cytological studies on plants and animals have revealed that the ecological habitat and geographical distribution have the correlation with chromosome numbers.


Taxonomy
Genetics
Physiology
Biochemistry
Molecular Biology
Pathology
Ecology
Cytology

CELL BIOLOGY 1

LECTURE 5

CELL MORPHOLOGY



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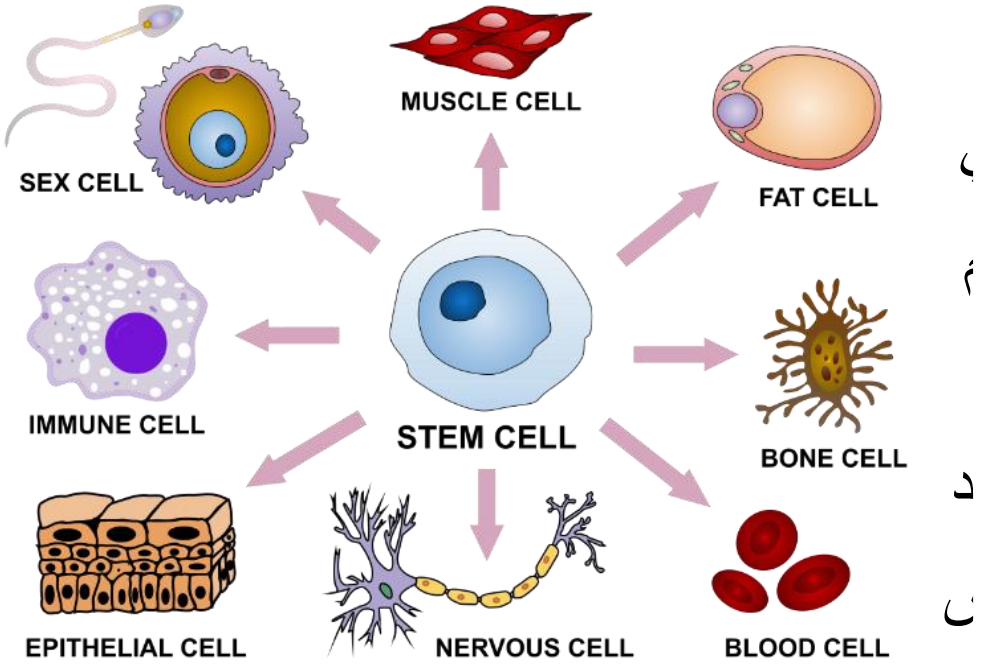
Level -1

CELL MORPHOLOGY

Cell morphology describes the shape, structure, form, and size of cells. In bacteriology, cell morphology relates to the size and shape of bacteria: cocci, bacilli, spiral, etc, and most mammalian cells grown in culture can be divided in to three categories based on their morphology: Fibroblastic, epithelial-like cells and lymphoblast-like cells.

Cellular morphogenesis play a fundamental role in developmental biology

Morphological characteristics play a key role in the diagnosis of cancer, normal cells having regular, ellipsoid shapes while cancer cells are often irregular and contoured. Cell morphology has also been shown to play a role in cell motility and ultimately tumour invasiveness.



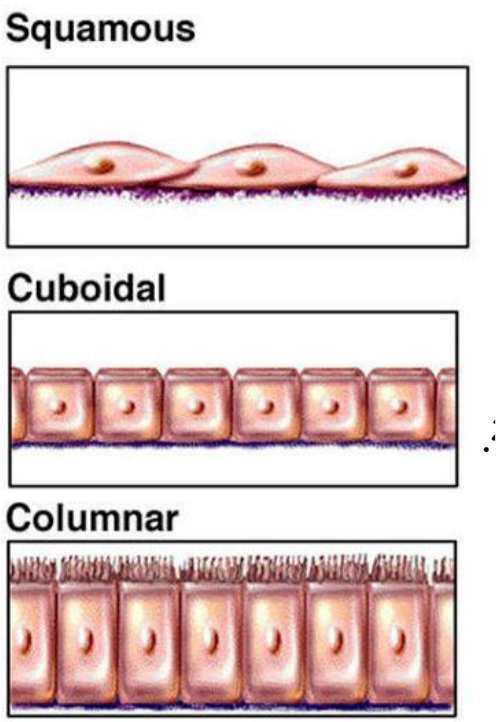
CELL SHAPES

The basic shape of the eukaryotic cell is **spherical**, however, the shape is ultimately determined by the specific function of the cell. Thus, the shape of the cell may be **variable** or **fixed.** In unicellular organisms the cell shape is maintained by tough plasma membrane and exoskeleton. In a multicellular organism, the shape of the cell depends mainly on its functional adaptations and partly on the surface tension, viscosity of the protoplasm, cytoskeleton of microtubules, microfilaments and intermediate filaments, the mechanical action exerted by adjoining cells and rigidity of the plasma membrane cells may have diverse shapes such as:

1- **Squamous** e.g., squamous epithelium

2- Cuboidal e.g., in thyroid gland

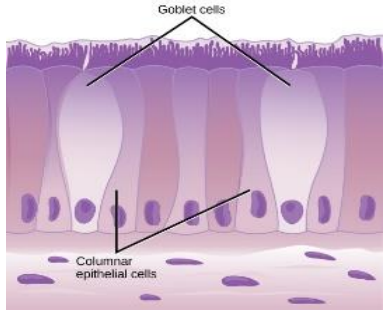
3- Columnar e.g., the cells lining the intestine

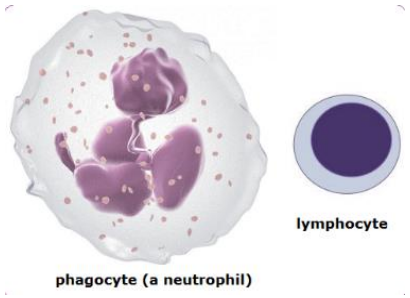


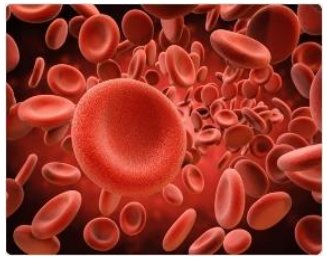
1. **Goblet** :

2. **Spherical** : (e.g., eggs of many animals);

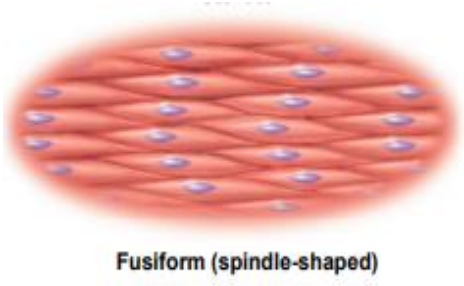
Discoid : (e.g., red blood cells or erythrocytes

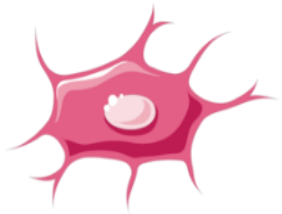


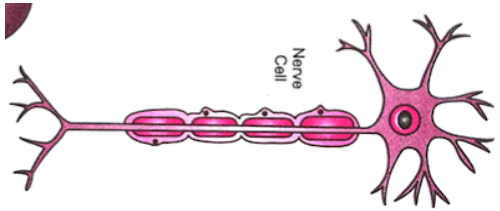




1. **Star** :
2. **Spindle** : (e.g., smooth-muscle fibres
3. **Elongated :** e.g., nerve cells or neurons



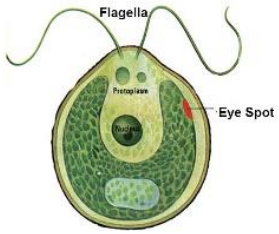




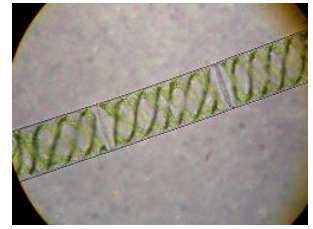
1. **Amoeboid** .: E.g. Amoeba
2. **Oval** :Chlamydomonas

3- Cylindrical :Spirogyra .

Amoeboid



Oval

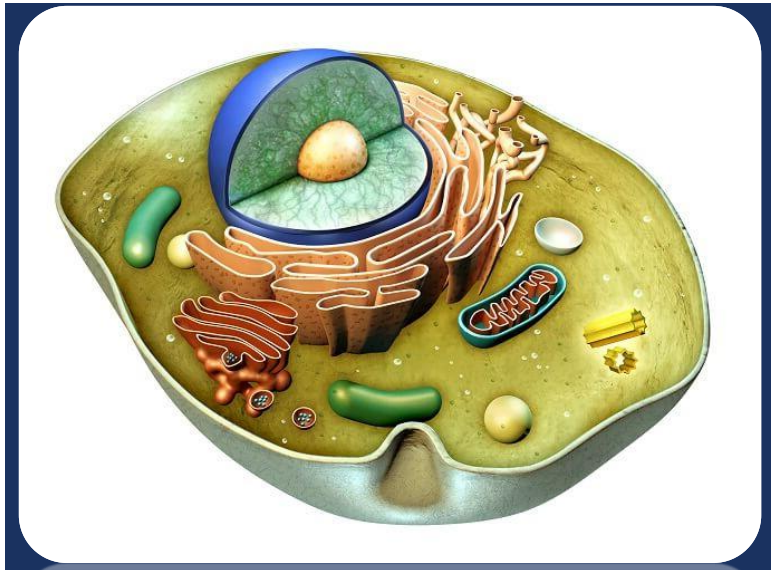


Cylindrical

CELL BIOLOGY 1

LECTURE 6

CELL SIZE, VOLUME, NUMBER



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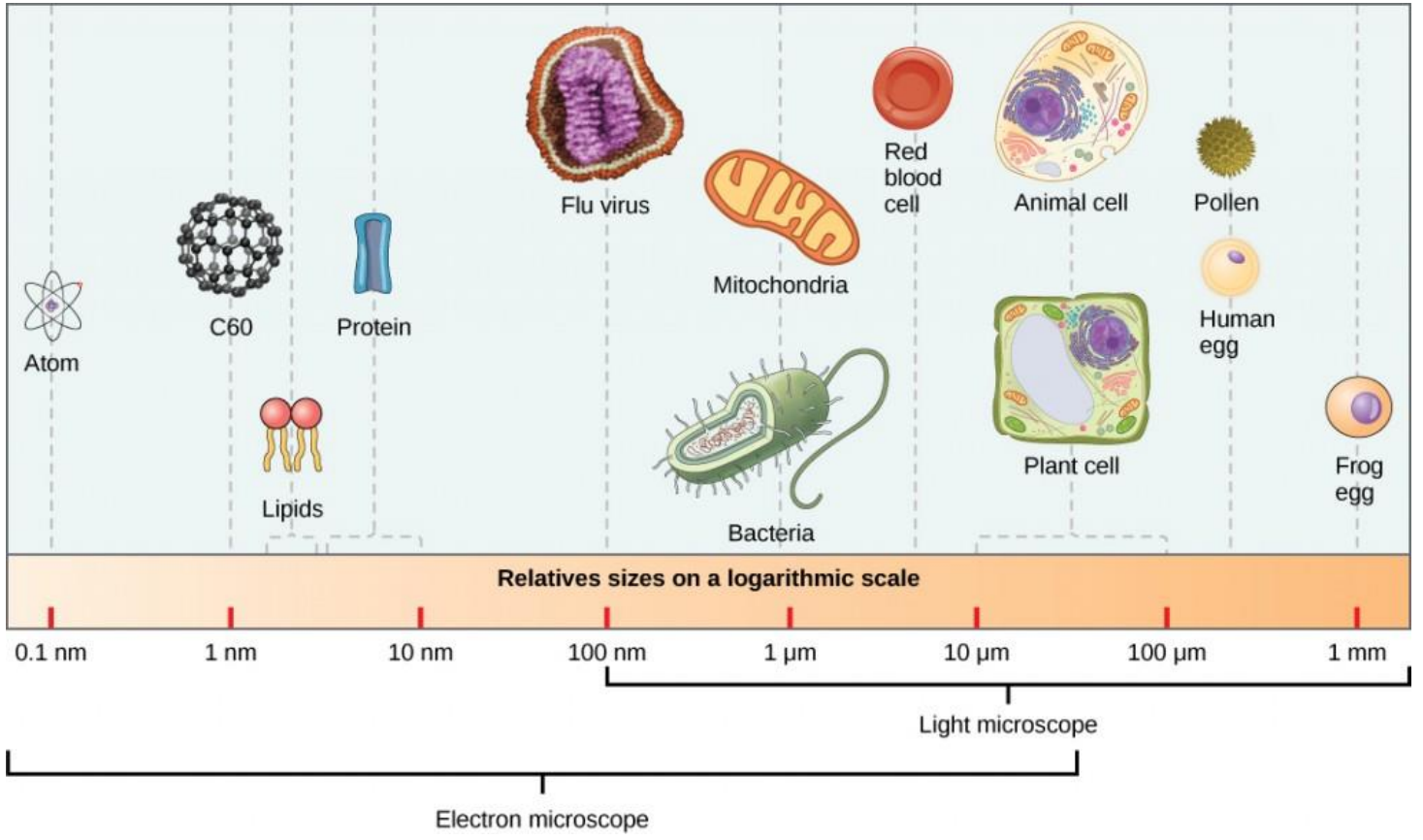
CELL SIZE :

The eukaryotic cells are typically larger (mostly ranging between 10 to 100 µm) than the prokaryotic cells (mostly ranging between 1 to 10 υm). Size of the cells of the unicellular organisms is larger than a typical multicellular organism's cells For example, *Amoeba proteus* is biggest among the unicellular organisms The size of the cells of multicellular organisms ranges between 20 to 30 µm. Among animals, the smallest cells have a diameter of 4 µm (*e.g.,* polocytes); human erythrocytes being 7 to 8 µm in diameter. Largest animal cell is the egg of ostrich, having a diameter of 18 cm though, some nerve cells of human beings have a meter long "tails" or axons.



