جمهورية العراق
وزارة التعليم العالي والبحث العلمي
كلية الكوت الجامعة
Kut University College

Course Outline

Bacteriology

Course

Lecturer Ibrahim H. Madhloom

Academic Year

2020-2021

Institution	Kut University Colleges
Department	Dentistry

A. Course Identification and General Information:

Course Title	Bacteriology
Credit Hours	2
Program in Which Course is Offered	Dentistry
Name of Faculty Member Responsible for the Course	Course Lec. Ibrahim H. Madhloom
Level	Third
Pre-requisite	NON
Location	E-Learning & Campus

B. Aims and Objectives:

1. Aims of the Course:

- Teaching of bacteriology to enable the students for recognize, identify and differentiate between bacteria, fungi, viruses and protozoa that causing many diseases, in addition understanding immunity and its role in the healing stages of diseases.
- The students should be able to know the pathogen microbes, what pathogenesis they cause, symptoms of microbial diseases, how to diagnose them, treatment and control them.

2. Course Development Objectives:

Upon completion of this course, the student will be able to:

- Demonstrate familiarity and competency with a wide variety of microbiological laboratory techniques, including transfer, culture, isolation and identification, growth rates and antibiotic sensitivity.
- Describe the components and cellular structure of bacteria, viruses and fungi.
- Explain the bacterial genetic processes of replication, transcription and translation.
- Understand the principles of microbial pathogenic mechanisms and strategies to identify and manage infectious disease transmission.
- Define immunity and understand the mechanisms of the immune response.

C. COURSE DESCRIPTION:

Topics covered	No. of Weeks	Contact Hours
Introduction to microbiology.	١	٢
Classification, diagnosis and identification of microorganisms.	2	4
The bacteria, cellular structure and staining reactions.	2	4
Growth and nutritional requirements.	2	4
Sterilization and disinfection.	2	4
Chemotherapy and antibiotic resistance	1	2
Ecology of oral flora and the interrelationships between the microorganisms and their hosts.	2	4
Dental plaque and caries formation.	١	2
Immunology, immune response, antigen antibody reactions, natural and acquired immunity, immunodeficiency diseases.	3	6
Pathogenicity and virulence.	2	4
Oral pathogenic bacteria and clinical manifestation: G+ bacteria, G- bacteria, *spirochaetes*, *actinomycetes, reketssia*, *chlamydia* and *mycoplasma*.	3	6
Mycology (molds and yeasts)	2	4
Oral pathogenic fungi and yeasts.	1	2
Protozoa, oral pathogenic protozoa.	1	2
Virology: viral shape and structure classification and viral diseases.	3	6
Microbial genetics, mutation and genetics recombination.	2	4
Total	**30**	**60**

D. FACULTY and STAFF:

– Lec. Ibrahim H. Madhloom

E. LEARNING RESOURCES:

Required Text Book:

Marsh, P. D. and Martin, M. V. (2015). Oral Microbiology. Fifth Edition. Elsevier Limited 2015

Samaranayake, L. (2012). Essential microbiology for dentistry. Fourth Edition. Elsevier Limited 2012

Leboffe, M. J. and Pierce, B. E. (2011). A Photographic atlas for the microbiology laboratory. 4th EDITION

F. FACILITIES:

- The classroom utilizes traditional didactic lecture, data show presentation, and animated simulations of topics under discussion.
- A questions and answers approach centred on enhancing student critical thinking and problem-solving skills is used.
- Clinical emphasis is placed on individual and group study designed to enhance and augment the theoretical portion of the course.

G. COURSE EVALUATION:

Continuous Assessment first semester **Mid- year examination** **Continuous Assessment second semester** **Final examination**	13% ——— 13% 40%
Total	66%

Medical Biology Dentistry
Lab: 1 1st Stage

The Microscope

What is the microscope?

• One of the most important tools used to study living things.

"Micro" means very small

"Scope" means to look at.

• Magnifies objects (makes objects look bigger)

• Help Scientists study objects & living things too small to see with the naked eye.

The word "microscope" means:

A. Glass eye

B. Small ~ to look at

C. To search for

Types of Microscopes:

• **Simple microscope:** has only 1 lens.

• **Compound microscope:** has 2 sets of lenses. It can magnify things 100 - 200 times larger than they really are.

• **Electron microscope:** can magnify objects up to 300,000 times.

They do not use lenses, but use electrons to enlarge the image. Light microscopy involves use of optical lenses and light radiations.

• Electron microcopy is of two types:

1. Transmission Electron Microscope

2. Scanning Electron Microscope

Parts of Microscopes:

Arm: supports the body tube. Used to carry the microscope.

Base: bottom part of the microscope often shaped like a horseshoe.

Stage Clips: holds down the slide on the stage.

Eyepiece: the lens you look through that magnifies the specimen.

Body Tube: the hollow tube through which light passes. It holds the lenses apart.

Course adjustment: raises or lowers the Body Tube to focus

Fine adjustment: raises and lowers the Body Tube and used to bring objects into focus.

The NOSEPIECE: is the round part that holds the OBJECTIVE LENSES apart.

Low Power Objective: magnifies the specimen at a lower power.

High Power Objective: magnifies the specimen at a higher power.

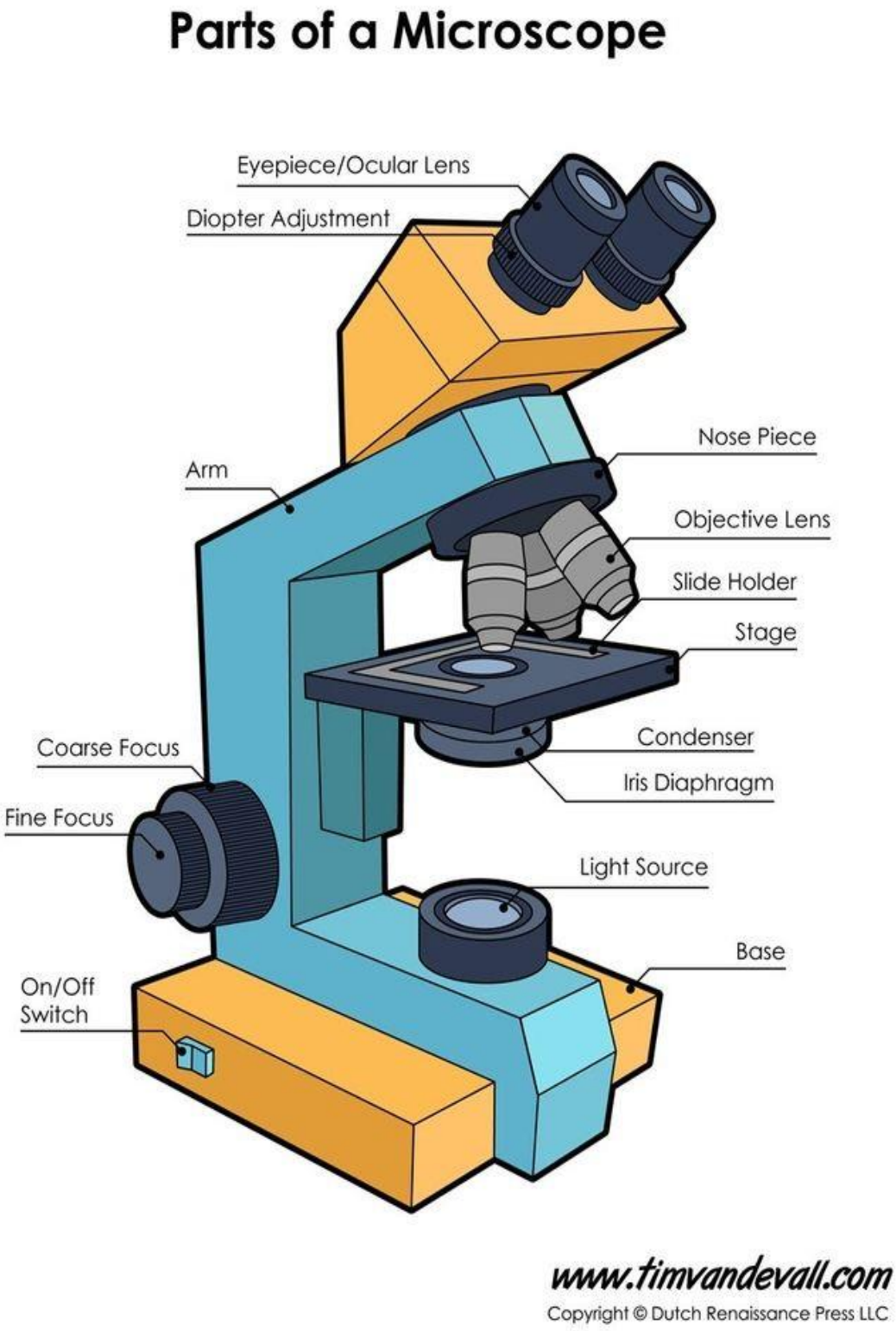
Diaphragm: changes the amount of light reaching the objective lenses. Located under the Stage.

Light Source: located beneath the Stage and Diaphragm. Sends light towards the hole in the stage.

Magnification by a microscope:

The total magnification achieved with the microscope depends on the multiplication of the initial magnification of the objective by the magnification of ocular.

Magnification of the objectives	Magnification of the eyepiece	Total magnification
4X	10X	40X
10X	1OX	100X
40X	10X	400X
100X	10X	1000X



Basic parts of Microscope

Introduction of medical biology

Medical biology is a field of biology that has practical applications in medicine, health care and laboratory diagnostics.

Biology

The study of living organisms, divided into many specialized fields that cover their morphology, physiology, anatomy, behavior, origin, and distribution.

Levels of organization of living things

This mean describe the biological levels of organization from the smallest (cell) to highest level (organism) fig. (1), to facilitate the study of living organisms.

