BIOLOGY

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General Objective

In this educational bag you will learn about:

- Providing the basic concepts about human body
- To provide the students with the biological grounding upon which the practice of dentistry rests.
- It is an introduction to the anatomy and physiology of the human body in particular the teeth and oro-facial regions.
- It serve as an introduction to various fields of human biology, such as molecular science, parasitology, histology, immunity, and microbiology.

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Introduction of Medical and Oral Biology
Prokaryotes and Eukaryotes

Lecture (1 and 2)

OBJECTIVE

This lecture has been designed to learn about the basic concepts in medical biology.

Pre-test Quiz

Define oral biology

Introduction to Medical and Oral Biology

Human biology is the study of all aspects of the human organism including evolution, genetics, ecology, anatomy and physiology, development, anthropology, and nutrition, among others.

Medical biology is the branch of human biology related to cellular and genetic causes of major medical disorders such as cancer, autoimmune diseases, genetic disorders, as well as develop your knowledge of stem cell biology, and how major human diseases develop and explore the various ways in which medical disorders can be treated.

Oral Biology is the branch of dentistry that includes the study of embryology (pre and post-natal growth), oral physiology, gross anatomy, histology and development with special emphasis on study of dental hard and soft tissue (enamel, dentin, pulp and periodontium) and extraoral structures (salivary glands and TMJ).

The cell biology: is a field of biology that focuses on understanding the composition, behavior, and structure of cells.

A cell is the smallest structure that possesses all the characteristics of life matter, is capable of maintaining these characteristics on its own, and transmits it to later generations.

The Cell-theory Hypothesis: Cells are the fundamental building block of life, making up every living thing, and they can only be created by other cells. They may be unicellular or multicellular. Cell theory was proposed by German scientists Theodor Schwann, Matthias Schleiden, and Rudolph Virchow.

The original version of the cell Theory states:

1. The cell is the basic unit of life.
2. All living organisms are composed of cells. They may be unicellular or multicellular.
3. Cells arise from pre-existing cells. (They are not derived from spontaneous generation.)

The modern version of cell theory states:

1. Energy flows within the cells.
2. Hereditary information (DNA and nucleic acids) is passed on from parents to daughter cells or between cells without replication or division.
3. The basic biochemical composition of all cells is the same.

Cell Components: **a cell consists of main parts:**

1. **The cell membrane**: is found in all cells and separates the interior of the cell from the outside environment.
2. **The nucleus**: is the membrane-enclosed organelle within a cell that contains the chromosomes.
3. **The cytoplasm:** is the gelatinous liquid that fills the inside of a cell.

Cell Components: a cell consists of main parts:

4. The Organelles: is a subcellular structure that has one or more specific jobs to perform in the cell.

i. **Mitochondria** are called the powerhouses of the cell as they produce energy-rich molecules for the cell.

ii. **Ribosomes** are non-membrane-bound and important cytoplasmic organelles found in close association with the endoplasmic reticulum.

4. The Organelles: is a subcellular structure that has one or more specific jobs to perform in the cell.

iii. Golgi apparatus is also termed as **Golgi complex**. It is a membrane-bound organelle, which is mainly composed of a series of flattened, stacked pouches called cisternae. This cell organelle is primarily responsible for transporting, modifying, and packaging proteins and lipids to targeted destinations.

4. The Organelles: is a subcellular structure that has one or more specific jobs to perform in the cell.

iv. **Cytoskeleton**: It is a continuous network of filamentous proteinaceous structures that run throughout the cytoplasm.

v. The **centrosome organelle** is made up of two mutually perpendicular structures known as centrioles.