CELL VOLUME

- The volume of a cell is fairly constant for a particular cell type and is independent of the size
- of the organism. (This is called the **law of constant volume**.) For example, kidney or liver cells are
- about the same size in the bull, horse and mouse. The difference in the total mass of the organ or
- organism depends on the number, not on the volume of the cells. Thus, the cells of an elephant are not
- necessarily larger than those of other tiny animals or plants. The large size of the elephant is due to
- the larger number of cells present in its body.

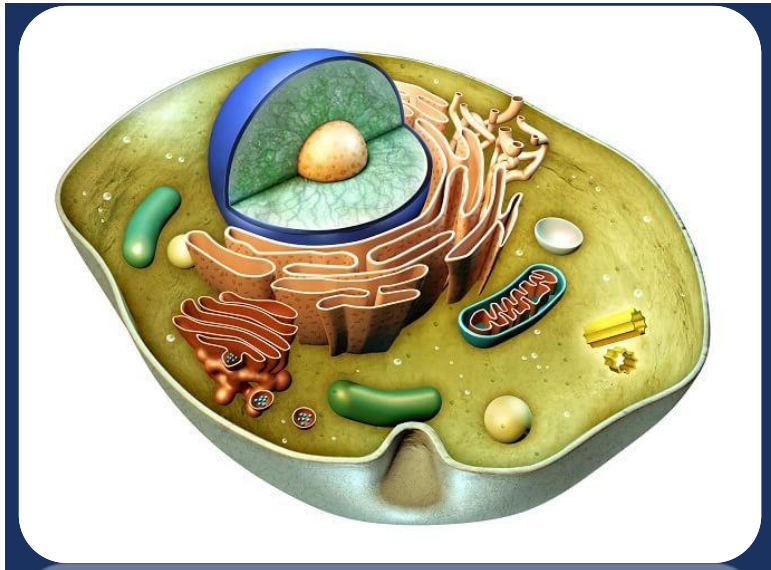
CELL NUMBER

- The number of cells present in an organism varies from a single cell in a **unicellular organism**
- (Protists such as protozoa and protophyta) to many cells in multicellular organisms (Most plants, fungi
- and animals). The number of cells in the multicellular organisms usually remains correlated with size
- of the organisms and, therefore, small-sized organism has less number of cells in comparison to largesized
- organisms. For example, a human being weighing about 80 kg may contain about 60 thousand
- billion cells in his body. This number would be more in certain other multicellular organisms.

CELL BIOLOGY 1

LECTURE 7

CELL CHARACTERISTICS



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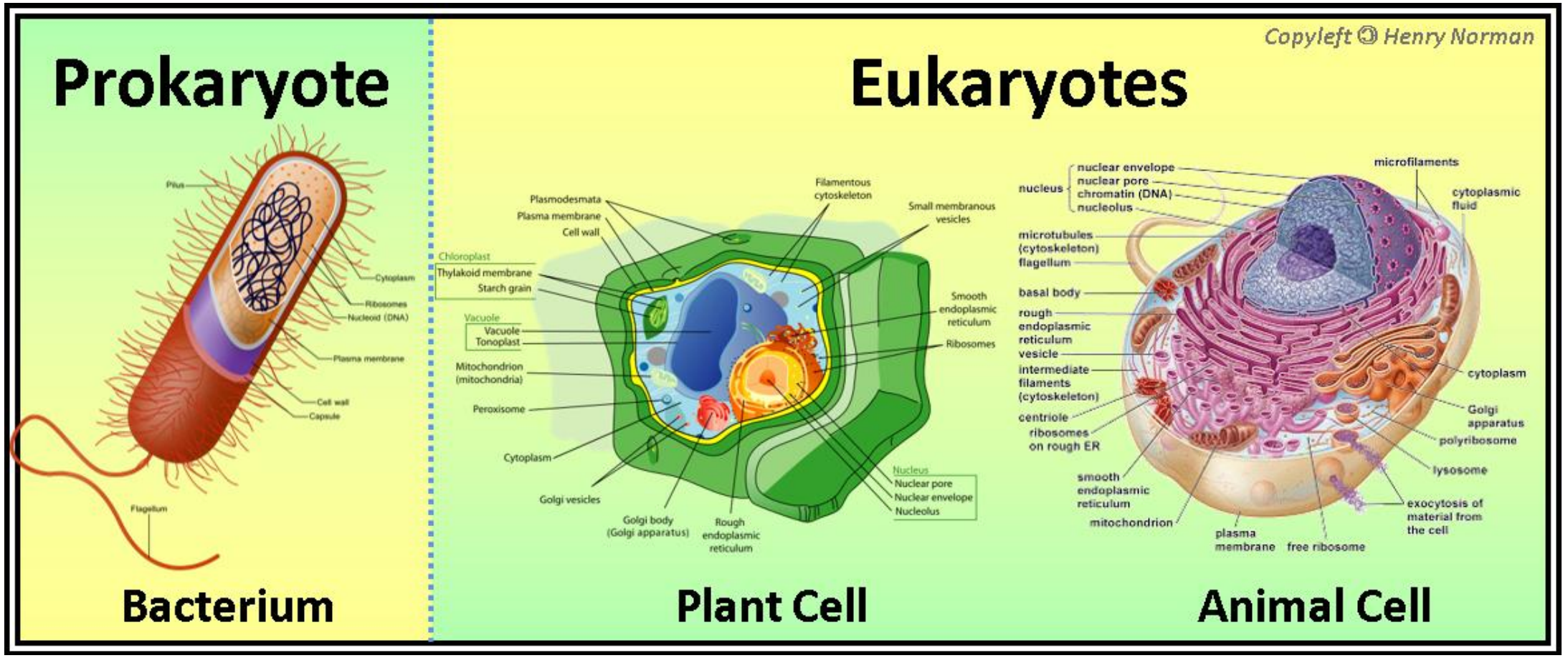
CELL CHARACTERISTICS

All cells have cell membranes, organelles, cytoplasm, and DNA. But there are two basic types of cells. Cells without a nucleus are prokaryotic cells. Cells that have a nucleus are eukaryotic cells. Prokaryotic cells are further classified into two groups: bacteria and archaea

CELL TYPES


Copyleft © Henry Norman
Prokaryote
Pilus
Cytoplasm
Ribosomes
Nucleoid (DNA)
Plasma membrane
Cell wall
Capsule
Flagellum
Bacterium
Eukaryotes
Plasmodesmata
Plasma membrane
Cell wall
Filamentous cytoskeleton
Small membranous vesicles
Chloroplast
Thylakoid membrane
Starch grain
Vacuole
Vacuole
Tonoplast
Smooth endoplasmic reticulum
Ribosomes
Mitochondrion (mitochondria)
Peroxisome
Cytoplasm
Golgi vesicles
Golgi body (Golgi apparatus)
Rough endoplasmic reticulum
Nucleus
Nuclear pore
Nuclear envelope
Nucleolus
Plant Cell
nucleus
nuclear envelope
nuclear pore
chromatin (DNA)
nucleolus
microfilaments
cytoplasmic fluid
microtubules (cytoskeleton)
flagellum
basal body
rough endoplasmic reticulum
vesicle
intermediate filaments (cytoskeleton)
centriole
ribosomes on rough ER
smooth endoplasmic reticulum
mitochondrion
plasma membrane
free ribosome
cytoplasm
Golgi apparatus
polyribosome
lysosome
exocytosis of material from the cell
Animal Cell

LIVING COMPONENTS

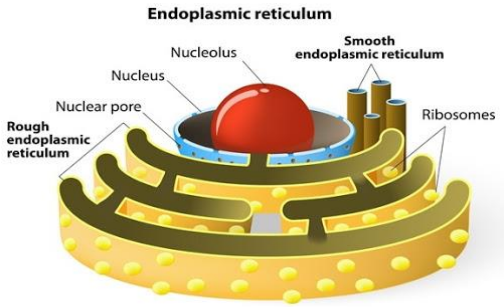
- **Plasma membrane:** Every kind of animal cell is bounded by a living, extremely thin and delicate membrane called **plasmalemma, cell membrane** or **plasma membrane**. In plant cells, plasma membrane occurs just nner to cell wall, bounding the cytoplasm. The plasma membrane exhibits a tri-laminar (*i.e.*, three-layered) structure with a translucent layer sandwiched between two dark layers. At molecular level, it consists of a continuous bilayer of lipid molecule (*i.e.*, phospholipids and cholesterol) with protein molecules embedded in it or adherent to its both surfaces

- **Cytoplasm :** The plasma membrane is followed by the cytoplasm which is distinguished into following structures :

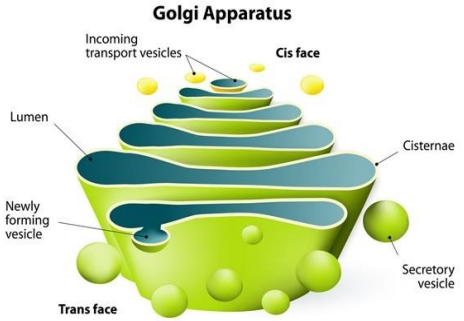
A- Cytosol : The plasma membrane is followed by the colloidal organic fluid called **matrix** or **cytosol**. The cytosol is the aqueous portion of the **cytoplasm** (the extranuclear protoplasm) and of the **nucleoplasm** (the nuclear protoplasm). It fills all the spaces of the cell and constitutes its true **internal milieu**. Cytosol is particularly rich in differentiating cells and many fundamental properties of cell are because of this part of the cytoplasm. The cytosol serves to dissolve or suspend the great variety of small molecules concerned with cellular metabolism, *e.g.*, glucose, amino acids, nucleotides, vitamins, minerals, oxygen and ions. In all type of cells, cytosol contains the soluble proteins and enzymes which form 20 to 25 per cent of the total protein content of the cell.

B- Organelles: such as

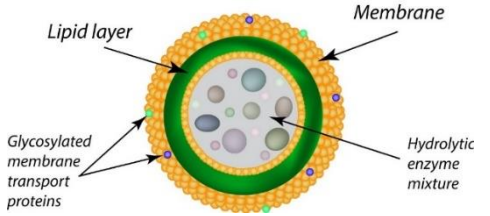
Endoplasmic reticulum (ER). Within the cytoplasm of most animal cells is an extensive network (reticulum) of membrane-limited channels, collectively called **endoplasmic reticulum** (or ER). Some portion of ER membranes remains continuous with the plasma membrane and the nuclear envelope. The outer surface of **rough ER** has attached ribosomes, whereas **smooth ER** do not have attached ribosomes.