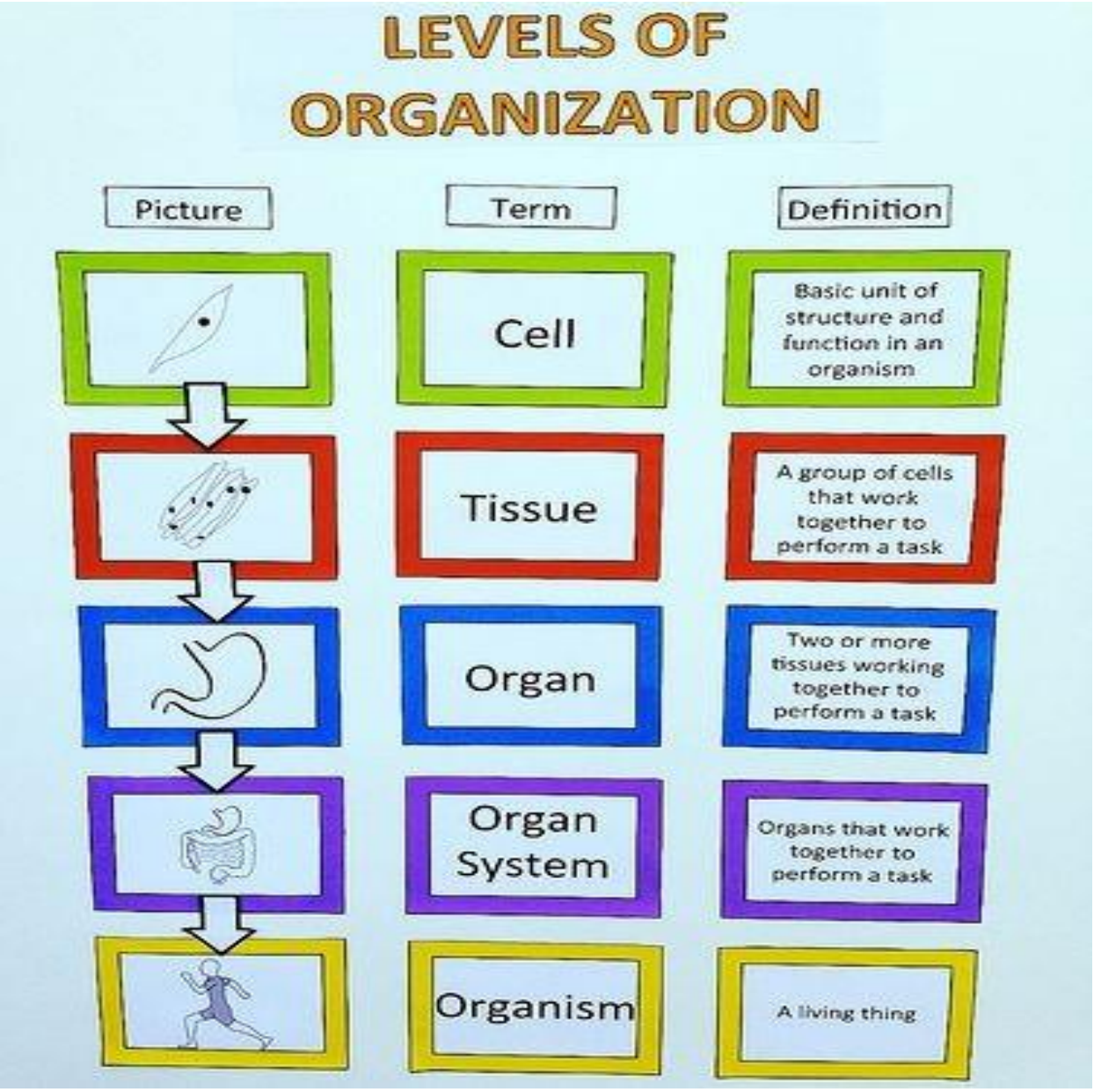


Figure 1: Levels of organization of living things

The cell

The smallest unit of life, and the basic structural, functional, and biological unit of all living organisms. Study of the structure and function of cells called **cytology**. The organisms that made up of a single cell are called **unicellular** organisms such as amoeba, euglena and paramecium, while the organisms made up of more than one cell are called **multicellular** organisms such as animals and plant.

Types of cells

Cells may be prokaryotic or eukaryotic. *Prokaryotes* include bacteria (fig.2) & lack a nucleus or membrane-bound structures called organelles. Prokaryote composed from nucleoid region contains the DNA, cell membrane, cell wall and contain ribosomes to make proteins in their cytoplasm.

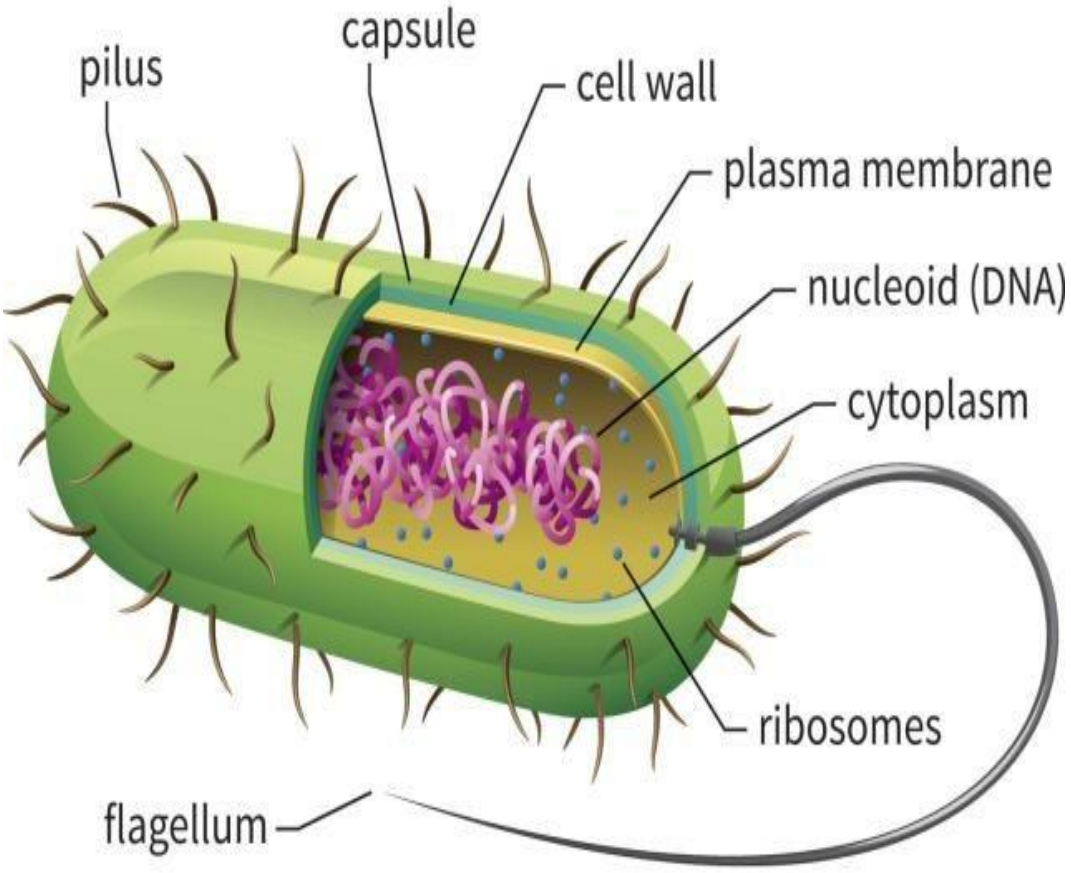


Figure 2: Typical structure of bacteria

Eukaryotes include most other cells & have a nucleus and membrane-bound organelles (plants, fungi & animals fig.3).

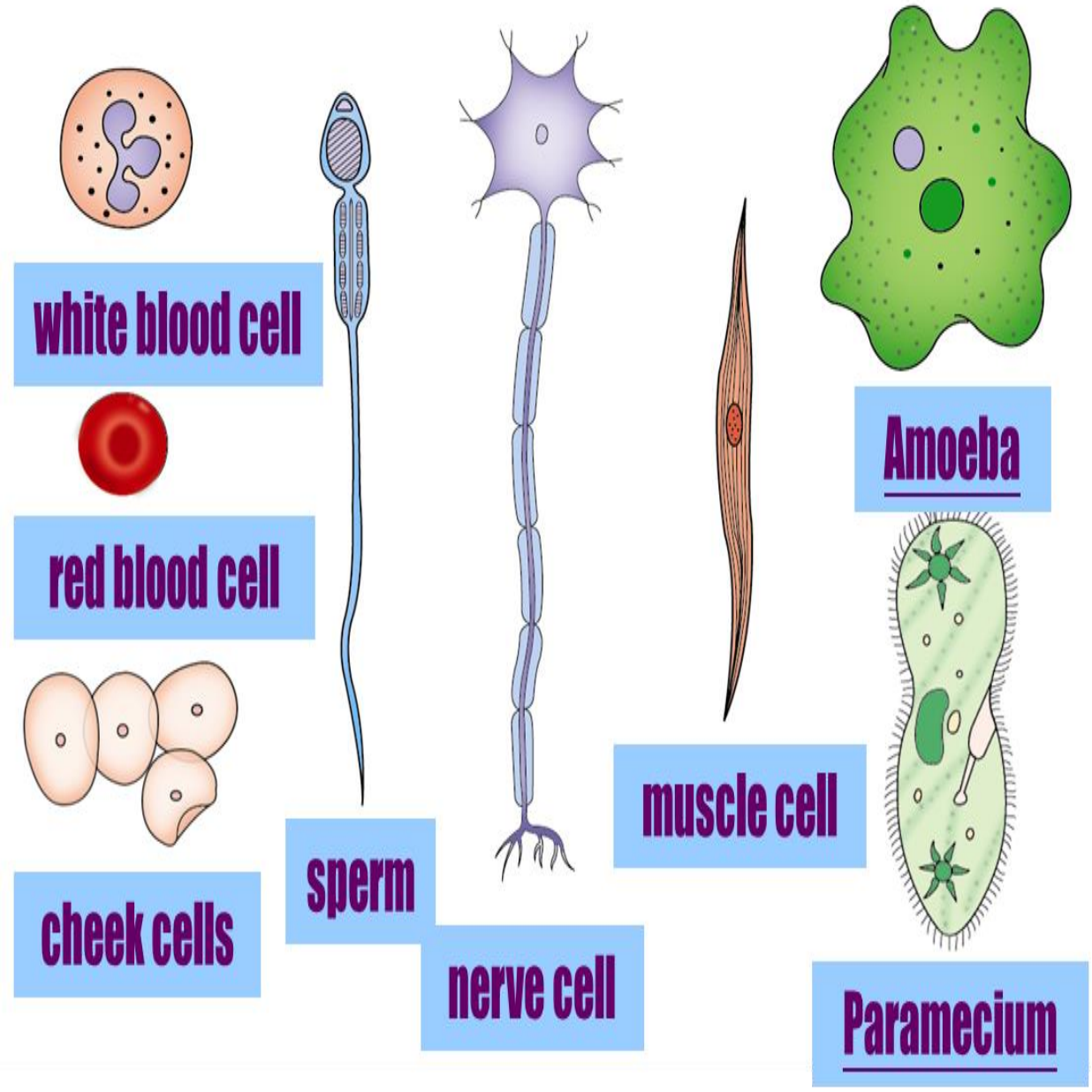


Figure 3: Different kinds of animal cells

Cell structure

A cell consists of basic three parts: the nucleus, cell membrane and the cytoplasm with organelles fig. (4).

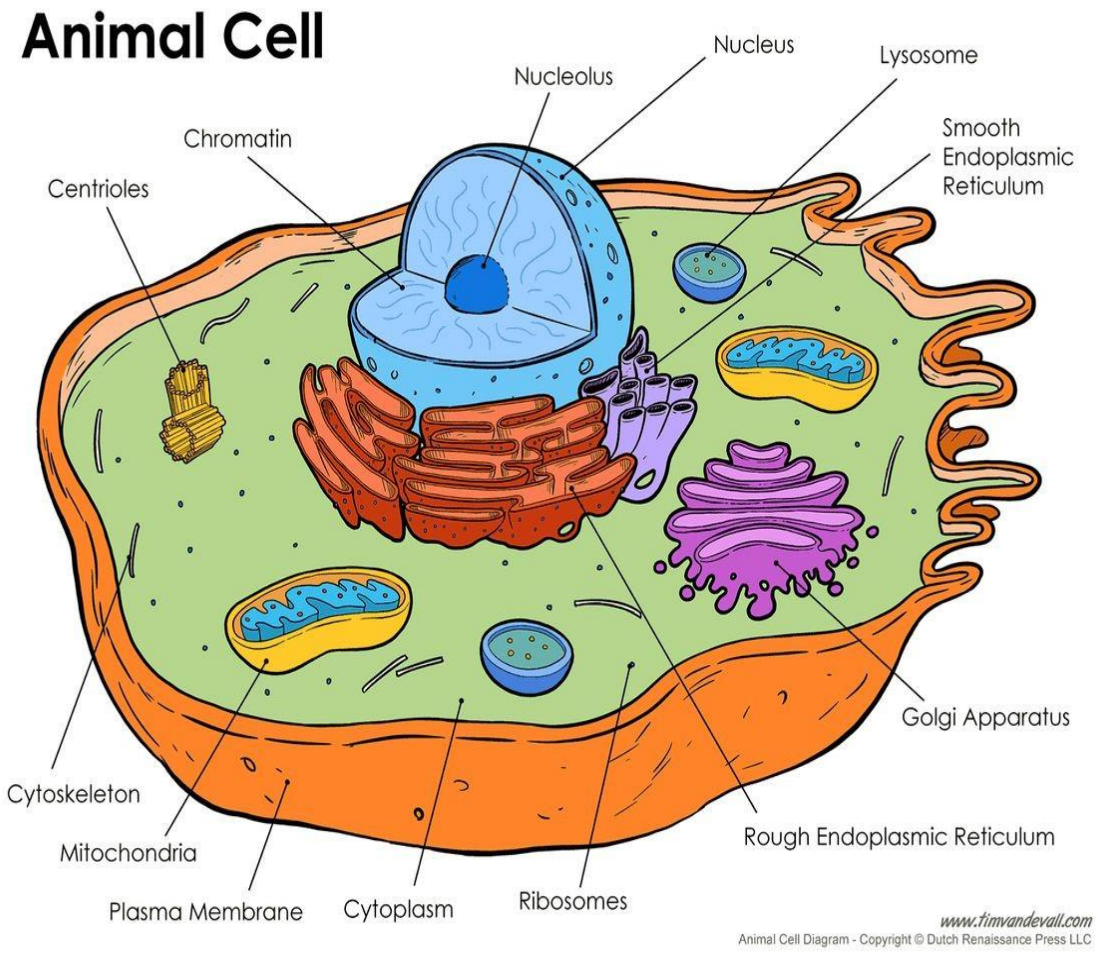


Figure 4: Structure of animal cell

1- Golgi Bodies

- Stacks of flattened sacs
- Have a shipping side & a receiving side
- Receive & modify proteins made by ER
- Transport vesicles with modified proteins pinch off the ends.