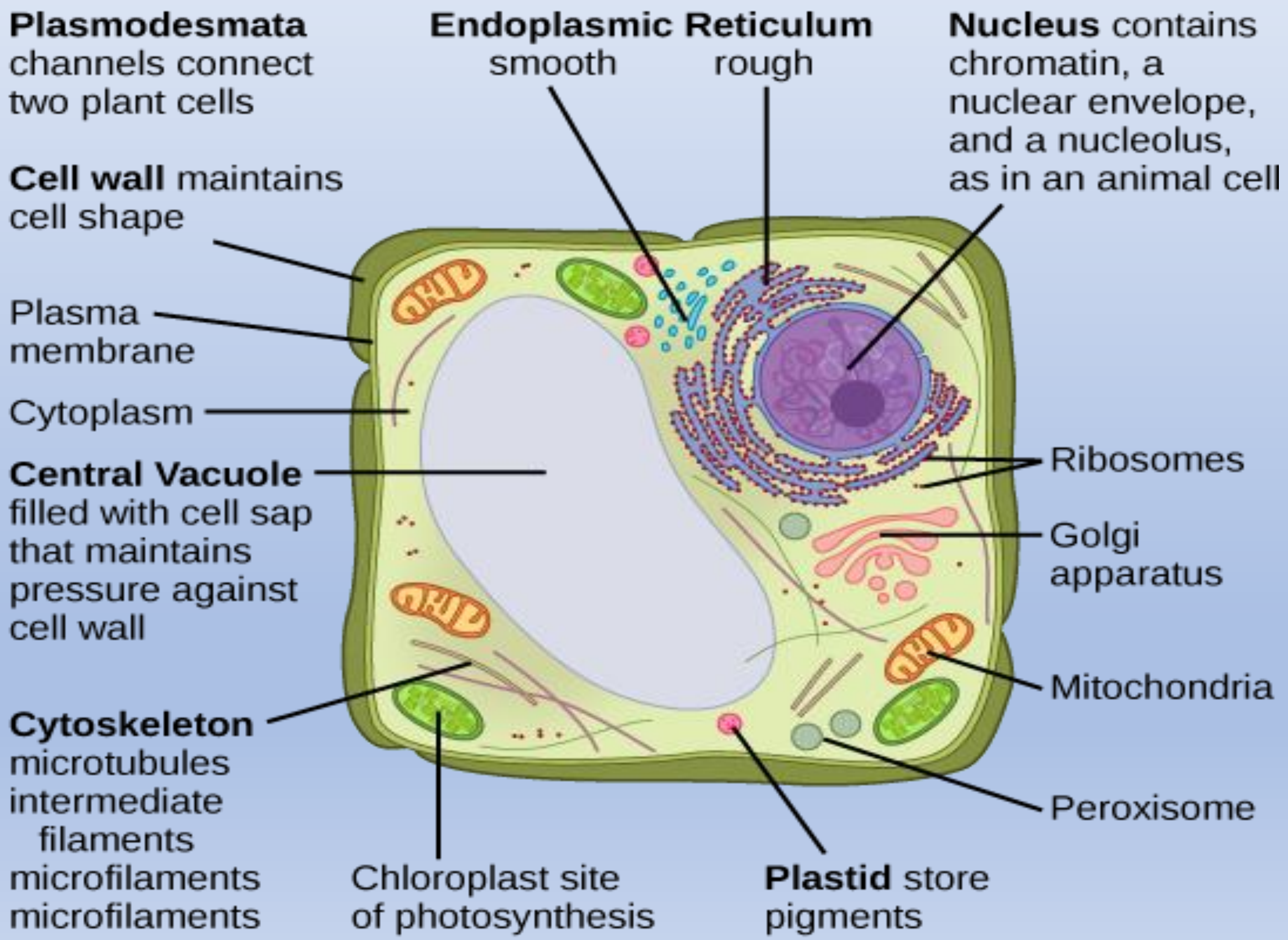
4. The Organelles: is a subcellular structure that has one or more specific jobs to perform in the cell.

vi. Endoplasmic Reticulum: is a network of membranous canals filled with fluid.