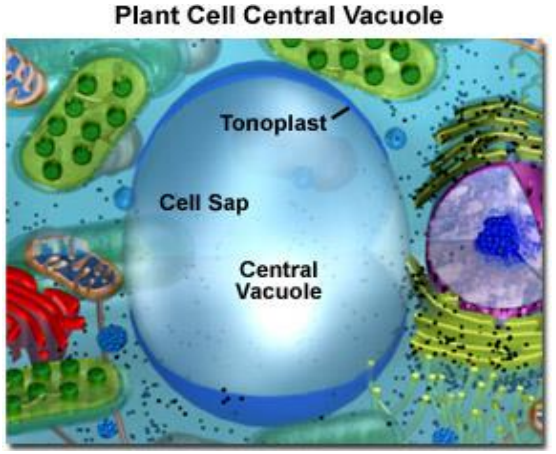
Golgi apparatus. It is a cup-shaped organelle which is located near the nucleus in many types of cells. Golgi apparatus consists of a set of smooth **cisternae** (*i.e.*, closed fluid-filled flattened membranous sacs or vesicles) which often are stacked together in parallel rows. It is surrounded by spherical membrane bound **vesicles** which appear to transport proteins to and from it.



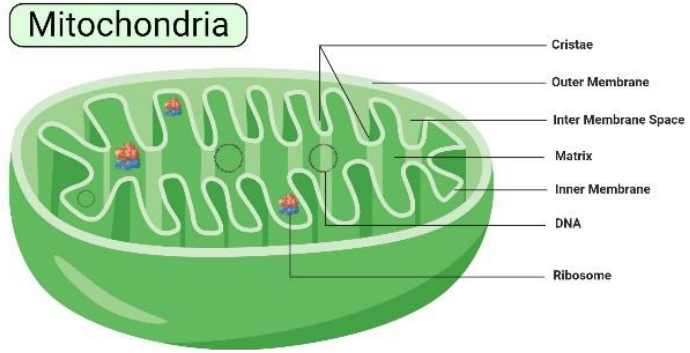
Lysosomes. The cytoplasm of animal cells contains many tiny, spheroid or irregular-shaped, membrane-bounded vesicles known as **lysosomes**.



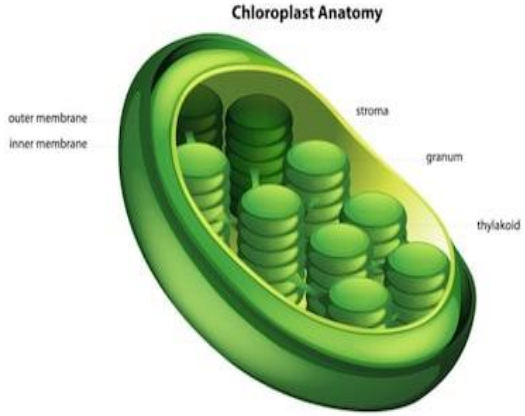
Cytoplasmic vacuoles. The cytoplasm of many plant and some animal cells (*i.e.*, ciliate protozoans) contains numerous small or large-sized, hollow, liquid-filled structures, the **vacuoles**. These vacuoles are supposed to be greatly expanded endoplasmic reticulum or Golgi apparatus. The **vacuoles** of animal cells are bounded by a lipoproteinous membrane and their function is the storage, transmission of the materials and the maintenance of internal pressure of the cell.



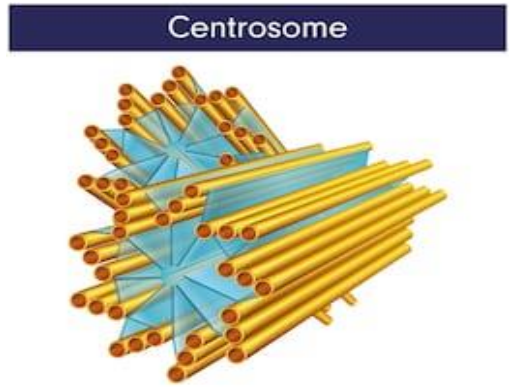
Mitochondria. Mitochondria are oxygen-consuming ribbon-shaped cellular rganelles of immense importance. Each mitochondrion is bounded by two unit membranes. The outer mitochondrial membrane resembles more with the plasma membrane in structure and chemical composition.



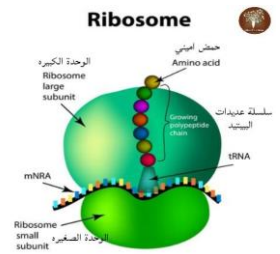
Plastids. Plastids occur only in the plant cells. They contain pigments and may synthesize and accumulate various substances.



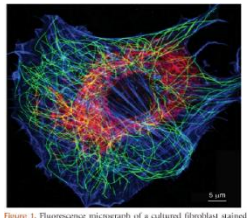
Centrosome The centrosome is juxtanuclear (L., juxta = near) and firmly attached to the nuclear envelope. At the time of cell division two pairs of centrioles are formed and form the spindle of microtubules which help in the separation and movement of chromosomes during concluding stages of cell divisions.

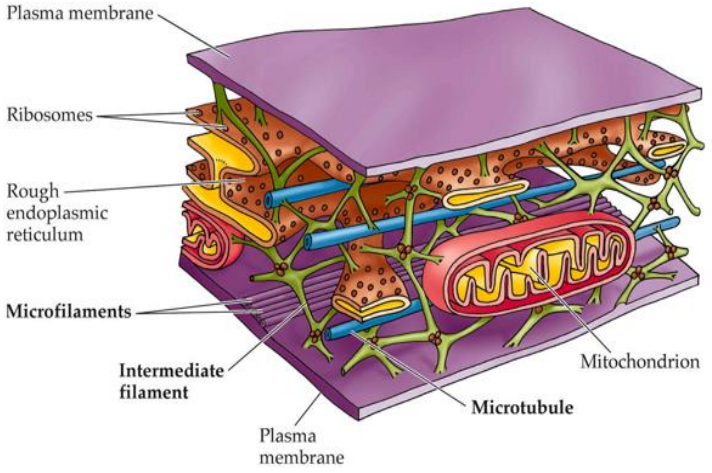


Ribosomes. Ribosomes are tiny spheroidal dense particles (of 150 to 200 A_0 diameter) that contain approximately equal amounts of RNA and proteins. They are primarily found in all cells and serve as a scaffold for the ordered interaction of the numerous molecules involved in protein synthesis.



Cytoskeleton: is a structure that helps cells maintain their shape and internal organization, and it also provides mechanical support that enables cells to carry out essential functions like division and movement. In eukaryotes, it is composed of three main components, microfilaments, intermediate filaments and microtubules





NUCLEUS

Nuclear envelope: comprises two nuclear membranes— an **inner nuclear membrane** which is lined by nuclear lamina and an **outer nuclear membrane** which is continuous with rough ER. At certain points the nuclear envelope is interrupted by structures called **pores** or **nucleopores.** Nuclear pores contain octagonal **pore complexes** which regulate exchange between the nucleus and cytoplasm

Chromatin. Nucleus being the heart of every type of eukaryotic cell, contains the **genes**, the hereditary units. Genes are located on the **chromosomes** which exist as **chromatin network** in the non- dividing cell

Nucleolus: Nucleus contains in its nucleoplasm a conspicuous, darkly stained, circular suborganelle, called **nucleolus**. Nucleolus lacks any limiting membrane and is formed during interphase by the ribosomal DNA (rDNA) of **nucleolar organizer** (**NO**). Nucleolus is the site where ribosomes are manufactured. It is here where ribosomal DNA transcribes most of rRNA molecules and these molecules undergo processing before their step-wise addition to 70 types of ribosomal proteins to form the ribosomal sub-units.

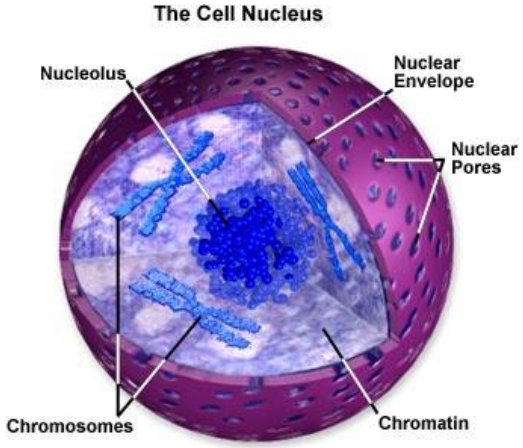
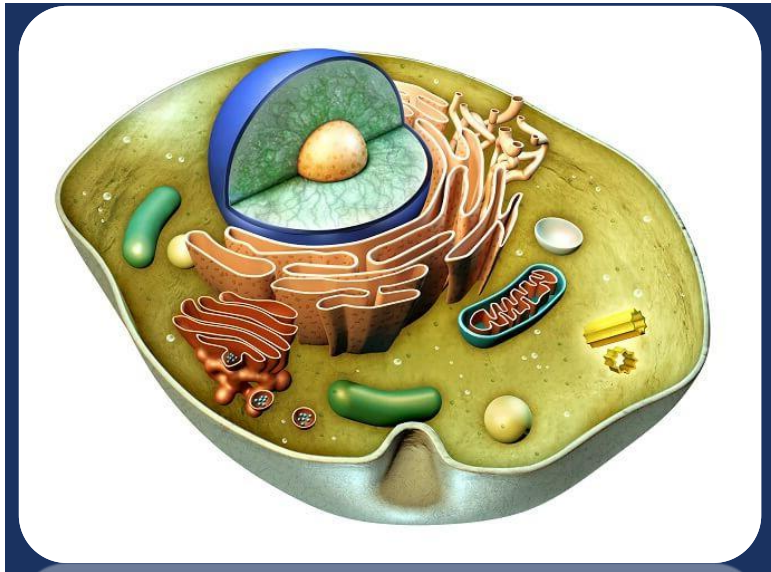


Figure 1

CELL BIOLOGY 1

LECTURE 8

NON-LIVING COMPONENTS



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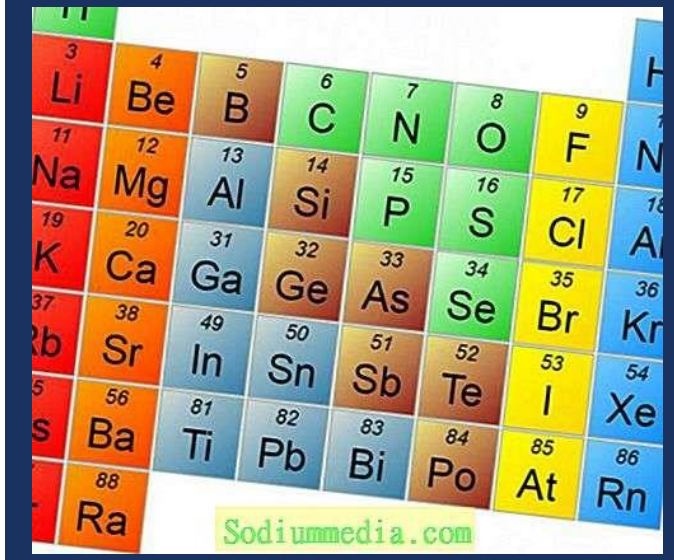
NON-LIVING COMPONENTS

The cytoplasmic matrix is composed of many chemical elements n the form of atoms, ions and molecules. Chemical compounds are conventionally divided into two groups : **organic** and **inorganic**.
Organic compounds form 30 per cent of a typical cell, rest are the inorganic substances such as water and other substances.

Chemical Elements

Of the 92 naturally occurring elements, perhaps 46 are found in the cytosol (cytoplasmic matrix). Twenty four of these are considered essential for life (called **essential elements**), while others are present in cytosol only ecause they exist in the environment with which the organism interacts These **major elements** are carbon (C, 20 per cent), hydrogen (H, 10 per cent), nitrogen (N, 3 per cent), oxygen (O, 62 per cent), phosphorus (P, 1.14 per cent) and sulphur (S, 0.14 per cent). Most organic molecules are built with these six elements.