2- Lysosome

- Contain digestive enzymes
- Break down food and worn out cell parts for cells

- Programmed for cell death (lyse & release enzymes to break down & recycle cell parts).

3- Nucleolus

- Cell may have 1 to 3 nucleoli inside nucleus
- Disappears when cell divides
- Makes ribosomes that make proteins.

4- Smooth & Rough Endoplasmic Reticulum

- Smooth ER: no ribosomes makes lipids
- Rough ER: has ribosomes involved in making proteins.

5- Cell Powerhouse (Mitochondria)

- Rod shape
- Site of cellular respiration
- Active cells like muscles have more mitochondria to burn sugars to produce energy ATP.

7- **Surrounding the Cell (Cell Membrane)**

- Lies immediately against the cell wall in plant cells
- Made of protein and phospholipids
- Selectively permeable.
- Living layer
- Controls the movement of materials into and out of the cell.

8- Cell Wall

- Nonliving layer
- Gives structure and shape to plant and bacterial cells**.**

9- Cytoplasm of a Cell

- Jelly-like substance enclosed by cell membrane
- Provides a medium for chemical reactions to take place
- Contains organelles to carry out specific jobs examples: chloroplast & mitochondrion.

10- Nucleus

- Controls the normal activities of the cell
- Contain the DNA (chromosomes) bounded by a nuclear membrane
- Each cell has fixed number of chromosomes that carry genes
- Genes control cell characteristics.

Cell Membrane

The thin outside layer that surrounds a cell and controls the movement of materials into and out of the cell (fig.1).

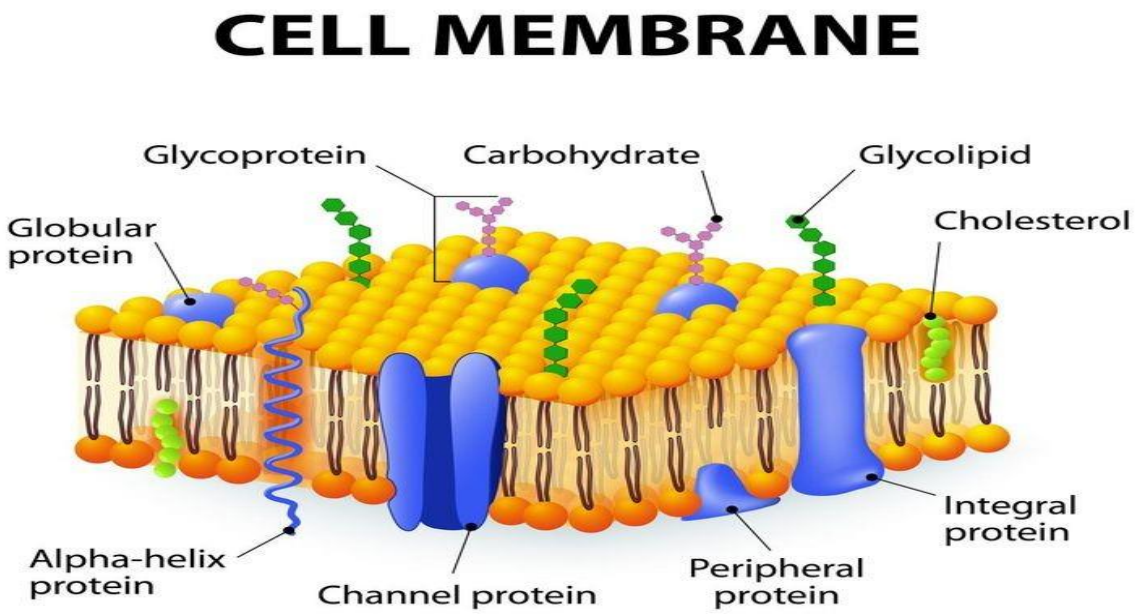


Figure 1: Cell membrane

Movement across cell membrane:

There are several ways in which substances can enter or leave a cell:

- Diffusion

The molecules moving from a high to low concentration and continues until equilibrium is reached. Many substances move across the membrane by diffusion.

Major examples of diffusion:

• Gas exchange at the alveoli - oxygen from air to blood, carbon dioxide from blood to air.

• Gas exchange for respiration - oxygen from blood to tissue cells, carbon dioxide in opposite direction.

- Osmosis

Diffusion of water through a semipermeable membrane. Effects of osmosis on cells (fig. 2).

Major examples of osmosis:

• Re-absorption of water by the proximal and distal convoluted tubules of the nephron.

• Absorption of water by the alimentary canal - stomach, small intestine and the colon.

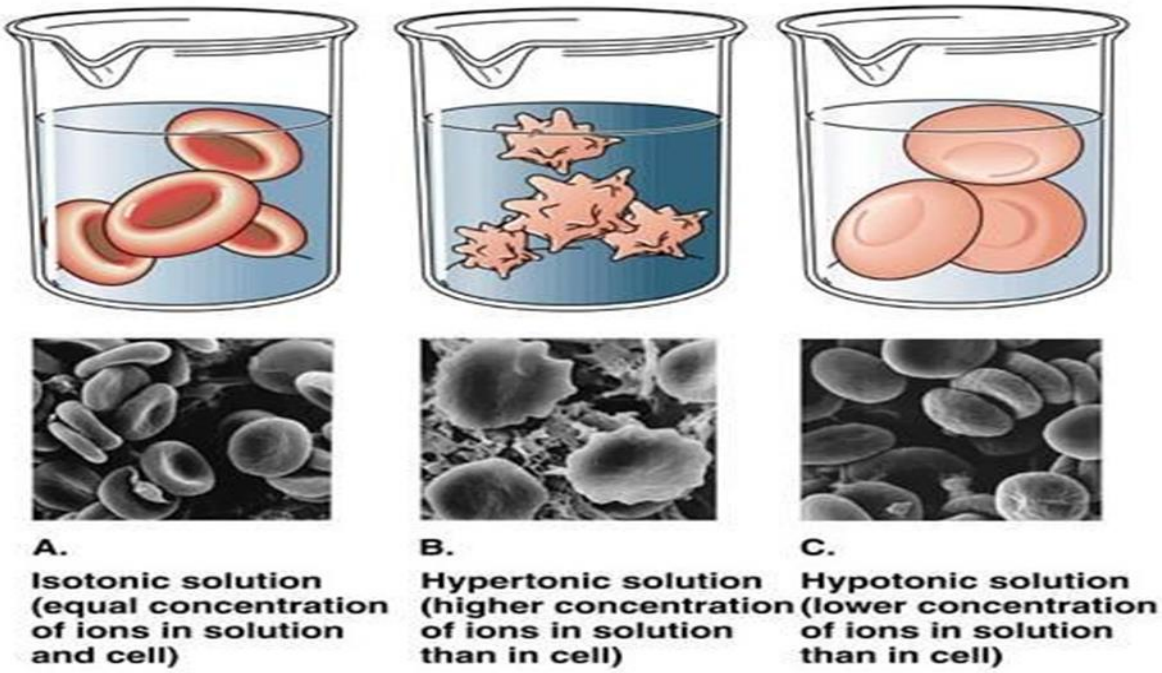


Figure 2: Effects of osmosis on cells

* Note: diffusion and osmosis are both passive, i.e. energy from ATP is not used.

- Passive transport

The movement of ions and other substances across cell membrane without the need of energy (fig. 3).

- Active transport

The use of energy to move substances across a membrane from low to high concentration (fig.3).

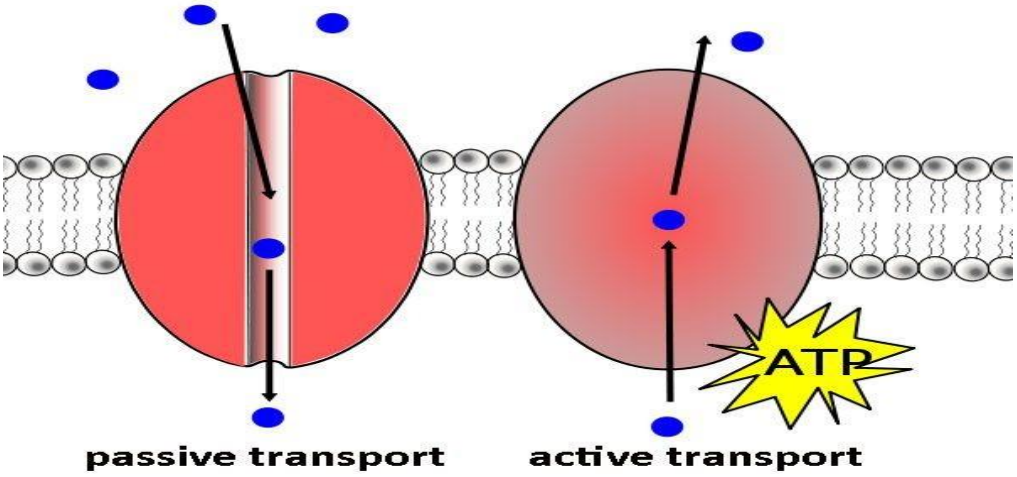


Figure 3: Active and passive transport

- Sodium potassium pump

A type of active transport that uses energy to move ions against its concentration gradient (fig. 4).

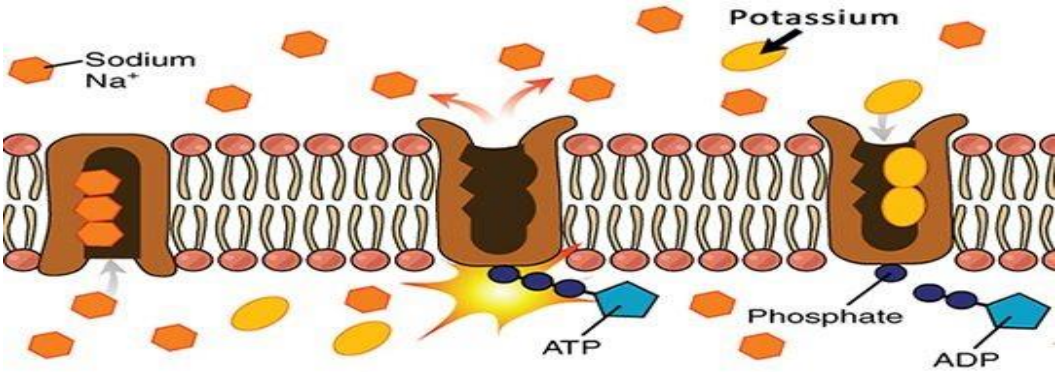


Figure 4: Sodium potassium pump

- Endocytosis

A process where a cells membrane folds inward to bring materials into the cell (fig.5).