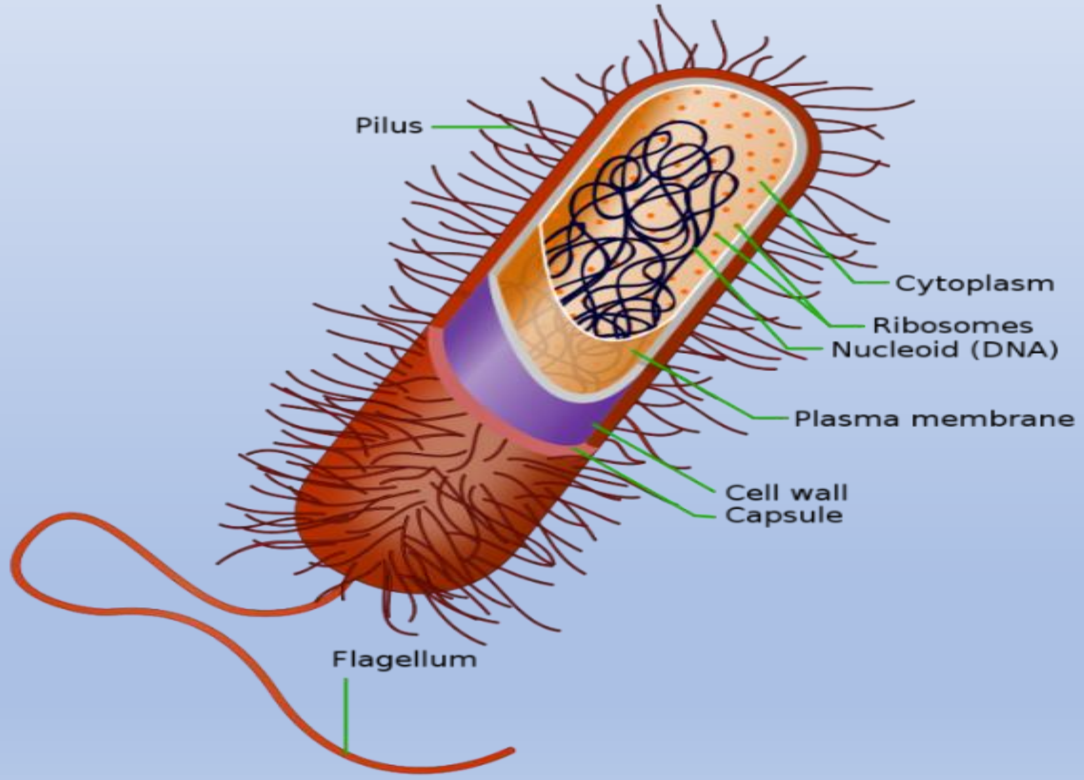
a. **Rough Endoplasmic Reticulum**: involved in protein manufacture.

b. **Smooth Endoplasmic Reticulum:** associated with the production of lipids, steroids, and also responsible for detoxifying the cell.

Eukaryotes have a true nucleus enclosed within the nuclear membrane and form large and complex organisms.



Prokaryotes are single-celled organisms do not have true nucleus but have nucleoid region that belonging to the domains Bacteria and Archaea.



The comparison between **prokaryotic** and **eukaryotic cells**

Feature	**Eukaryotic Cell**	**Prokaryotic Cell**
Nucleus	**Yes**	**No instead presence of Nucloid**
Cell Size	Larger (10-100 μm)	Smaller (0.1-5 μm)
Genetic material	Circular DNA present in cytosol as free material	DNA in the form of linear chromosome present in well-defined double membrane nucleus, no direct connection with cytosol
Presence of Mitochondria	Yes	No
Organelles	No membrane bound organelles	Membrane bound organelles with well-defined function.
Example Organisms	Plants, Fungi, Protists, Animals	Bacteria, Archaea

Both types of cells have the similarities:

1. Both types of cells carry on all the necessary functions of life
2. Both cells carry DNA (genetic information in an organism)

Post-test Quiz

Give The modern version of cell theory

GENERAL AND ORAL IMMUNITY

LECTURE (3)