INORGANIC COMPOUNDS:



Chemical Elements

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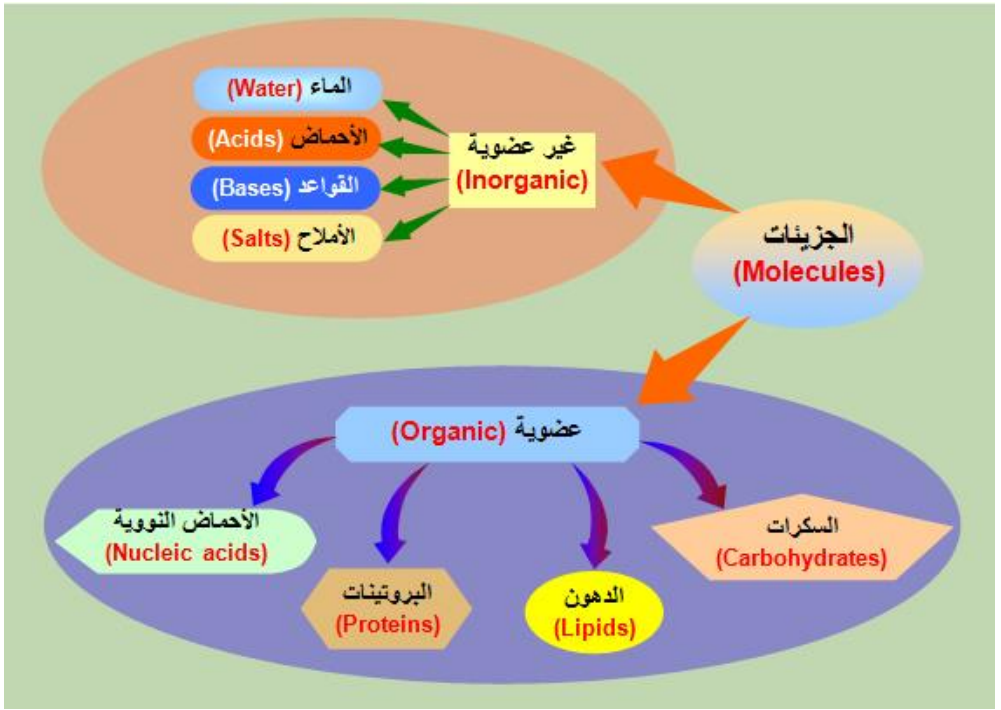
Ions

- The cytoplasmic matrix consists of various kinds of ions. The ions are important in maintaining osmotic pressure and acid-base balance in the cells. Retention of ions in the matrix produces an increase in osmotic pressure and, thus, the entrance of water in the cell. The concentration of various ions in the intracellular fluid (matrix) differs from that in the interstitial fluid. For example, in the cell K+ and Mg++ can be high, and Na+ and Cl—high outside the cell. In muscle and nerve cells a high order of difference exists between intracellular K+ and extracellular Na+. Free calcium ions (Ca++) may occur in cells or circulating blood. Silicon ions occur in the epithelium cells of grasses.

NON-LIVING COMPONENTS

Molecular include :

- organic compounds like amino acids, fatty acids, mono sugars etc. interlinked by specific bonds to form polymers.
- Inorganic compounds like water and carbon dioxide react during the photosynthesis to produce simple organic compound like glucose in the chloroplast present in the plants. Specific elements forms inorganic compound.



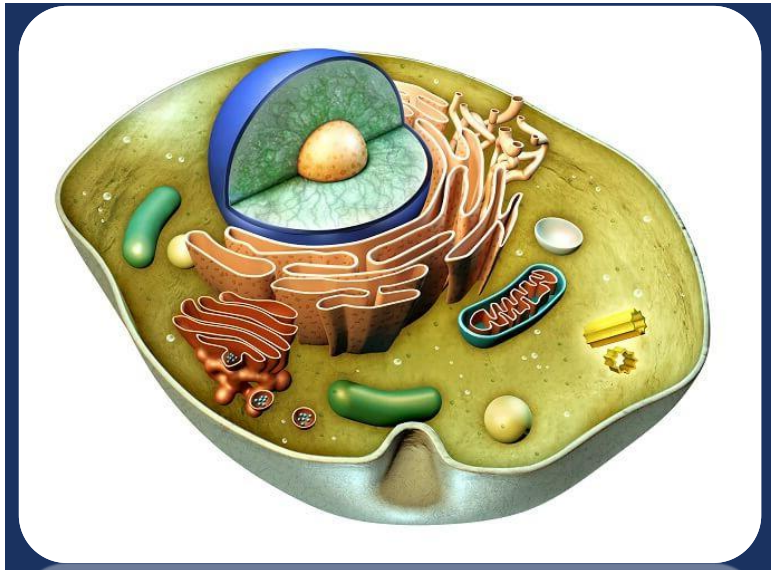
WATER

- The most abundant inorganic component of the cytosol is the water (the notable exceptions are seeds, bone and enamel). Water constitutes about 65 to 80 per cent of the matrix. In the matrix the water occurs in two forms, *viz*., **free water** and **bound water**. The 95 per cent of the total cellular water is used by the matrix as the solvent for various inorganic substances and organic compounds and is known as **free water**. The remaining 5 per cent of the total cellular water remains loosely linked with protein molecules by hydrogen bonds or other forces and is known as **bound water.**
- Some of the unique properties of water are the following :
- **Water as a solvent**.
- **Water's thermal**
- **properties**.
- **Surface tension**
- **Transparency**

CELL BIOLOGY 1

LECTURE 9

NON-LIVING COMPONENTS



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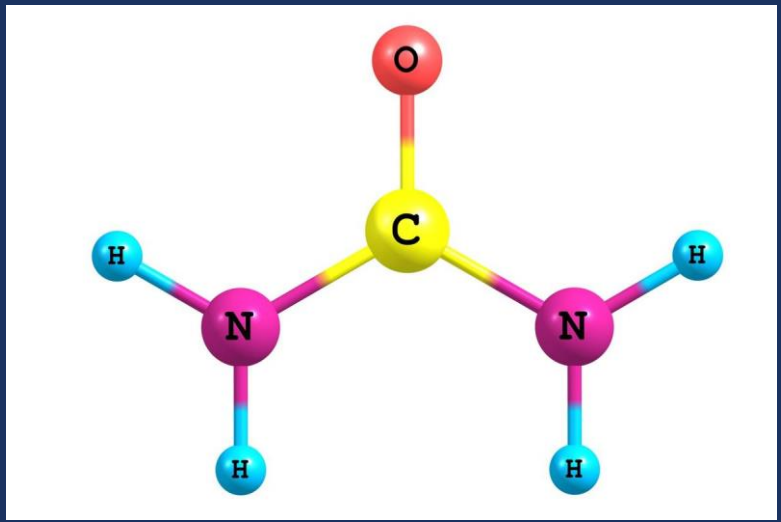
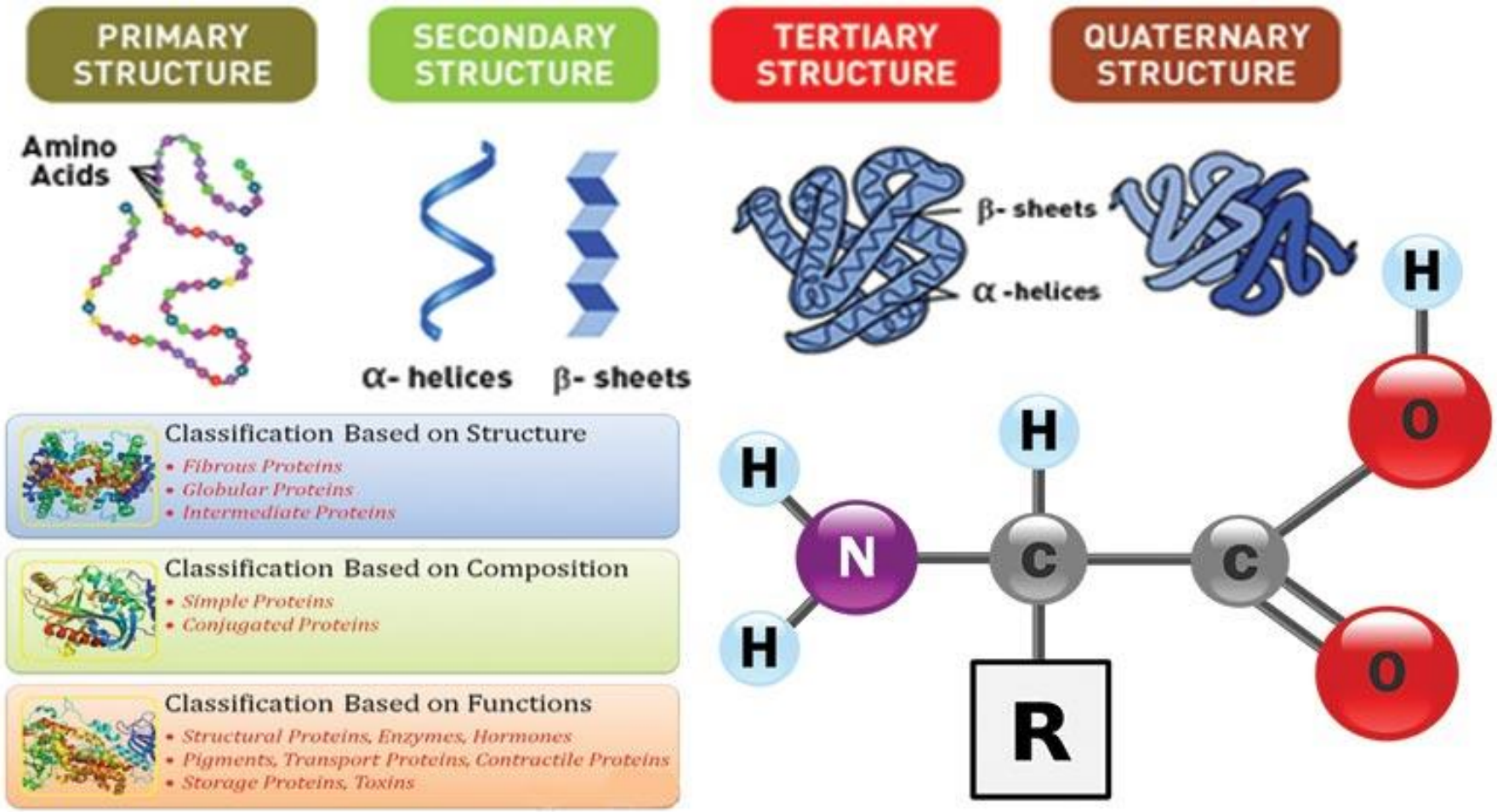
:ORGANIC COMPOUNDS



PROTEINS :

- Of all the macromolecules found in the cell, the proteins are chemically and physically more diverse. They are important constituents of the cell forming more than 50 per cent of the cell's dry weight. Proteins serve as the chief structural material of protoplasm and play numerous other essential roles in living systems. They form enzymes—globular proteins specialized to serve as catalysts in virtually all biochemical activities of the cells. Other proteins are antibodies (immunoglobulins), transport proteins, storage proteins, contractile proteins, and some hormones. In every living organism, there are thousands of different proteins, each fitted to perform a specific functional or structural role.


PRIMARY STRUCTURE
SECONDARY STRUCTURE
TERTIARY STRUCTURE
QUATERNARY STRUCTURE
Amino Acids
α- helices
β- sheets
β- sheets
α -helices
Classification Based on Structure
• Fibrous Proteins
• Globular Proteins
• Intermediate Proteins
Classification Based on Composition
• Simple Proteins
• Conjugated Proteins
Classification Based on Functions
• Structural Proteins, Enzymes, Hormones
• Pigments, Transport Proteins, Contractile Proteins
• Storage Proteins, Toxins
H
O
H
H
N
C
C
O
R

TYPES OF PROTEINS

- **Classification based on biological functions**

1- Structural proteins which include **keratin**,

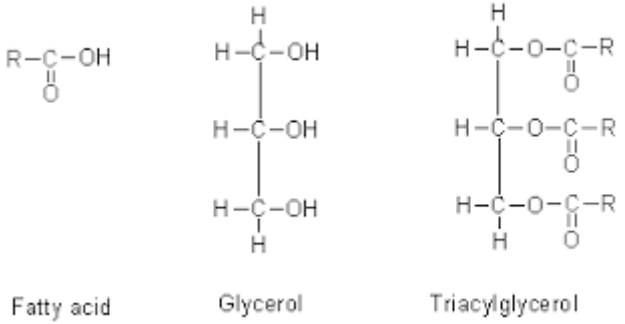
2- Dynamic or functional proteins

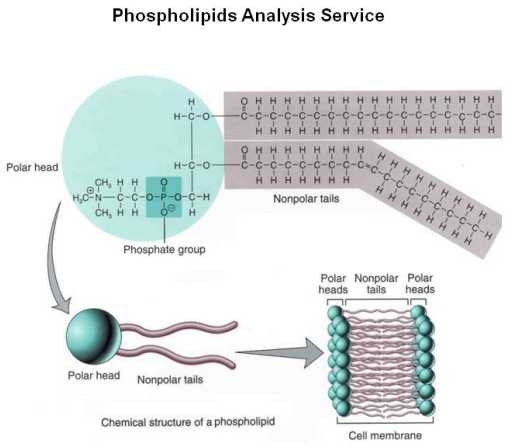
- **Classification based on shape of proteins.**

1- Fibrous proteins.