- Exocytosis

The release of material within vesicles by fusing with the cell membrane (fig.5&6).

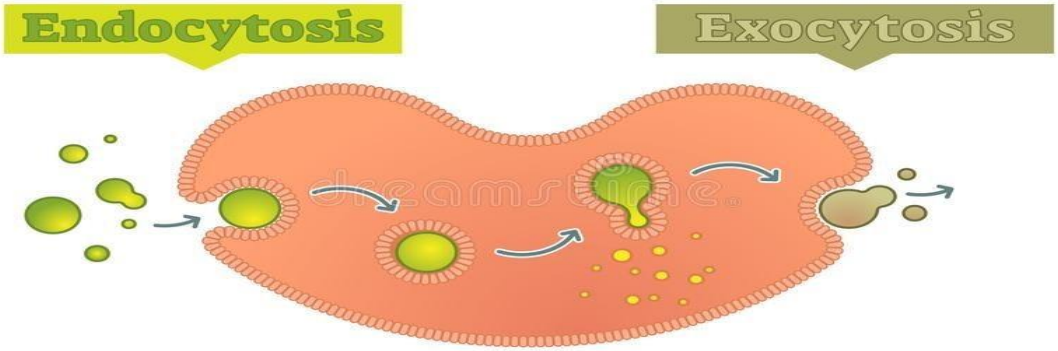


Figure 5: Endocytosis and exocytosis

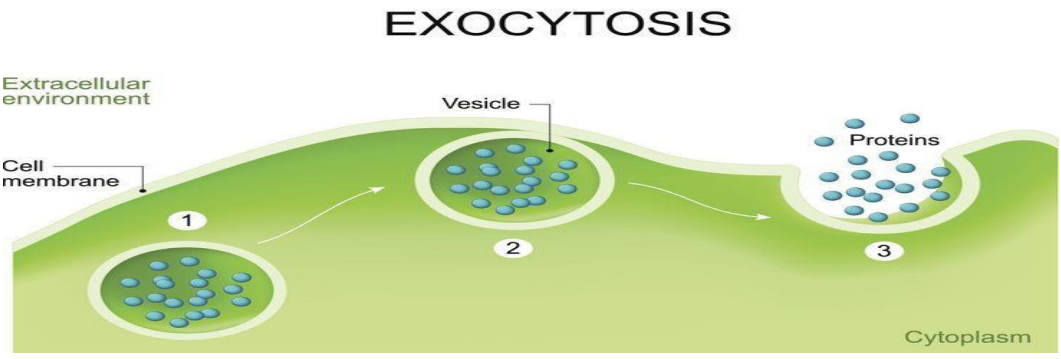


Figure 6: Endocytosis

- Pinocytosis ('cell drinking')

The ingestion of liquid into a cell by budding of small vesicles from the cell membrane (fig.7).

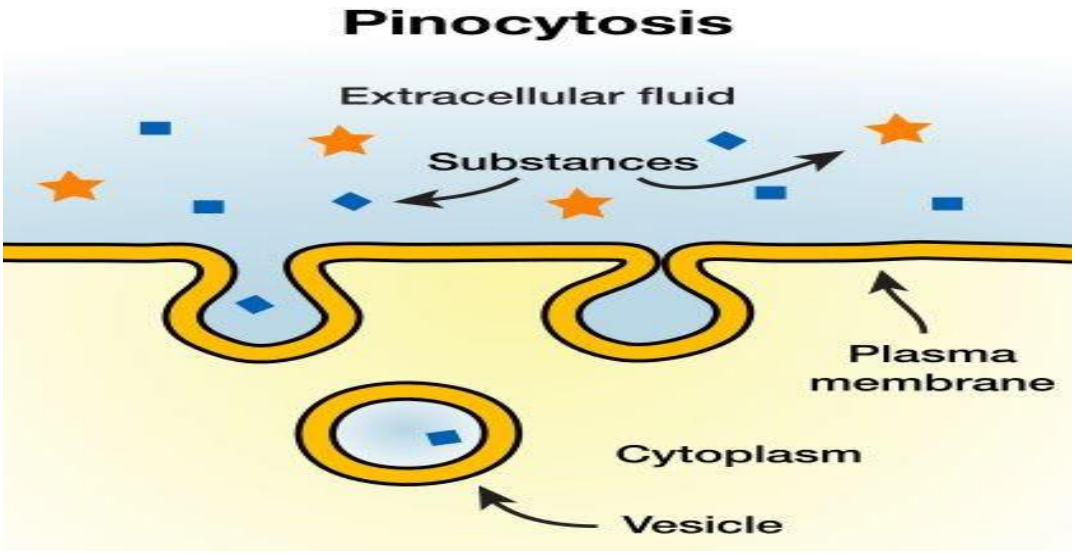


Figure 7: Pinocytosis

- Phagocytosis ('cell eating')

The process by which a cell engulfs practical's such as bacteria into cell (fig.8).

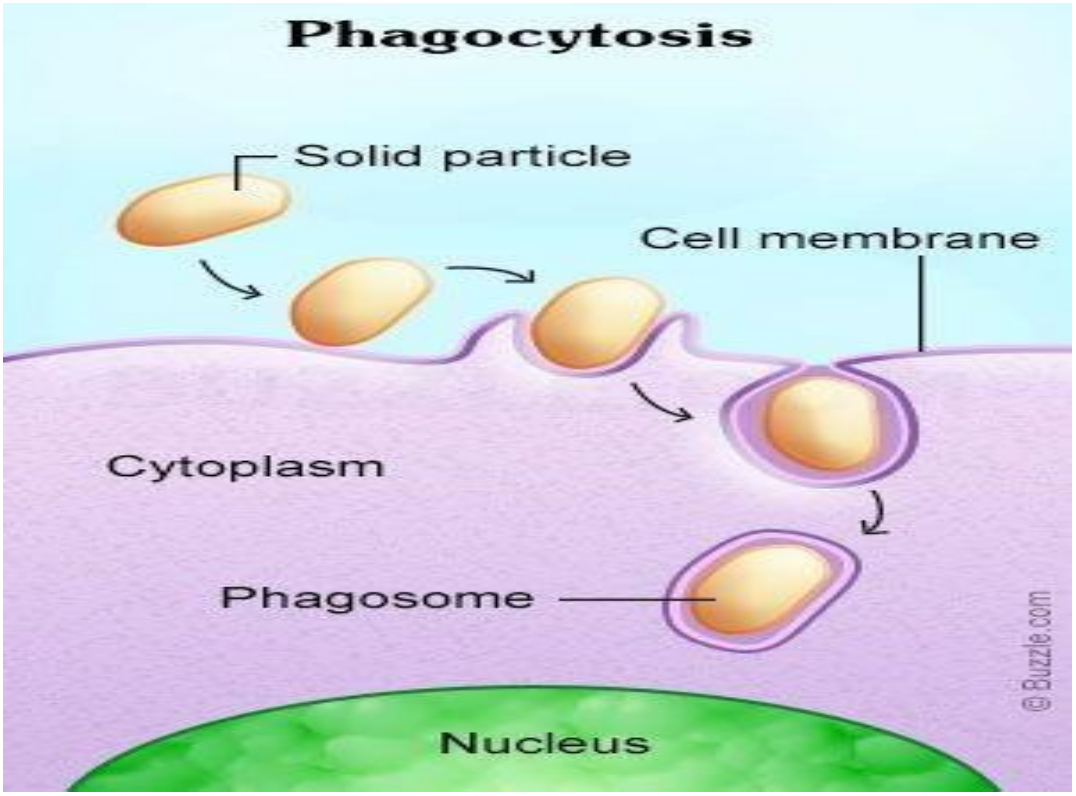


Figure 8: Phagocytosis

Nucleic acids (DNA & RNA)

Nucleic acids are polymers that consist of nucleotides carry on chromosomes located in nuclei of cell. There are two kinds of nucleic acids in cells:

1) Ribonucleic acids (RNA) **single helix**
2) Deoxyribonucleic acids (DNA) **double helix (**fig.1).

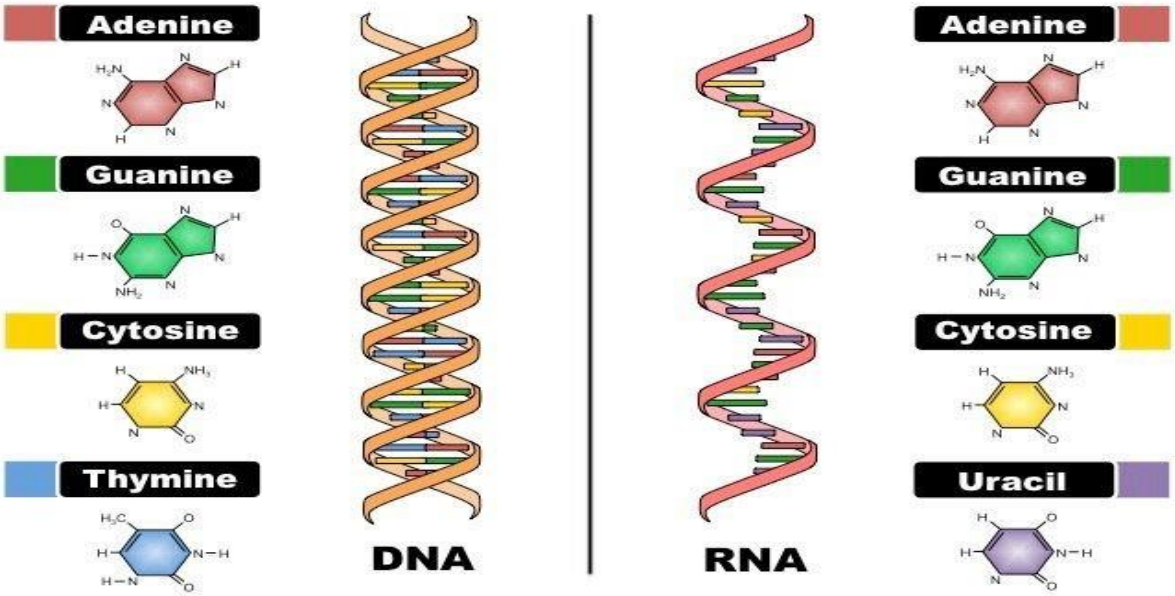


Figure 1: DNA & RNA

Gene

Segment of DNA that carries **codons** specifying for a particular polypeptide (fig.2).

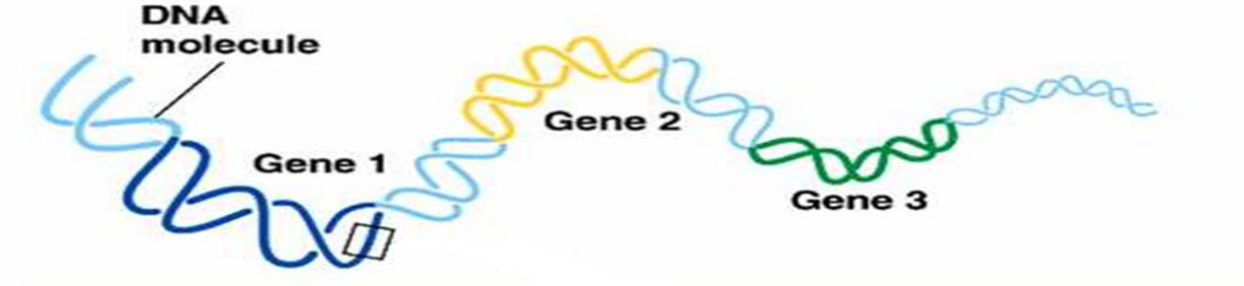


Figure 2: Genes

Both RNA and DNA are polymers built from monomers called nucleotides. A nucleotide is composed of:

- **Nitrogenous bases:**
  - Purines: adenine & guanine
  - Pyrimidines: cytosine, thymine (in DNA), & uracil (in RNA)
- **Pentose sugars:**
  - Ribose (found in RNA)
  - Deoxyribose (found in DNA)
- **Phosphate group** (fig.3&4).