2- Globular proteins.

LIPIDS:





- The lipids (Gr., *lipos*=fats) are the organic compounds which are insoluble in the water but soluble in the non-polar organic solvents such as acetone, benzene, chloroform and ether. The cause of this general property of lipids is the predominance of long chains of aliphatic hydrocarbons or benzene ring in their molecules. The lipids are non-polar and hydrophobic

1- Neutral fats

2- Phospholipids :

3- Steroid:

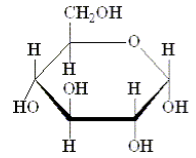
CARBOHYDRATES:

- The carbohydrates (L., *carbo*=carbon or coal, Gr., *hydro*=water) are the compounds of the carbon, hydrogen and oxygen. They form the main source of the energy of all living beings. Only green part of plants and certain microbes have the power of synthesizing the carbohy drates from the water and CO2 in the presence of sunlight and chlorophyll by the process of photosynthesis, it is include:

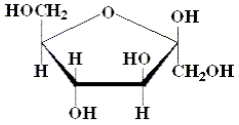
1 -Monosaccharides.

2- Oligosaccharides

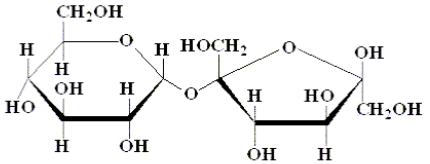
3- Polysaccharides



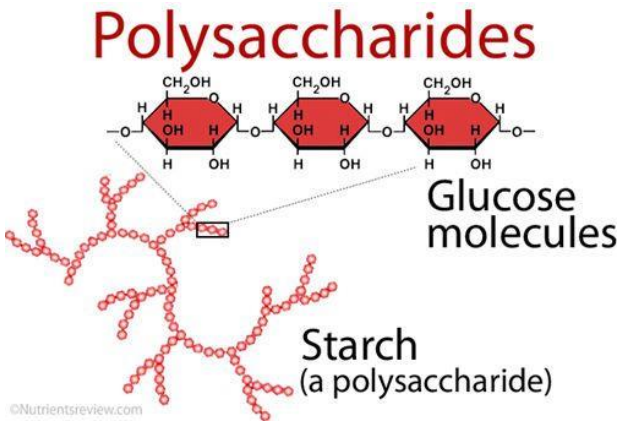
glucose



fructose



sucrose



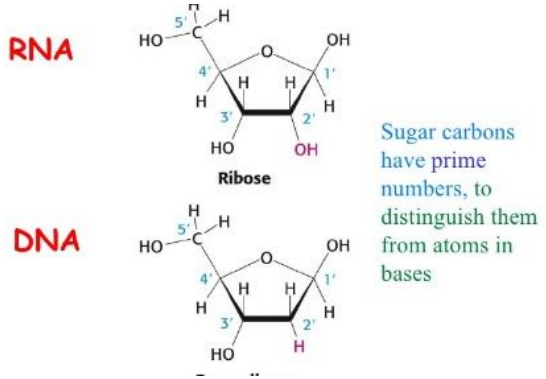
:NUCLEIC ACIDS

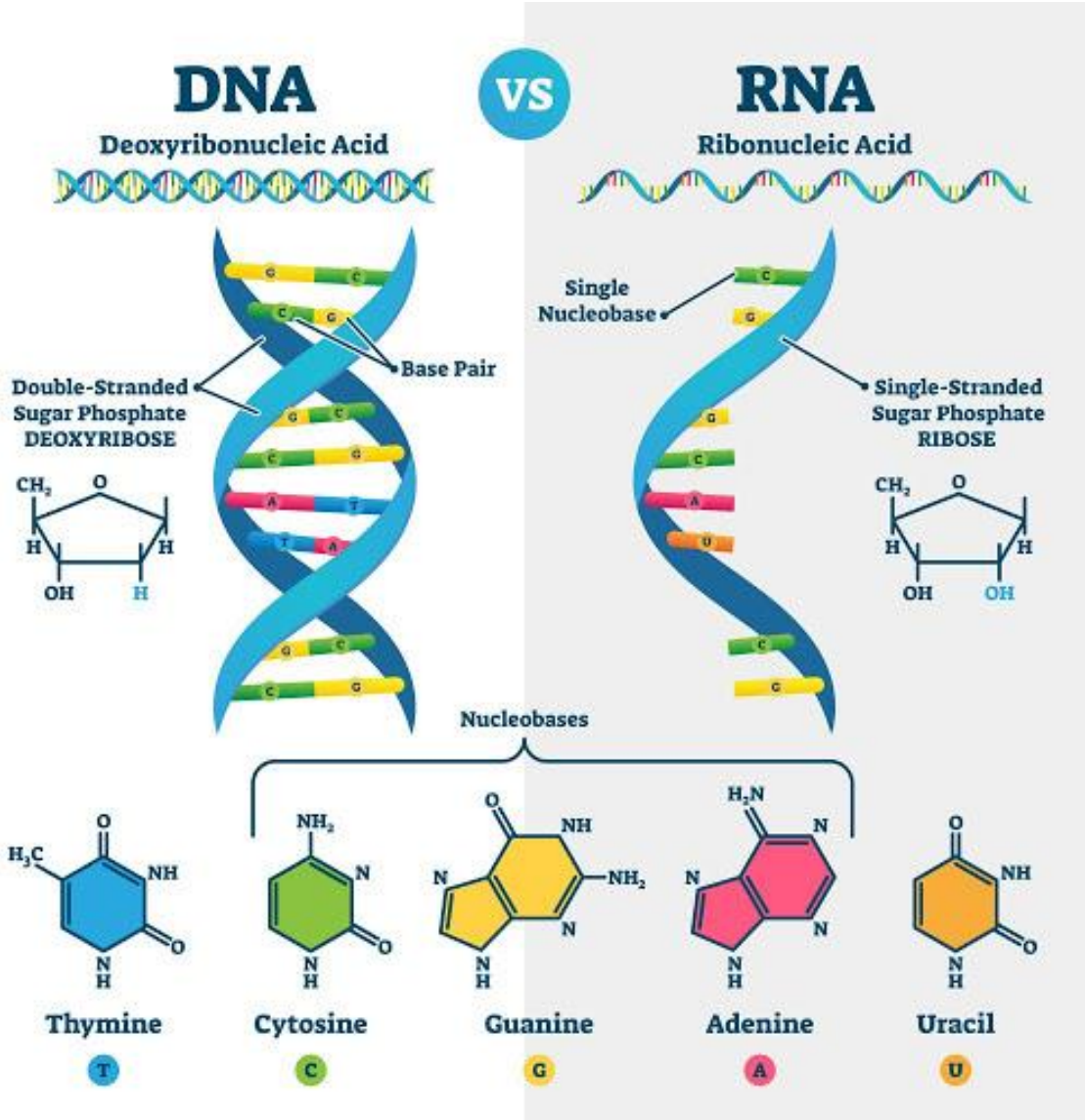
- Nucleic acid is an important class of macromolecules found in all cells and viruses. The functions of nucleic acids have to do with the storage and expression of genetic information. Deoxyribonucleic acid (DNA) encodes the information the cell needs to make proteins. A related type of nucleic acid, called ribonucleic acid (RNA), comes in different molecular forms that participate in protein synthesis.

1- DNA -Deoxyribonucleic acid

2- RNA -Ribonucleic acid

1. Pyrimdine C, T, U
2. Purines: G, A

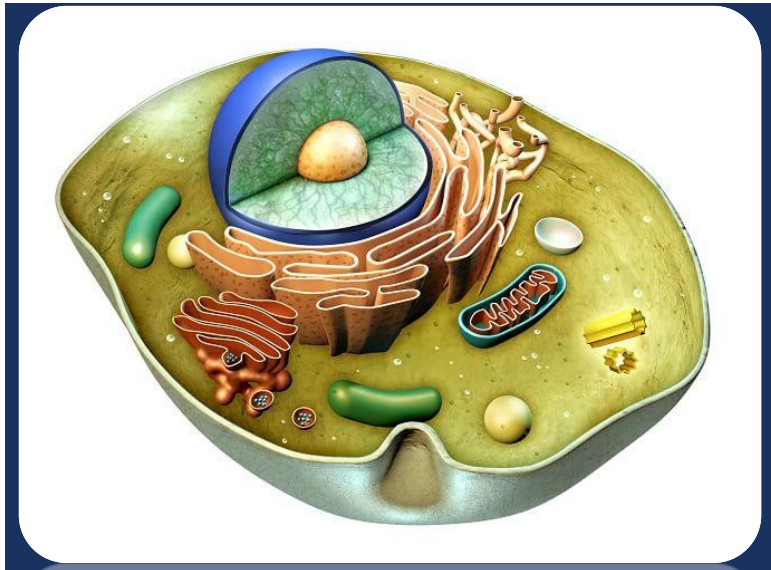



DNA
VS
RNA
Deoxyribonucleic Acid
Ribonucleic Acid
Single Nucleobase
Base Pair
Double-Stranded Sugar Phosphate DEOXYRIBOSE
Single-Stranded Sugar Phosphate RIBOSE
Nucleobases
Thymine
Cytosine
Guanine
Adenine
Uracil
T
C
G
A
U

CELL BIOLOGY 1

LECTURE 10

VIRUSES



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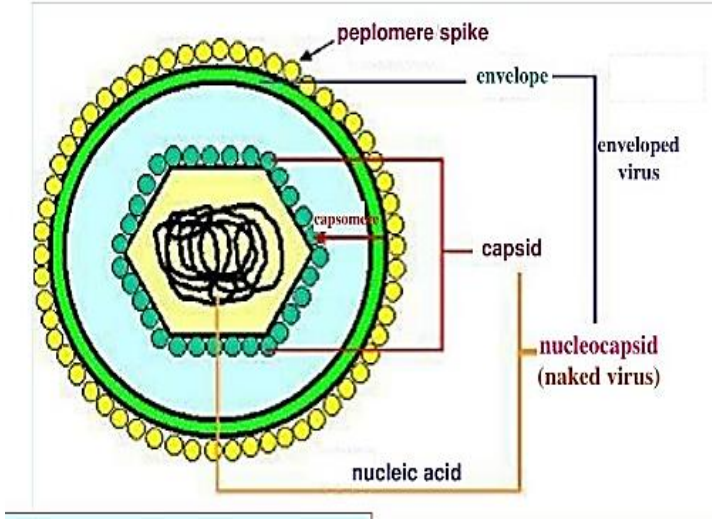
VIRUSES

- Viruses are very small submicroscopic biological entities which though lack cellular organization (*viz*., plasma membrane and metabolic machinery) possess their own genetic material, genetically determined macromolecular organization and characteristic mode of inheritance. For their multiplication, they essentially require the presence of some host cell, *i.e*., they are obligate cellular parasites of either bacteria, plants or animals.