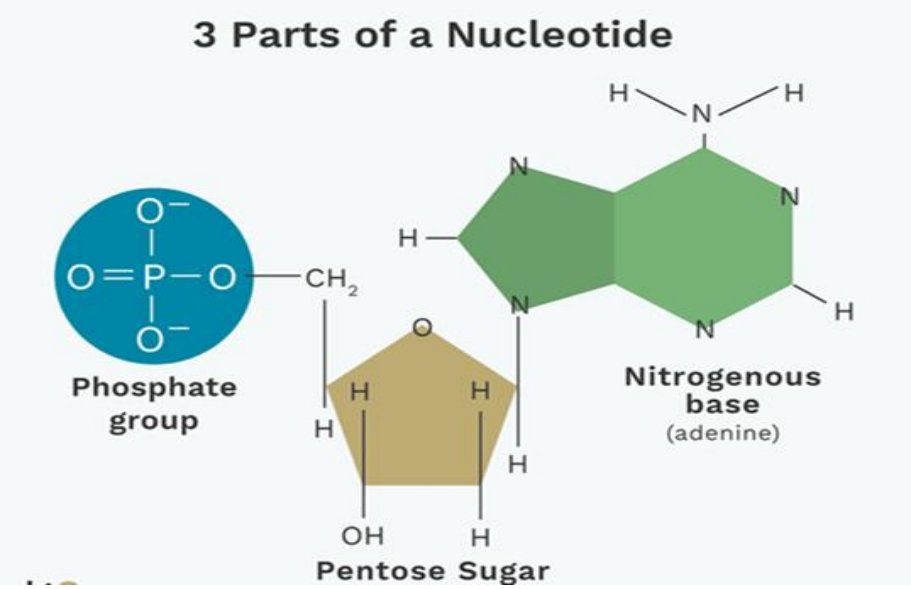


Figure 3: Parts of nucleotide

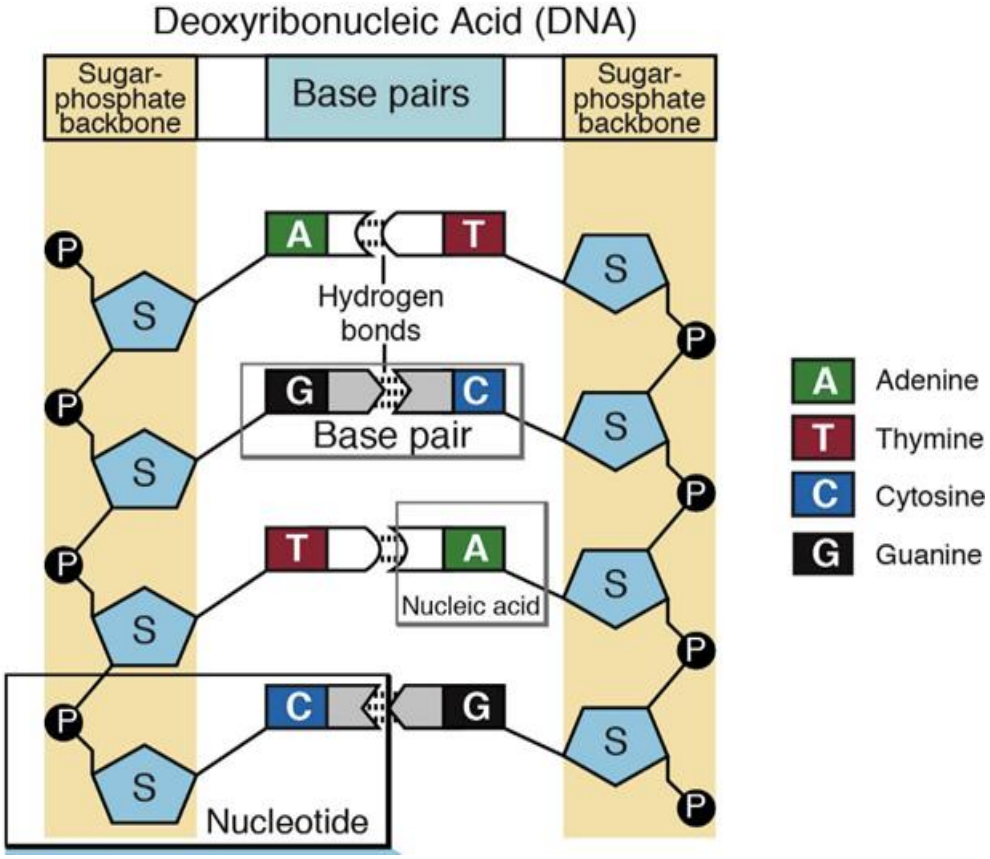


Figure 4: Nucleotides

DNA found in all living cells except RBC in the nucleus, while the RNA is in the cytoplasm. Bases in nucleic acids for DNA: A, G, C, T, and bases for RNA: A, G, C, U (fig.5).

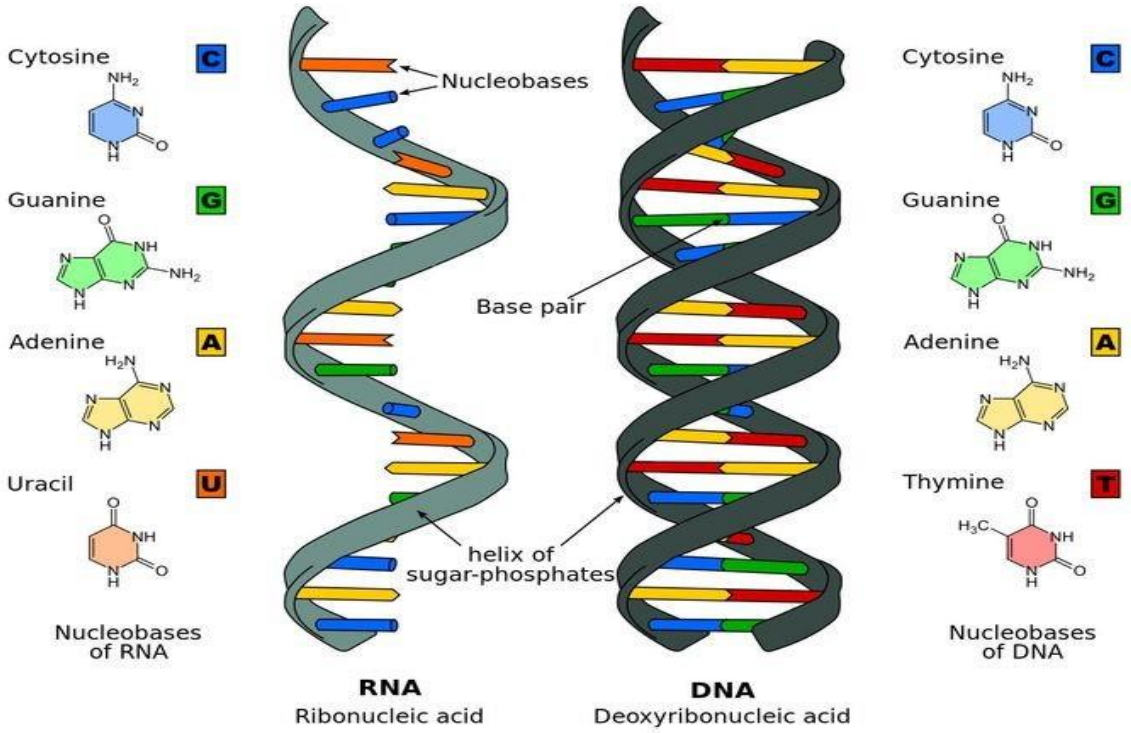


Figure 5: Structure of DNA &RNA

The three differences in structure between DNA and RNA are:

1- In DNA, the sugar is deoxyribose; in RNA, the sugar is ribose (fig.6).

2- The RNA contains the nitrogenous base uracil instead of thymine that is present in DNA.

3- DNA is always double stranded; there are several kinds of RNA, most of which are single-stranded (fig.5).

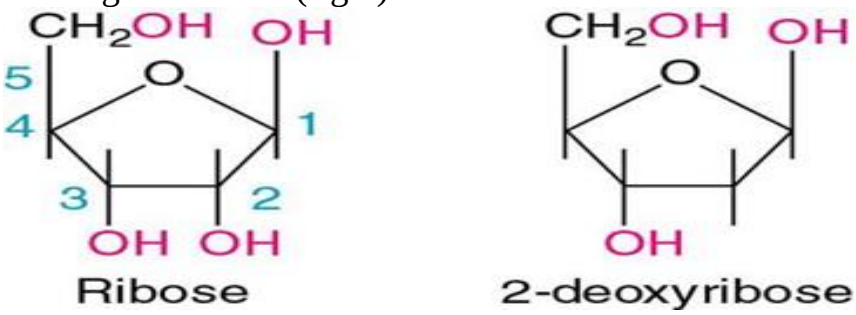


Figure 6: Pentose sugar in DNA and RNA

The double helix of DNA described by Francis Crick & James Watson early 1953. Watson and Crick discovered that held the two strands of DNA together by hydrogen bonds between nitrogen bases. Prokaryotic cells have a single circular DNA located in the cytoplasm and eukaryotic cells much more complex located in the nucleus in the form of chromosomes. The function of nucleic acids is carry the genetic information that necessary components and the actions of life.

Types of RNA

- **messenger** (mRNA): is like a genes encode proteins by transcribed into mRNA and translated into a protein.
- **ribosomal** (rRNA): is like a ribosomes, composed of rRNA and proteins (protein factories).
- **transfer** (tRNA): are like a transfers the genetic information carried in the mRNA into proteins.

Mutation

Variation in DNA caused by change in base sequence of DNA due to addition, deletion, or substitution of one or more bases in the nucleotide sequence of DNA (fig.7).