Structure

Viruses are quite a varied group (Fig. 3.1). They range in between 30 to 300 nm or 300 to 3000 A° in size, so they can be observed only by electron microscopy and X-ray crystallography. They have a regular geometrical and macromolecular organization. Basically an infectious virus particle (called **virion**) is composed of a **core** of only one type of nucleic acid (DNA or RNA) which is wrapped in a protective coat of protein, called **capsid**. The capsid consists of numerous **capsomeres**, each having a few **monomers** or **structural units**. Each structural unit is made up of one or more polypeptide chains. The capsomeres are of different shapes such as hollow prism, hexagonal, pentagonal, lobular or any other shape



CLASSIFICATION

Envelope

- Naked viruses
- Enveloped viruses

Nucleic acid type

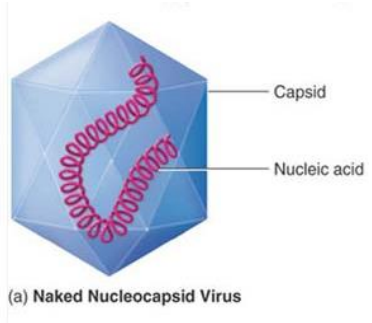
- DNA
- RNA

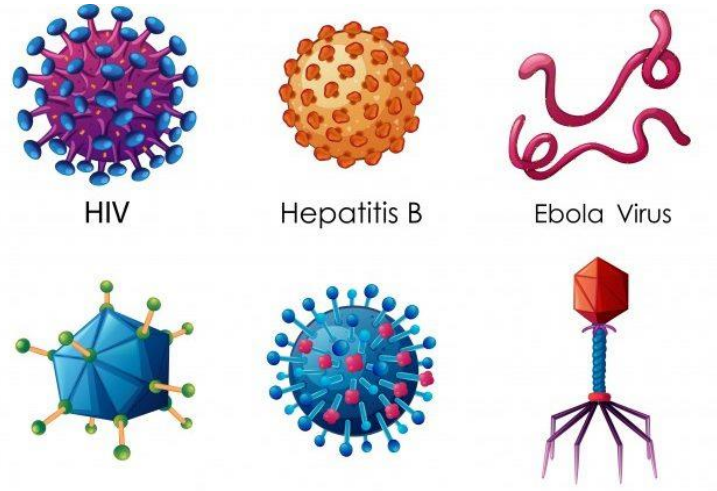
Shape of capsid

Spherical, Rod shape, Cubical, Tadpole, Bullet

Host type:

- Bacteriophages,
- Phytophages
- Zoophages

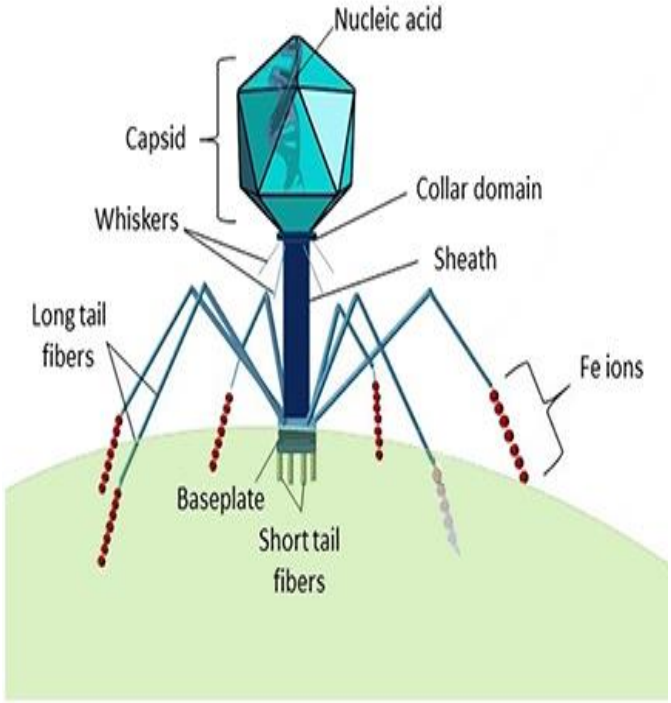




ات

THE LIFE CYCLE OF VIRUS:

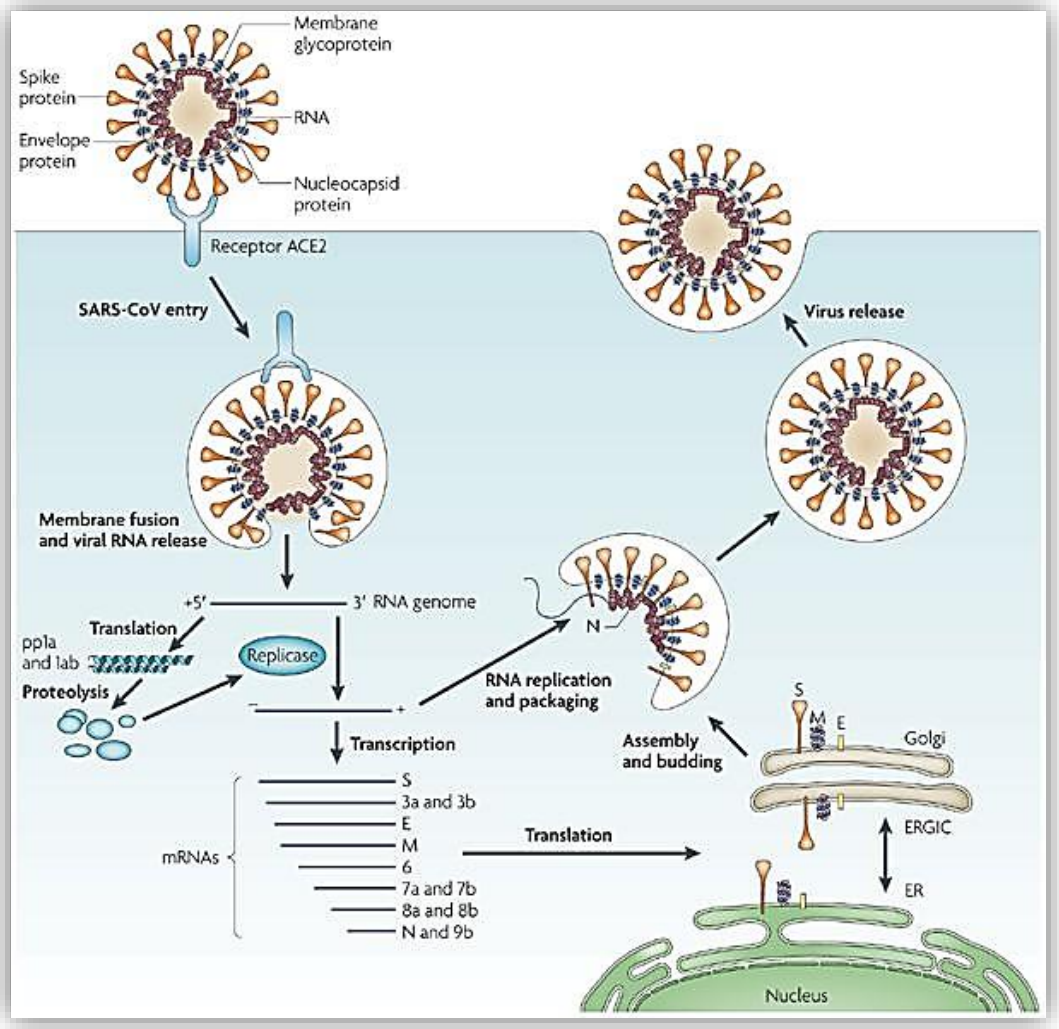
- **Life cycle of the bacteriophage.** Bacteriophages may have the following two types of life cycles: (1) **Lytic cycles**, in which viral infection is followed by **lysis** (bursting and death) of the host cell and release of new infective phages, e.g., virulent phages such as T4 and all other T-even coliphages. (2) **Lysogenic cycles**, in which infection rarely causes lysis, e.g., temperate phages such as P1 and lambda (λ) phages.



CORONAVIRUS

- It related to SARS-CoV ‹SARS-CoV-2)COVID-19 ‹(MERS-CoV.) contain:
- (S) Spike
- RNA
- envelope (E)
- nucleocapsid(N)
- membrane (M)

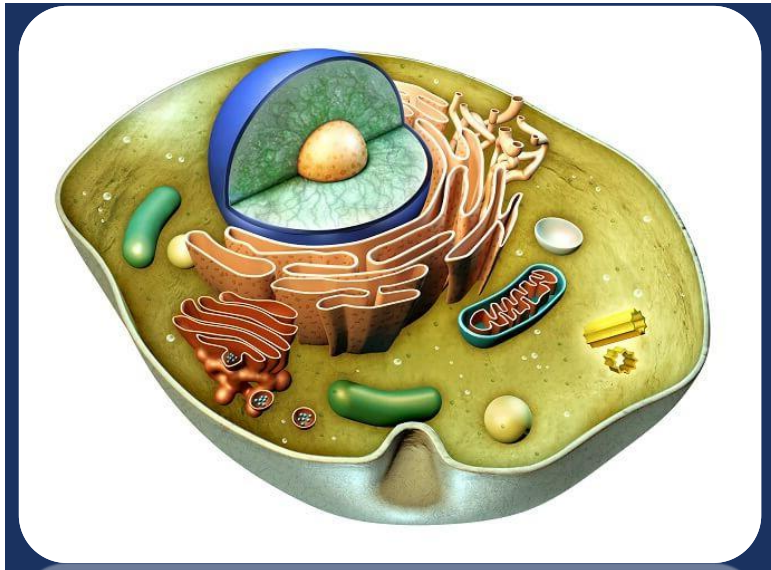
THE LIFE CYCLE OF CORONAVIRUS



CELL BIOLOGY 1

LECTURE 11

PROKARYOTIC



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Dr. Hiba A. Jasim

Collage of Education for Pure Sciences

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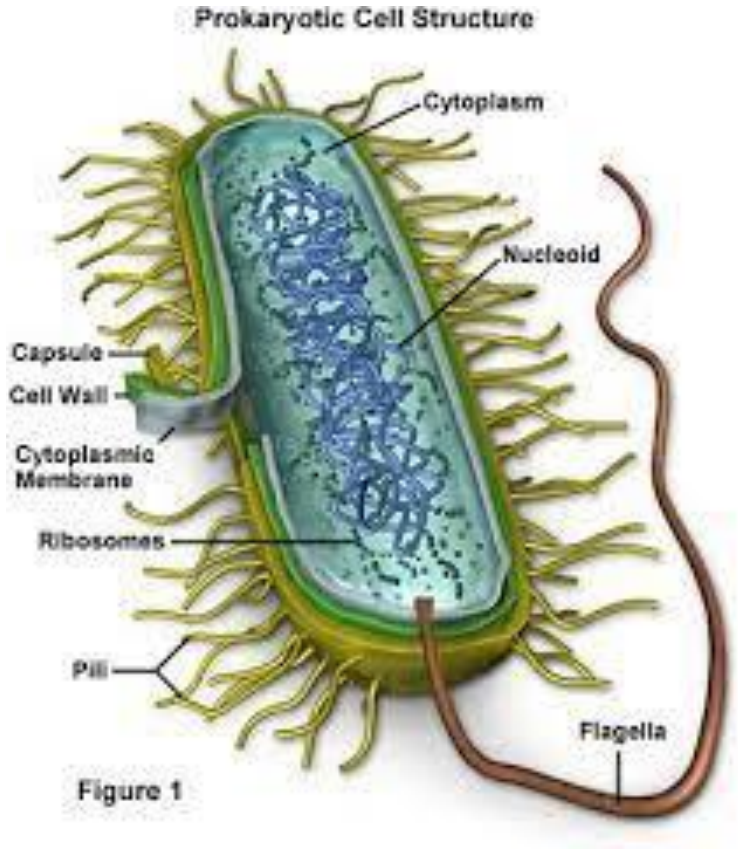
Level -1

PROKARYOTIC

- Prokaryote, any organism that lacks a distinct nucleus and other organelles due to the absence of internal membranes. The lack of internal membranes in prokaryotes distinguishes them from eukaryotes. The prokaryotic cell membrane is made up of phospholipids and constitutes the cell’s primary osmotic barrier. The cytoplasm contains ribosomes, which carry out protein synthesis, and a double-stranded deoxyribonucleic acid (DNA) chromosome, which is usually circular. Many prokaryotes also contain additional circular DNA molecules called plasmids, with additional dispensable cell functions, such as encoding proteins to inactivate antibiotics. Prokaryote like Bacteria and Blue green algae

BACTERIA :

- The bacteria (singular bacterium) are amongst the smallest organisms. They are most primitive, simple, unicellular, prokaryotic and icroscopic organisms. All bacteria are structurally relatively homogeneous, but their biochemical activities and the ecological niches for which their metabolic specialisms equip them, are extremely diverse.