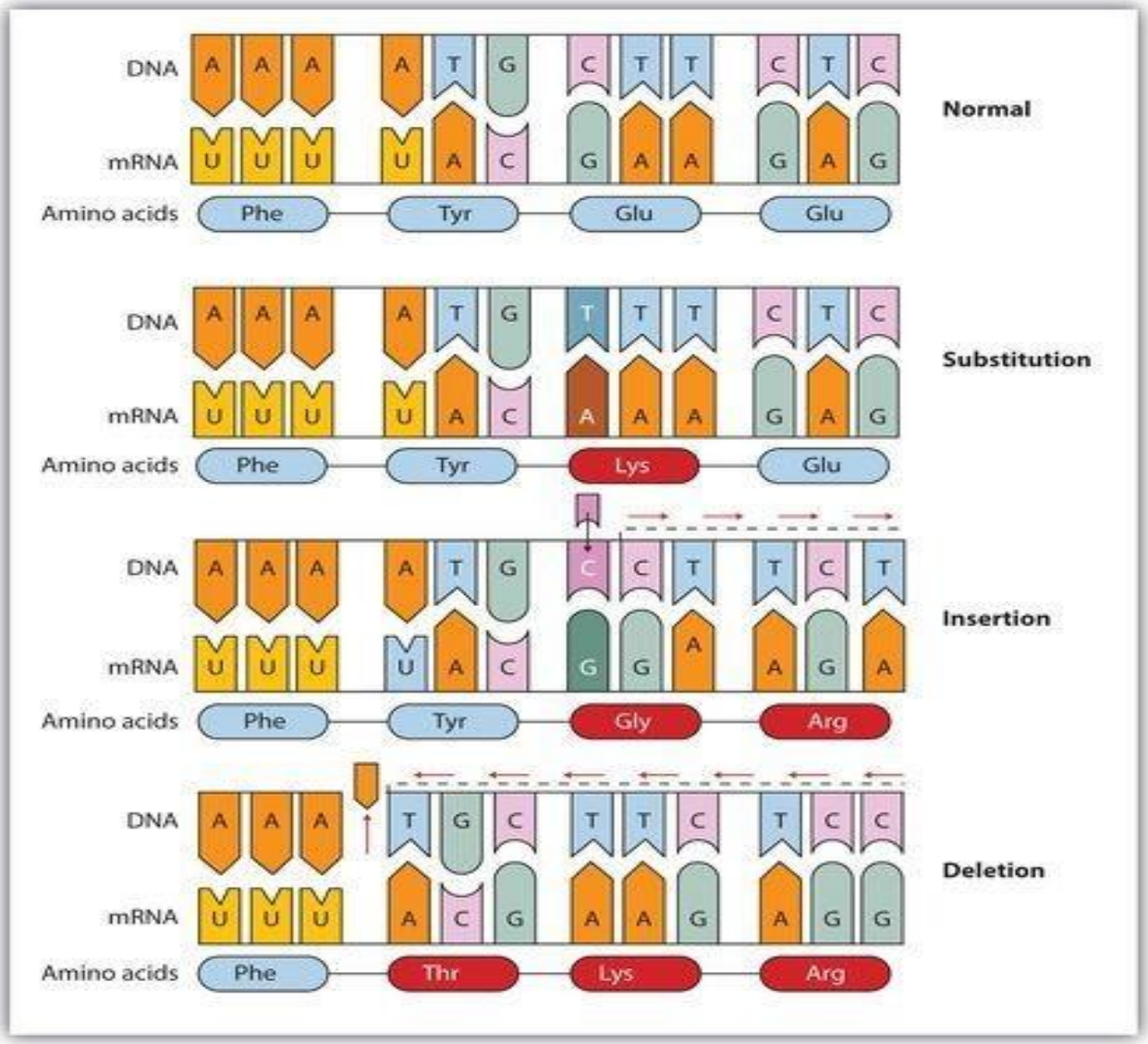


Figure 7: Types of mutations

The Basics of Mitosis & Meiosis

Cell division is the process by which a parent cell divides into two or more daughter cells. All eukaryotic cells store genetic information in chromosomes. Human cells have 46 chromosomes and 23 nearly identical pairs (fig.1&2).

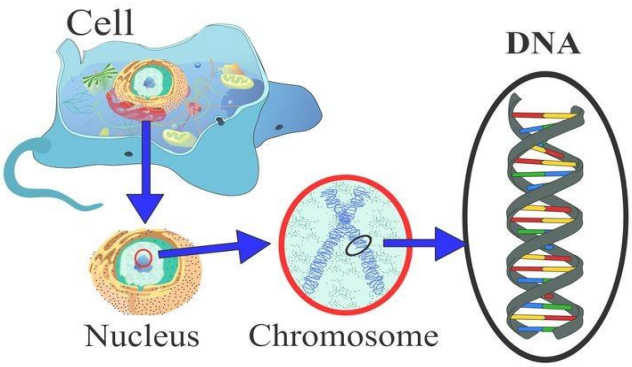


Figure 1: chromosome

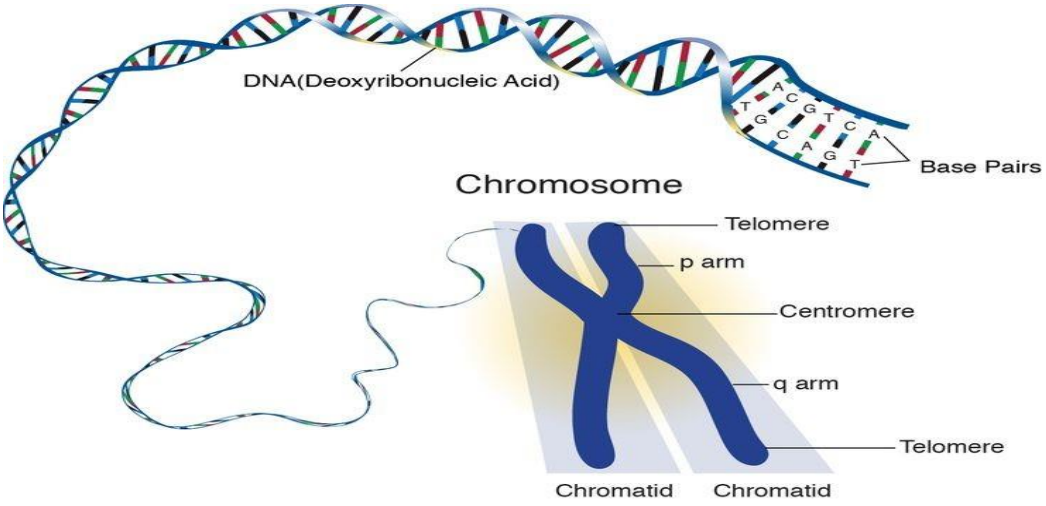


Figure 2: Chromosome structure

There are two kinds of cell division:

1. Mitosis: division of somatic cells (cells of the body) are diploid and this means that each cell has two chromosomes of each type. Biologists use "**2N**" to symbolize **diploid**.

2. Meiosis: creation of new sex cells (gamete cells). Gamete cells (egg & sperm) are haploid and this means that each cell has only one of each type of chromosome. Biologists use "**N**" to symbolize **haploid**.

Mitosis

Mitosis is the mechanism that allows the nuclei of cells to split and provide each daughter cell with a complete set of chromosomes during cellular division. Single cell divides to produce two identical daughter cells. Each daughter cell has the same number of chromosomes as the parent cell.

There are three main reasons for mitosis

1. Growth
2. Repair / healing
3. Asexual reproduction of unicellular (bacteria).

Cells division by mitosis

Some cells divide constantly: cells in the embryo, skin cells and gut lining cells. Other cells divide rarely or never include: brain cells, nerve cells, spinal cord cells and cardiac cells (heart muscle).

Characteristics of mitosis

1. A diploid cell will give rise to a diploid cell
2. Chromosome number remains the same
3. The DNA remains identically the same
4. One cell (2N) gives rise to two cells (2N).

During mitosis, the nucleus of the cell divides, forming two nuclei with identical genetic information. Mitosis is referred to in the following stages: interphase, prophase, metaphase, anaphase, telophase and cytokinesis (fig.3).

Interphase: DNA replicates

Prophase: Chromatin condenses into chromosomes/nuclear membrane breaks down

Metaphase: Chromosomes are lined up in the middle

Anaphase: Sister chromatids separate and migrate to opposite poles

Telophase: Chromosomes de-condense

Cytokinesis: Division of cytoplasm.

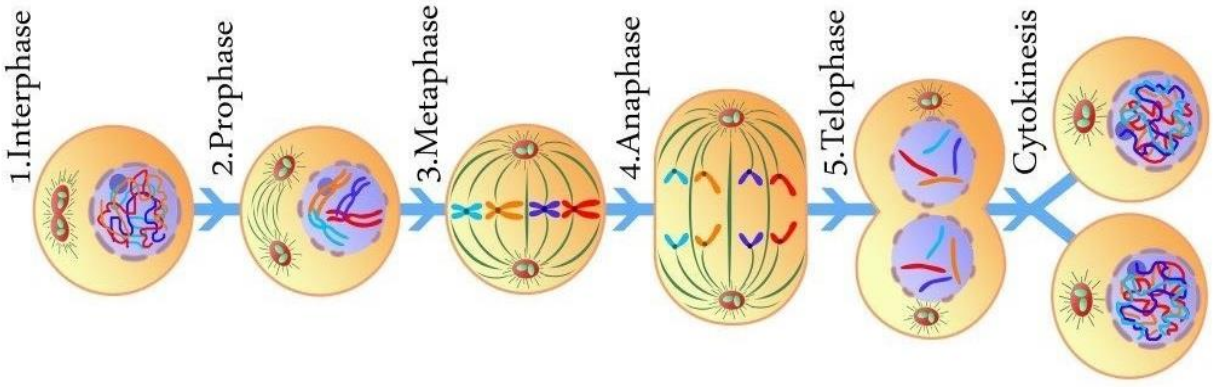


Figure 3: Mitosis stages

Meiosis

The form of cell division by which gametes, with half the number of chromosomes, are produced. Meiosis produce haploid gametes from a diploid parental cell. Gametes are genetically different from parent and each other. There are two meiotic divisions meiosis I and meiosis II.

There are three main reasons for meiosis

1. Allows sexual reproduction of diploid organisms
2. Enables genetic diversity
3. Aids the repair of genetic defects.

Cells division by meiosis

1. Sperm in males
2. Eggs in females.

Characteristics of meiosis

1. Occurs in sex cells (germ cells) and produces gametes
2. A reduction division resulting in haploid cells
3. Involves two sequential divisions resulting in four cells
4. Produces cells that are genetically different because of genetic recombination (crossing-over).

Meiosis I

Prophase I:

- Chromosomes condense
- Each pair contains four sister chromatids - tetrad
- Crossing over occurring.

Crossing over

Crossing over is one of the two major occurrences of meiosis in prophase I. During Crossing over segments of non-sister chromatids break and reattach to the other chromatid and the sites of crossing over called chiasma (fig.4). Each parent cell has pairs of homologous chromosomes, one homolog from the father and one from the mother.

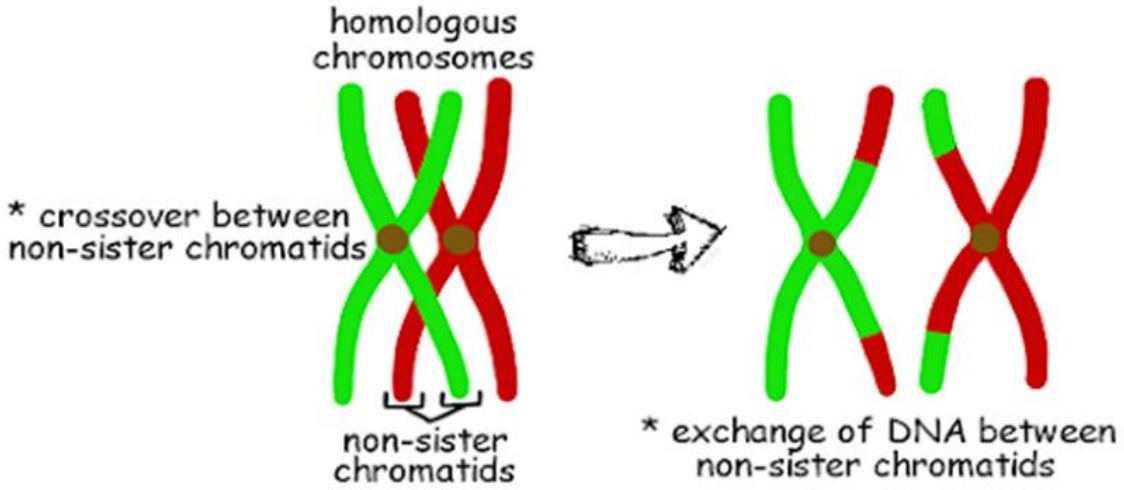


Figure 4: Crossing over in meiosis I

Metaphase I:

- Tetrads or homologous chromosomes move to center of cell.

Anaphase I:

- Homologous chromosomes pulled to opposite poles.

Telophase I:

- Daughter nuclei formed
- These are haploid (1n).

Meiosis II

Daughter cells undergo a second division that much like mitosis. The following meiosis II stages:

Prophase II: Spindle fibers form again

Metaphase II: Sister chromatids move to the center

Anaphase II: Centromeres split and individual chromosomes are pulled to poles

Telophase II & Cytokinesis: Four haploid daughter cells results from one original diploid cell. The main differences between mitosis and meiosis.