BACTERIA CLASSIFICATION

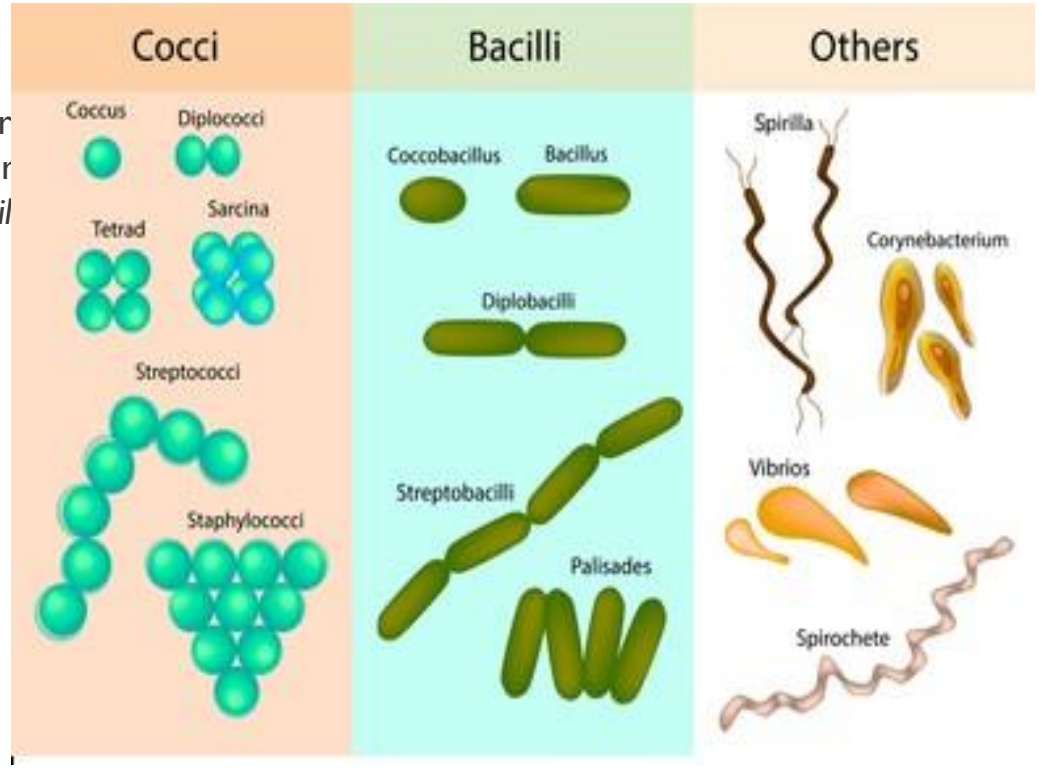
- *** Size of bacteria:** Typically bacteria range between 1µm (one micrometr µm, so they are barely visible under the light microscope. The smallest bacter *Dialister pneumosintes* (0.15 to 0.3µm in length). The largest bacterium is *Spiril volutans* (13 to 15µm in length).
- **Forms of bacteria**

1. **Coccus:** Diplococcus ,Streptococcus Staphylococcus,.
2. **Bacillus** diplobacilli ,streptobacilli

- **Spirilla :** *Treponema pallidum*

1. **Vibrios:** *Vibrio cholerae*

*** Gram negative and Gram positive bacteria**



CELL WALL :

- The plasma membrane is covered with a strong and rigid cell wall that renders mechanical protection and provides the bacteria their characteristic shapes

Types of cell wall

1. Gram positive cell wall

Cell wall composition of gram positive bacteria.

1.Peptidoglycan

2.Lipid

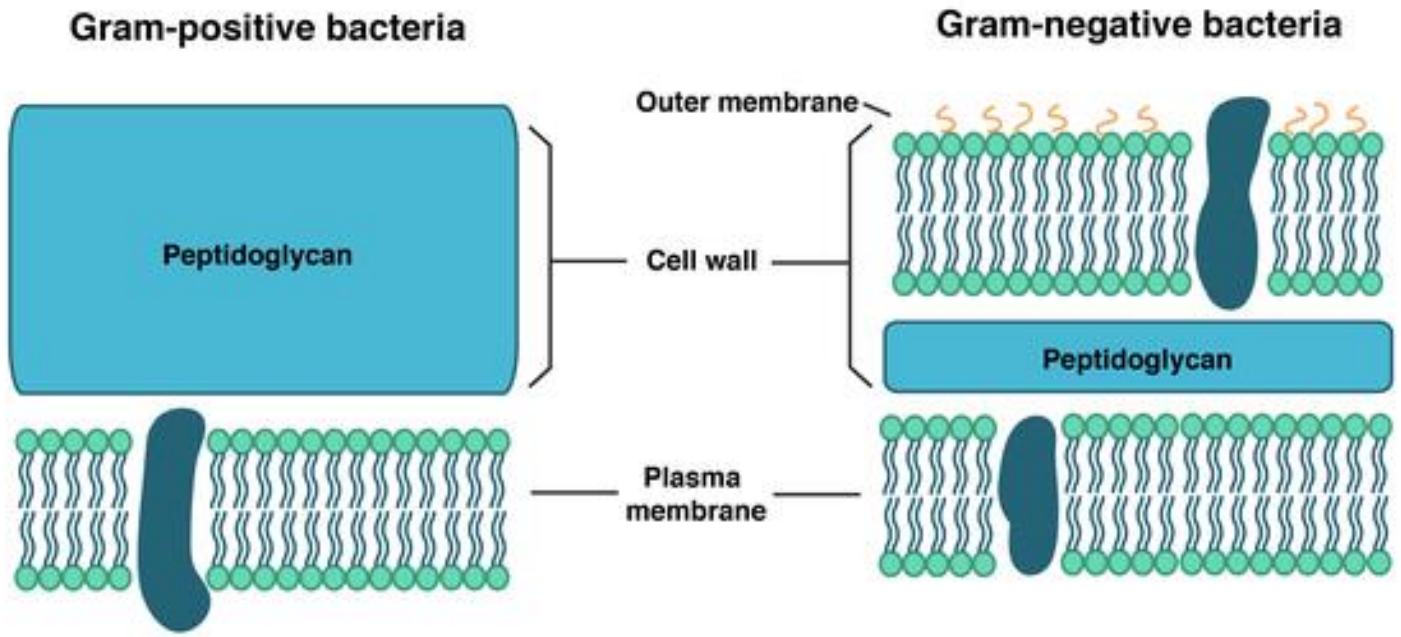
3.Teichoic acid

2. Gram negative cell wall

Cell wall composition of gram negative bacteria

1.Peptidoglycan

2.Outermembrane: Lipid, Protein, Lipopolysaccharide (LPS)



PLASMA MEMBRANE :

- The bacterial protoplast is bound by a living, ultrathin (6 to 8 nm thick) and dynamic plasma membrane. The plasma membrane chemically comprises molecules of lipids and proteins which are arranged in a **fluid mosaic pattern**. That is, it is composed of a bilayer sheet of **phospholipid** molecules with their polar heads on the surfaces and their fatty-acyl chains (tails) forming the interior. The **protein** molecules are embedded within this lipid bilayer, some spanning it, some exist on its inner side and some are located on its external or outer side. these membrane proteins serve many important functions of the cell

CAPSULE

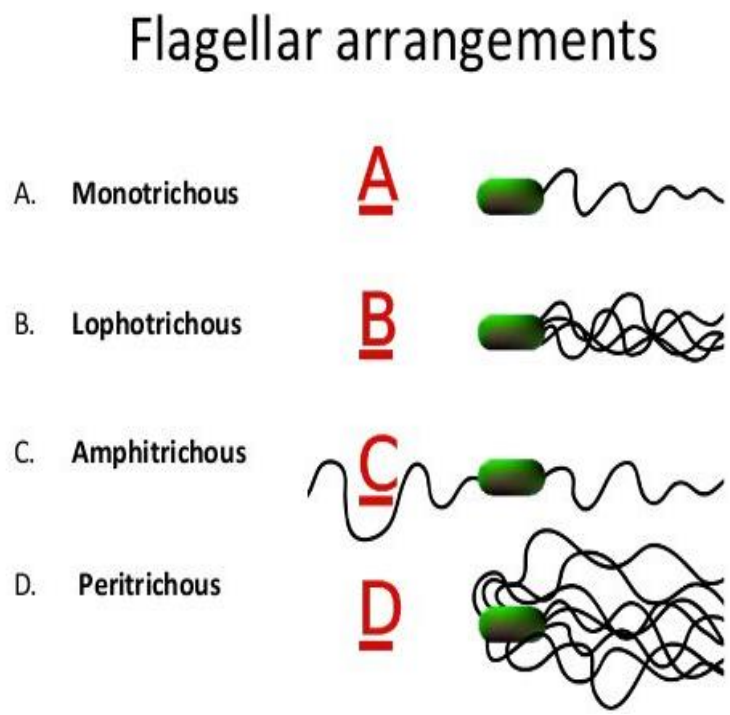
- In some bacteria, the cell wall is surrounded by an additional slime or gel layer called **capsule**. It is thick, gummy, mucilaginous and is secreted by the plasma membrane. The capsule serves mainly as a protective layer against attack by phagocytes and by viruses. It also helps in regulating the concentration, and uptake of essential ions and water.

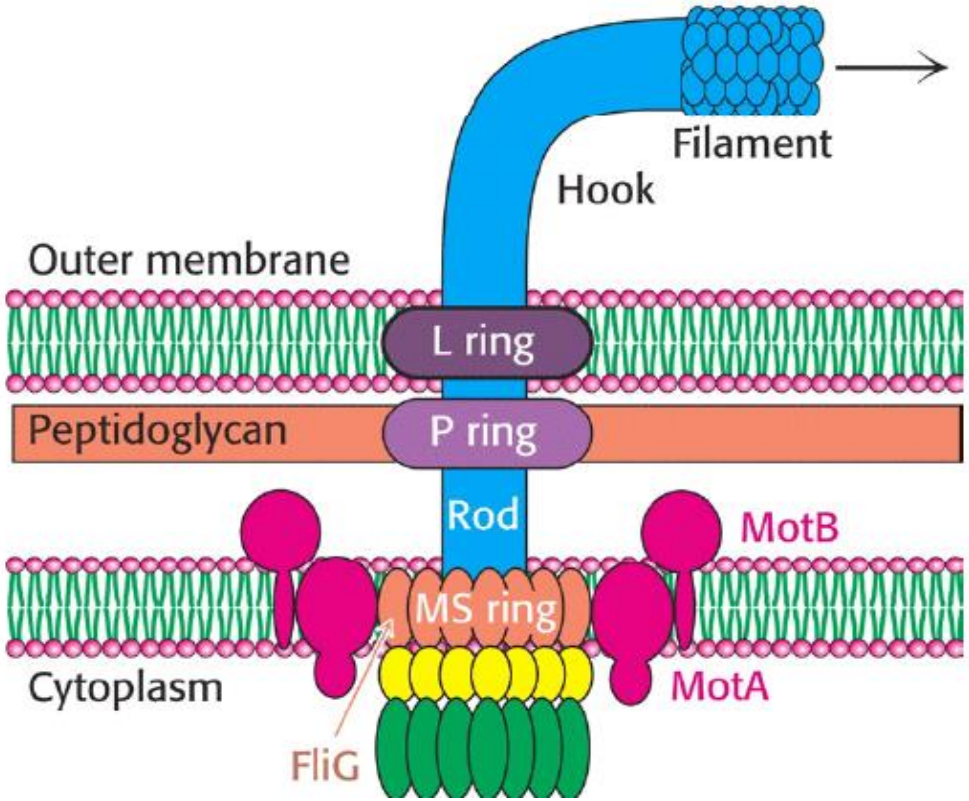
CYTOPLASM :

- The plasma membrane encloses a space consisting of **hyaloplasm, matrix** or **cytosol** which is the ground ubstance and the seat of all metabolic activities. The cytosol consists of water, proteins (including multifunctional enzymes), lipids, carbohydrates, different types of RNA molecules, and various smaller molecules. The cytosol of bacteria is often differentiated into two distinct areas : a less electron dense nuclear area and a very dense area (or dark region). In the dense cytoplasm occur thousands of particles, about 25 nm in diameter, called **ribosomes**.