MITOSIS	MEIOSIS
• 1 cell division	• 2 cell divisions
• Produces body cells	• Produces sex cells
• Produces 2 daughter cells	• Produces 4 daughter cells
• Daughter cells are diploid **2N**	• Daughter cells are haploid **N**
• Daughter cells **identical** to parent cells.	• Daughter cells are genetically different from parent cell due to crossing over of chromosomes.

Biological Characteristics of Bacteria

Bacteria are prokaryotes cells usually unicellular, in structure and vary in sizes, measure approximately 0.1 to 10.0 μm.

Structure of bacteria

Essential structure:

- Cell wall
- Cell membrane
- Cytoplasm
- Nuclear membrane

Particular structure:

- Capsule
- Flagella
- Pili
- Spore (fig. 1).

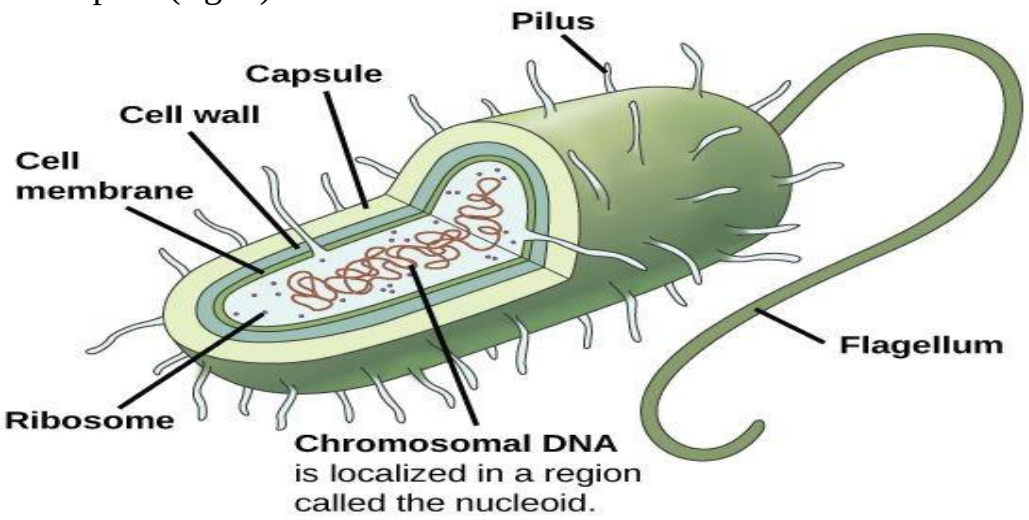


Figure 1: Bacteria structure

Bacterial cells morphology

The three basic bacterial shapes are coccus (spherical), bacillus (rod-shaped), and spiral (twisted).

1. Cocci (or coccus for a single cell) are round bacteria
2. Bacilli (or bacillus for a single cell) are rod-shaped bacteria
3. Spirilla (or spirillum for a single cell) are curved bacteria (fig.2).

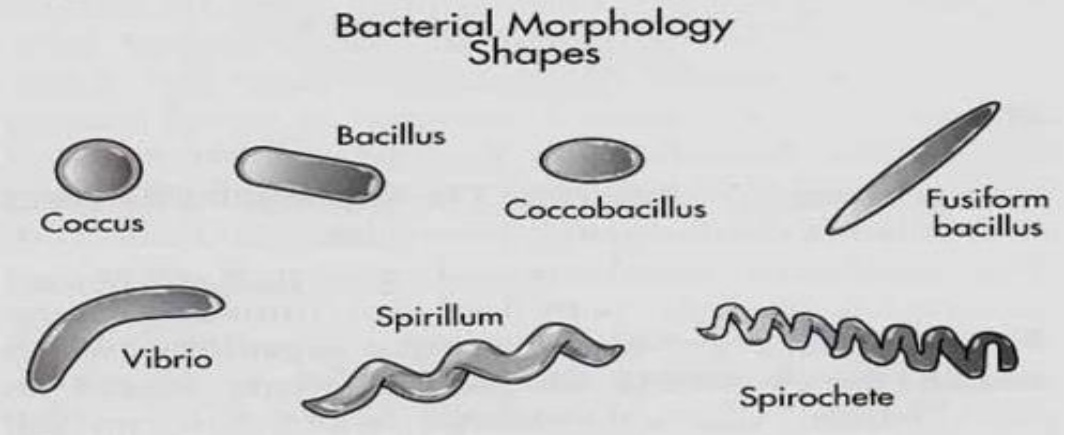


Figure 2: Bacterial morphology

Bacterial growth

The bacteria are single-celled organisms that reproduce by simple division, i.e. binary fission. Bacterial growth is an increase in the number of bacteria in a population rather than in the size of individual cells. The time that required for the parent cell splits into two daughter cells with approximately equal size called generation time.

Steps of binary fission

1. Bacterial cell first can been seen to enlarge or elongate
2. Then followed by the formation of transverse membrane and new cell wall
3. The new membrane and cell wall grow inward from the outer layers
4. The cell divided into two daughter cells (fig.3).

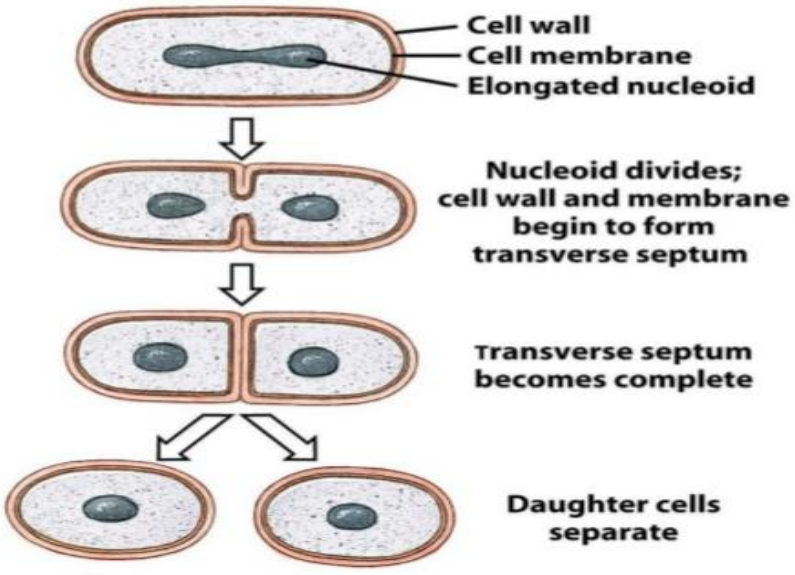
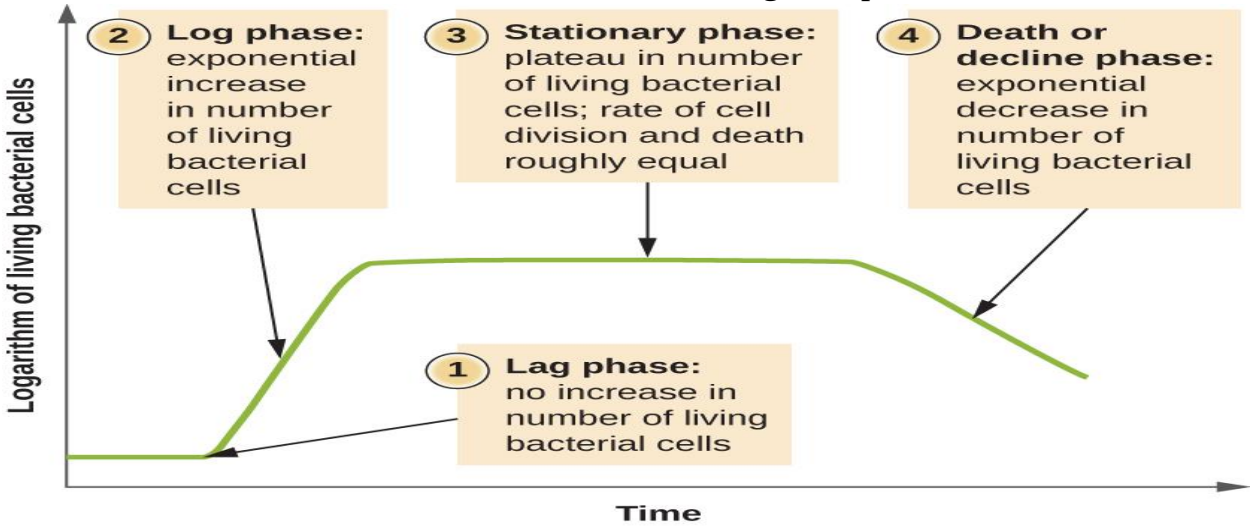


Figure 3: Binary fission

Growth curve of bacteria

Growth of bacteria in fresh medium show following four phases:



Arrangement of bacteria

Variety of arrangement of cells is observed in cocci and rod shape bacteria.

II: Arrangement of cocci cells:

1. Singly: cocci cell appear individually then simply it is called cocci.
2. Diplococci: two cells are attach to each other even after dividing them in one plane is called as diplococci.
3. Streptococcus: cocci cells are arranged in long chain and remain attach to each other even after dividing them in one plan is called as streptococcus.
4. Staphylococcus: cocci cells arranged in form of a cluster even after dividing them in three plane then these cocci cells are called staphylococcus (fig. 4).

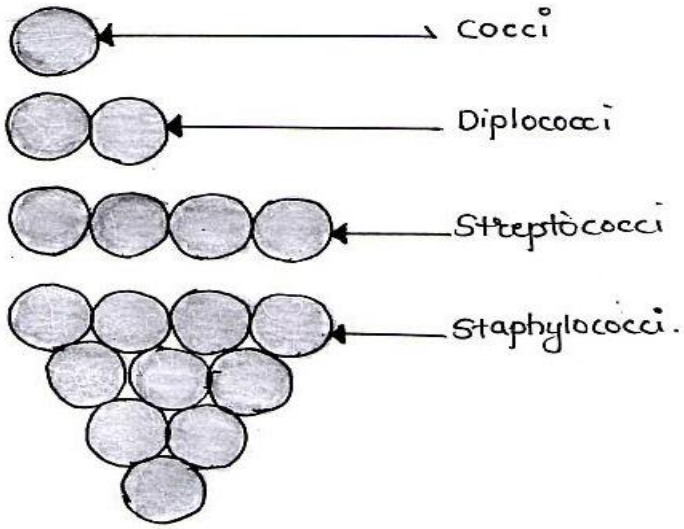


Figure 4: Arrangement of cocci cells

II: Arrangement of rod shape bacteria:

Bacillus cells show very less variety in arrangement of cells as these cells can be divided only in one plane.

1. Single cell: only one cell exist it is called as bacilli.
2. Diplobacilli: two bacilli cells are attach to each other it is called as diplobacilli.
3. Streptobacilli: bacilli cells are arranged in the form of long chain it is called as streptobacilli (fig. 5).

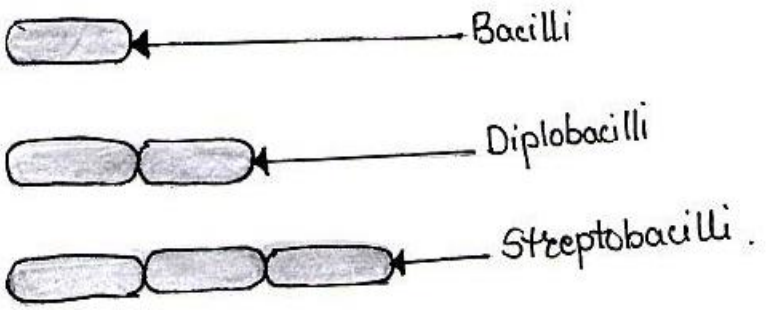


Figure 5: Arrangement of rod shape bacteria

Biological Characteristics of Protozoa

Protozoa are eukaryotic unicellular microorganisms located in most moist habitats. Most protozoa are asexual and reproduce in one of three ways: fission, budding, and multiple fission. Protozoa help in continuing the equilibrium of bacterial, algal and other microbial life forms.

Characteristics of protozoa

Protozoa vary in size and shape because do not have a cell wall and therefore can have a variety of shapes. Their sizes range from 10 to 55 micrometers, but they can be as large as 1 mm. Protozoa prefer living in moist and aquatic habitats. The life cycle of protozoa changes between proliferative stages and dormant cysts. The mode of nutrition of protozoa is heterotrophic, and most species obtain food by phagocytosis. Based on the mode of locomotion, protozoa have been divided into four types (fig.1).

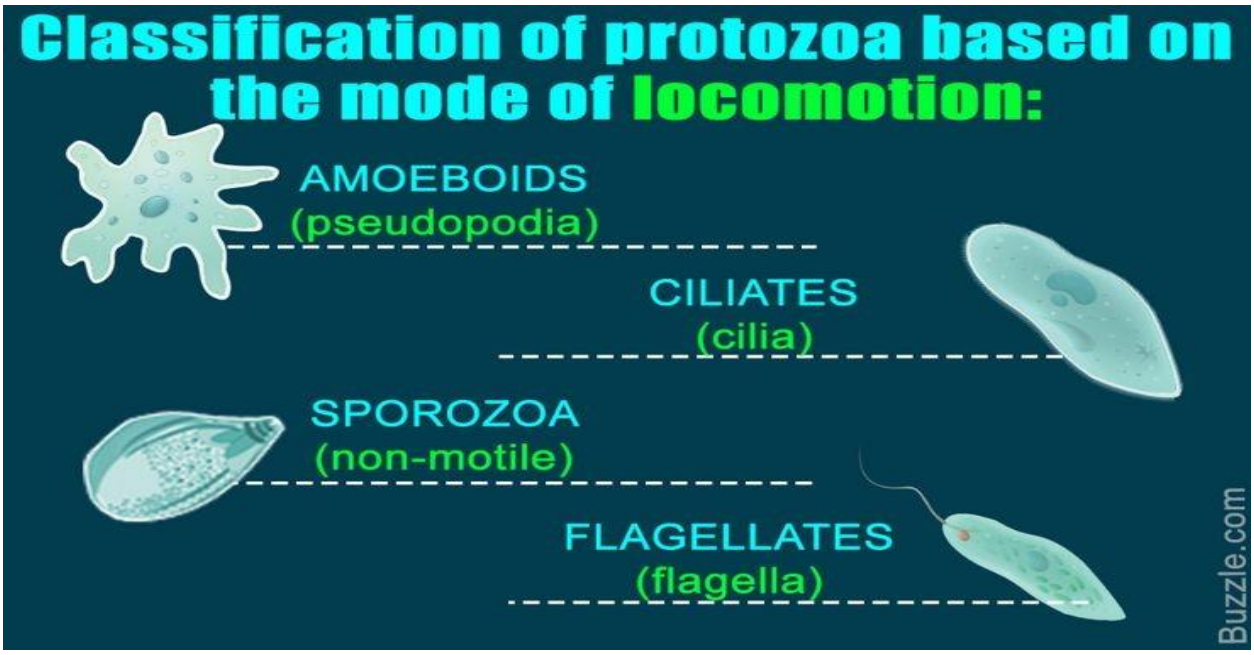


Figure 1: Classification of protozoa

1- An ameba is capable of changing its shape, mainly by extending and retracting pseudopods. They are found in the soil and in aquatic habitats and move by using pseudopods. They typically ingest their food by phagocytosis (fig. 2).

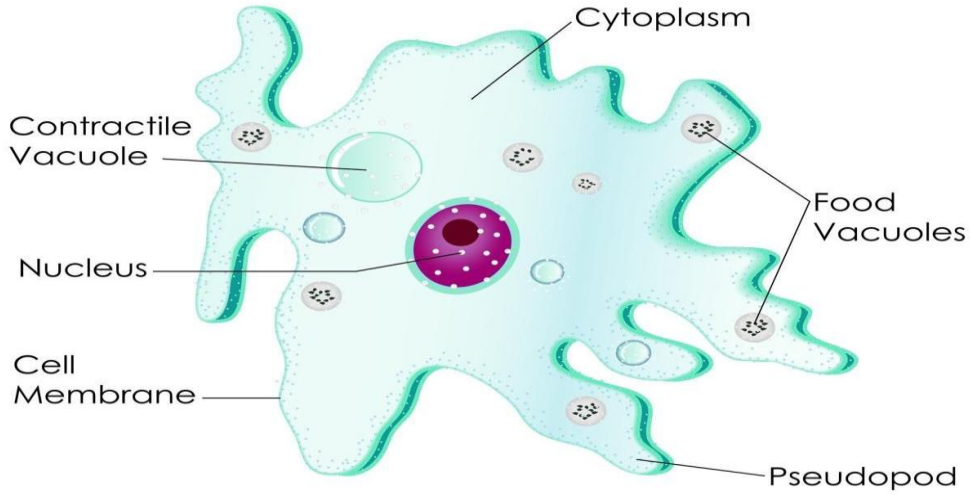


Figure 2: Ameba structure

2- Flagellates are organisms which have one or more whip-like organelles called flagella. They may be solitary, colonial, free-living or parasitic. Parasitic forms live in the intestine or bloodstream of the host. An example of a parasitic flagellate is Trypanosoma (fig. 3), which has an interesting life cycle as it uses two hosts; humans and tsetse fly.

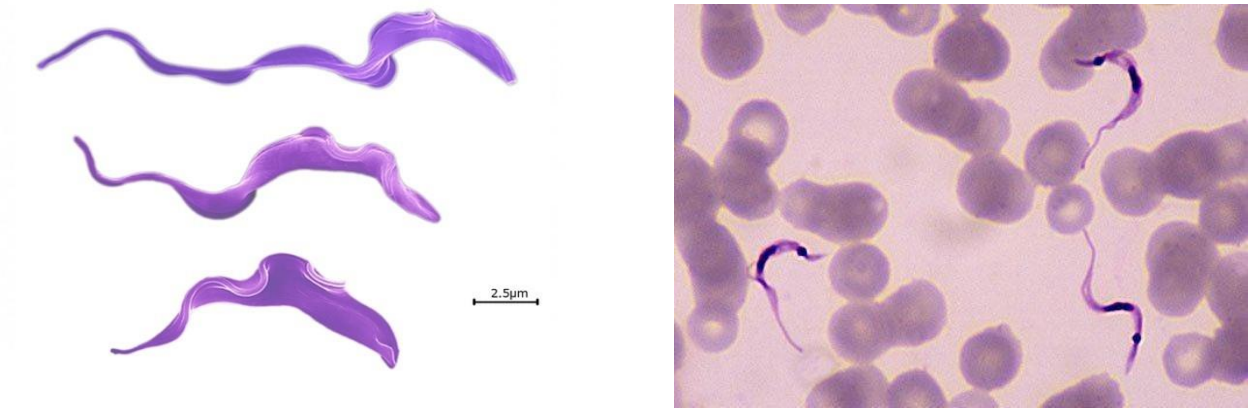


Figure 3: ***Trypanosoma brucei***

3- Ciliates The ciliates are protozoans which possesses hair-like organelles called cilia used in swimming, crawling, attachment, feeding, and sensation. Most ciliates are heterotrophs eat bacteria and algae. They sweep the food by their modified oral cilia into their oral groove (mouth) figure (4).

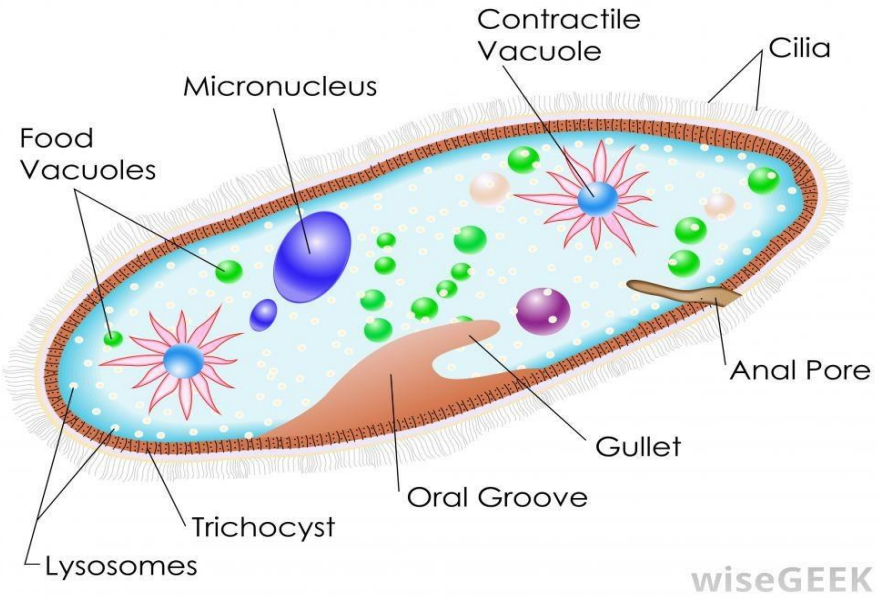


Figure 4: Ciliate protozoa

4- Sporozoans are non-motile, unicellular protists, usually parasites. These protozoans are also called intracellular parasites. An example is *plasmodium vivax* (fig. 5) that causes malaria in humans.

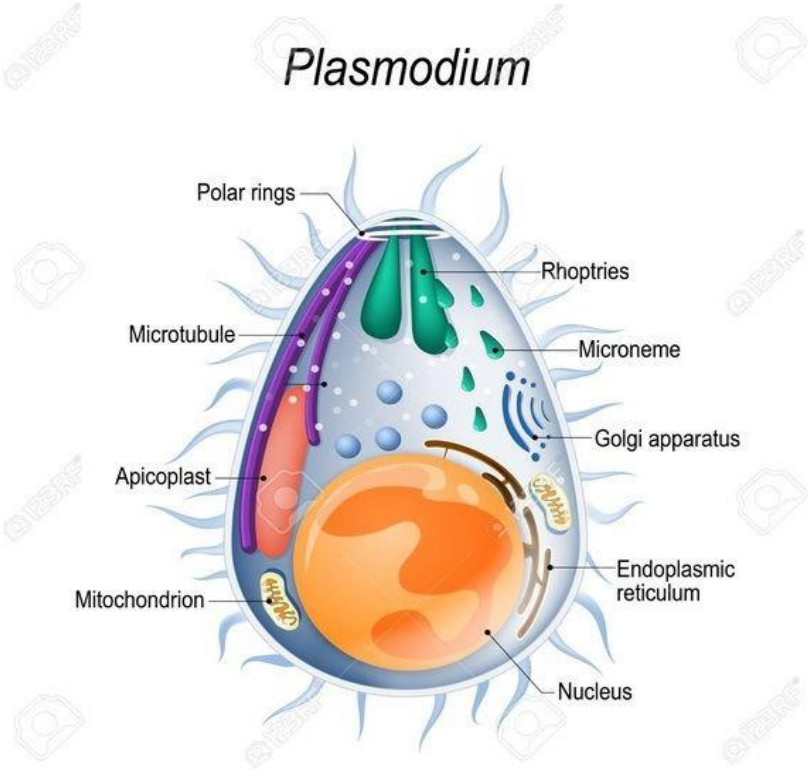


Figure 5: Plasmodium structure

Some facts

- *Trypanosoma brucei* causes the African sleeping sickness and *Giardia* causes diarrhea, and they are flagellates.
- *Trichomonas vaginalis* a sexually transmitted flagellate that can induce urogenital symptoms in infected women.
- *Plasmodium* is the cause of malaria in humans.