BACTERIAL FLAGELLA:

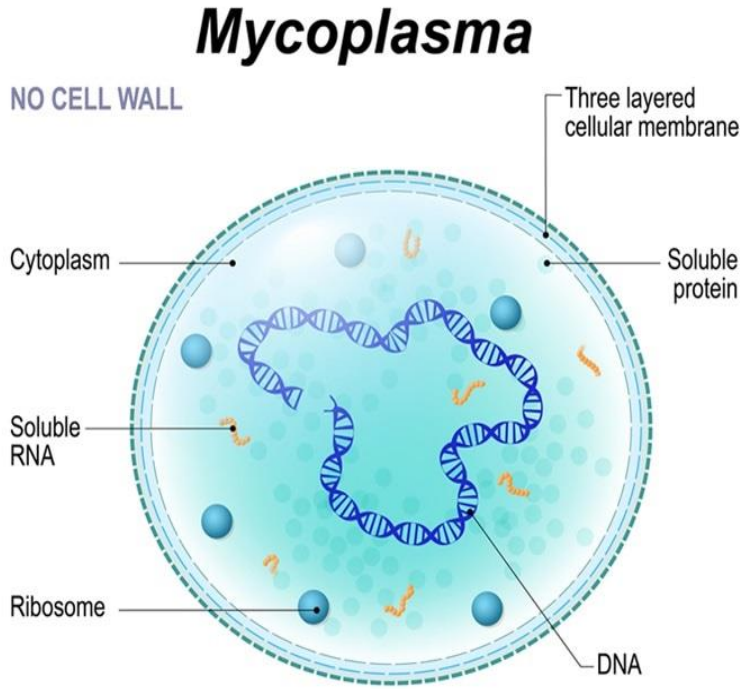
- A bacterial flagellum consists of a helical tube containing a single type of protein subunit, called **flagellin**. The flagellum is attached at its base, by a short flexible **hook** that is rotated, like a propeller of ship, by the flagellar rotatory "**motor**" (*i.e.*, basal body; Fig. 3.12). The flagellar motor comprises four distinct parts : rotor (M ring), stator, bearing (S ring) and rod. The '**rotor**' is a protein disc integrated into the plasma membrane.flagella types are:
- **Monotrichous،**
- **Lophotrichous**
- **Amphitrichous**
- **Peritrichous .**




Filament
Hook
Outer membrane
L ring
Peptidoglycan
P ring
Rod
MotB
MS ring
Cytoplasm
MotA
FliG

MYCOPLASMA

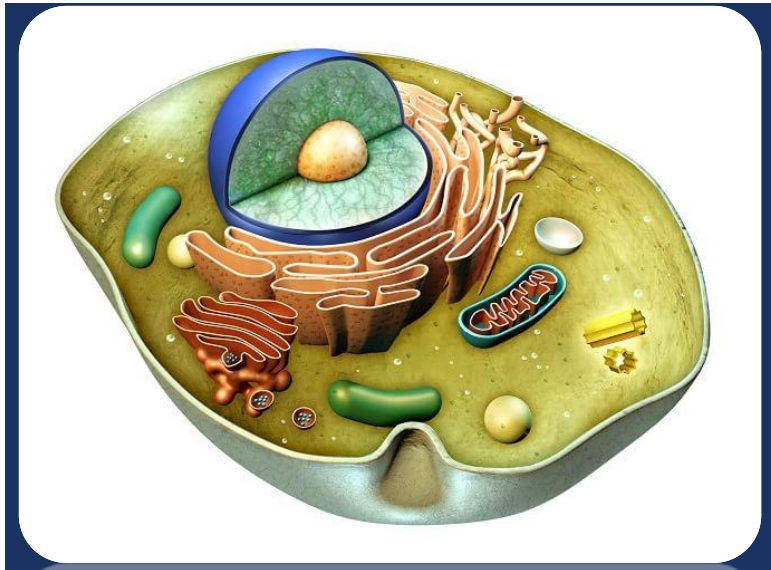
- Among living organisms that have the smallest mass, are small bacteria called **mycoplasmas** which produce infectious diseases in animals including humans. Mycoplasmas are unicellular, prokaryotic, containing a plasma membrane, DNA, RNA and a metabolic machinery to grow and multiply in the absence of other cells. They differ from the bacteria in the following respects :
- 1. Mycoplasmas are filterable through the bacterial filters
- 2. They do not contain cell wall and mesosomes.
- 3. Like the viruses and animal cells, they are resistant to antibiotics such as penicillin which kills bacteria by int
- 4. Their growth is inhibited by tetracyclines and similar antibiotics that act on metabolic pathways. erfering with cell wall synthesis



CELL BIOLOGY 1

LECTURE 12

PROKARYOTIC AND EUKARYOTIC CELLS



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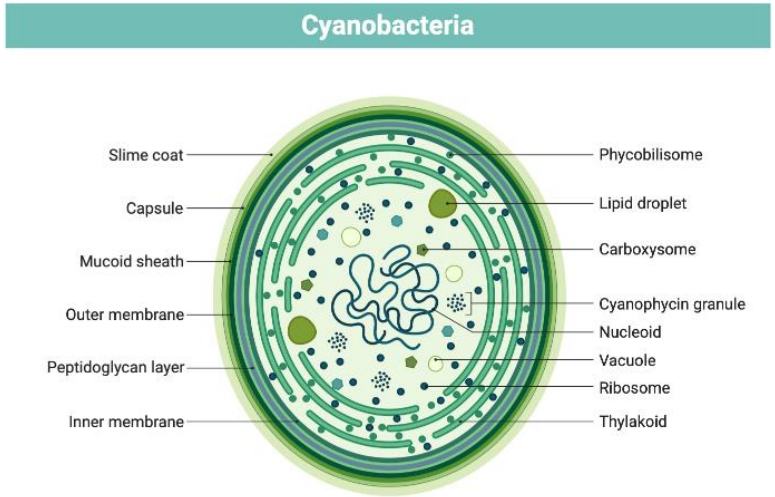
BLUE GREEN ALGAE

- **Cyanobacteria or blue-green algae.** The Gram-negative cyanobacteria or oxyphotobacteria are one of
- the most successful and primitive groups of organisms on earth. A typical cell of a blue green alga is composed of :
  - DNA
  - Photosynthetic Pigment : the chlorophyll and carotenoid
  - Phycobilosomes.
  - Ribosome:
  - Cyanophycin granule :
  - Carboxysome
  - myxophycean starch
  - **polyglucon granules**
  - Vacuoles



EUKARYOTIC CELLS

- **EUKARYOTIC CELLS** are organisms whose cells have a nucleus enclosed within a nuclear envelope.
- Though the eukaryotic cells have different shape, size, and physiology; all the cells are typically composed of plasma membrane, cytoplasm and its organelles, *viz*., mitochondria, endoplasmic reticulum, ribosomes, Golgi apparatus, etc., and a true nucleus. Here the nuclear contents, such as DNA, RNA, nucleoproteins and nucleolus remain separated from the cytoplasm by the thin, perforated nuclear membranes. The eukaryotic cells are the true cells such as Protozoa, Fungi, Algae, Plants and Animals

FUNGI

- A **fungus** is a member of the group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushrooms.
- **Characteristics of Fungi**
- Fungi are eukaryotic, non-vascular, non-motile and heterotrophic organisms.
- They may be unicellular or filamentous.
- They reproduce by means of spores.
- Fungi exhibit the phenomenon of alternation of generation.
- Fungi lack chlorophyll and hence cannot perform photosynthesis.

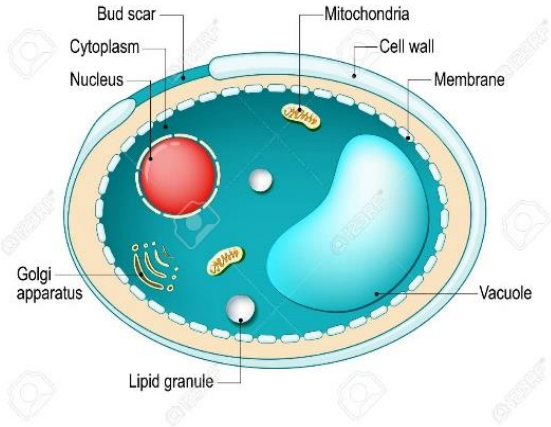
FUNGI COMPONENTS

Non-protoplasmic components

1. Cell membrane
2. Cytoplasm
3. Dictyosomes
4. Endoplasmic reticulum
5. Ribosomes
6. Mitochondria
7. Vacuoles
8. Nucleus

Protoplasmic components

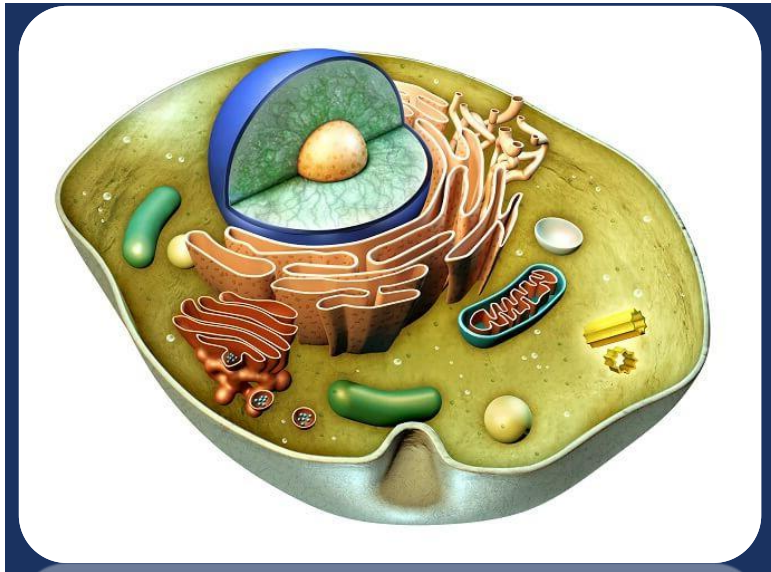
1. Lipids
2. Pigments
3. Water
4. Volutine
5. Glycogen
6. Cell wall



CELL BIOLOGY 1

LECTURE 13

EUKARYOTIC CELLS



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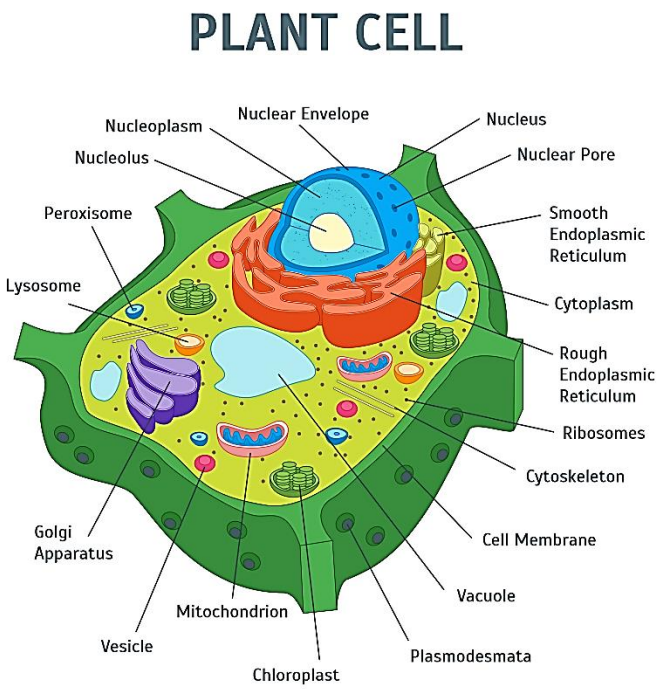
PLANT CELL:

- **Non-protoplasmic components**

1. **Cell wall**
2. **Lipids**
3. **Crystals**
4. **Carbohydrates**
5. **Proteins**
6. **Salts**
7. **Water**
8. **Resin**
9. **Tanner**
10. **Plant milk**
11. **Alkaloids**

Protoplasmic components

1. **cell membrane**
2. **cytoplasm**
3. **Plastids**
4. **Mitochondria :**
5. **Golgi apparatus (Dictyosome)**
6. **Cytoskeleton**
7. **Ribosomes**
8. **Endoplasmic reticulum**
9. **Lysosome**
10. **Vacuoles**
11. **Nucleus**
12. **nuclear membrane**
13. **nucleolus**



ANIMAL CELL

Protoplasmic components

1. cell membrane
2. cytoplasm
3. centriole
4. mitochondrion
5. golgi apparatus
6. Cytoskeleton
7. Nucleus
8. Ribosomes
9. Endoplasmic reticulum
10. lysosome

Non-protoplasmic components

- Lipids
- Carbohydrates
- Proteins
- Animal milk
- Salt and Ions
- Water