Objective: this lecture learn about immunological processes in the human body

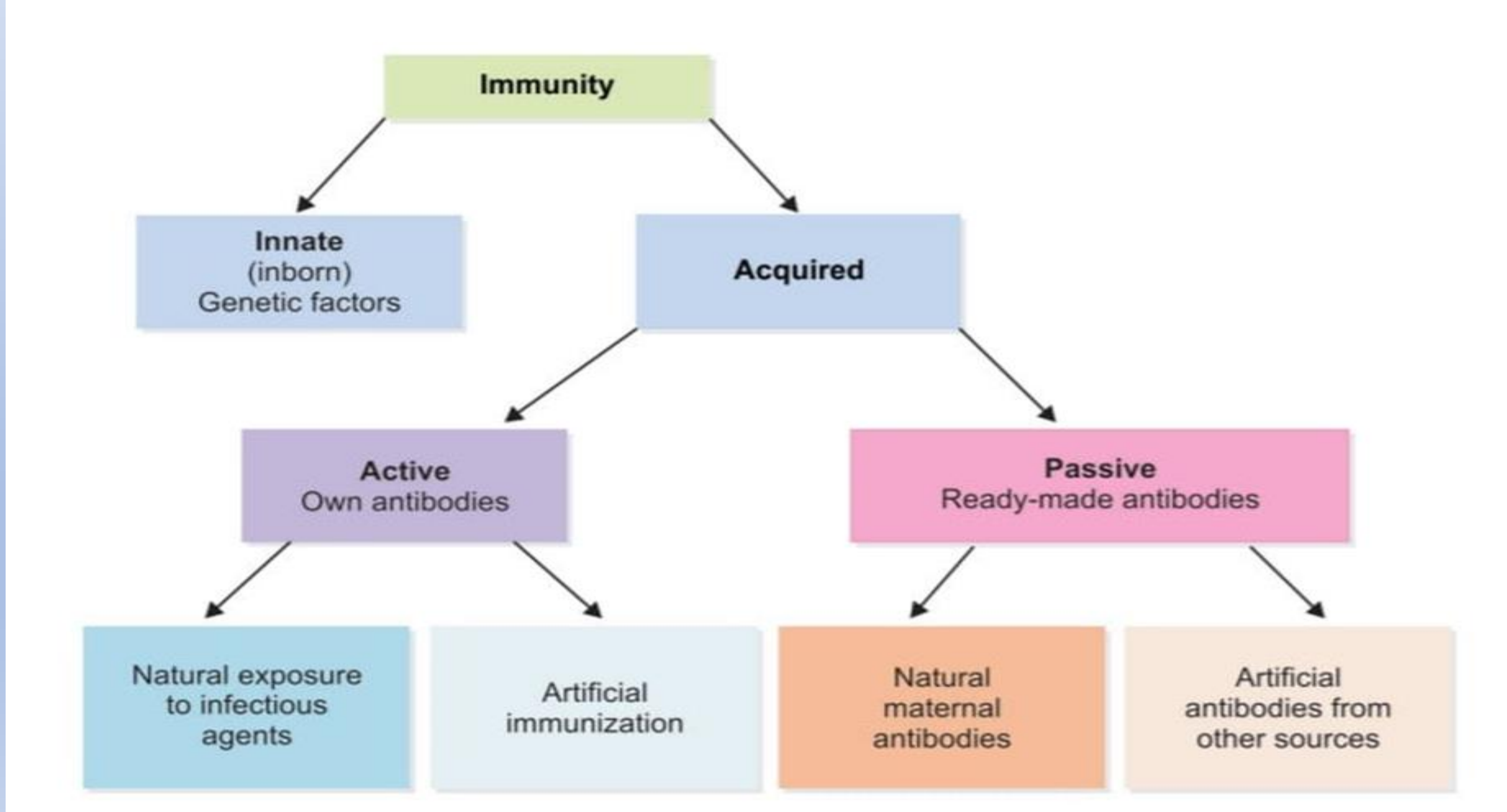
Pre-test Quiz

Define Immunization

Immunity: all of the physiological mechanisms that enable an individual's body to recognize materials as foreign and to neutralize, eliminate, or metabolize them without injury to its own tissue.

The immune system refers to a collection of cells, chemicals and processes that function to protect the body from foreign antigens, such as microbes (bacteria, fungi, parasites and viruses) as well as cancer cells, and toxins.

Immunization is the deliberate exposure of a person to a pathogen in order to provoke an immune response and the formation of memory cells specific to that pathogen.



1. **Innate immunity or Non-specific immunity**: is the first immunological mechanism for fighting against an intruding pathogen. It is a rapid immune response, initiated within minutes or hours after aggression, that has no immunologic memory. Including the physical, chemical and biological barriers such as the skin, the flushing action of tears and saliva, the gastrointestinal and respiratory tract.
2. **Adaptive immunity or Specific immunity**: is antigen-dependent or antigen-specific; it has the capacity for memory, which enables the host to mount a more rapid and efficient immune response upon subsequent exposure to the antigen.

The comparison between adaptive and innate immunity

	Innate (non-specific)	Adaptive (specific)
Line of Defense	First	Second
Timeline	Immediate response (0 -96 hours)	Long term (>96 hours)
Antigen Dependency	Independent	Dependent
Cells	Natural killer cells, macrophages, neutrophils, dendritic cells, mast cells, basophils, eosinophils	T and B lymphocytes

Acquired can be subdivided into two types:

1. **Passive immunity** is the immunity transferred from one individual to another.
2. **Active immunity** is the immunity which acquired by infection or immunization.

The comparison between Active and innate immunity

	Active	**Passive**
Source	Self	some other human or lower animal
Effectiveness	High	Moderate –low
Method	• Disease itself • immunization by Killed, attenuated or toxoids vaccine	• Maternal trans-placental • transfer of Abs
Time develop	5-14 days	Immediate on injection
Duration	Relatively long, years	Immediate on injection

There are two main mechanisms of immunity within the adaptive immune system – humoral and cellular

1. **Humeral immunity**: the protective function of immunization could be found in the humor (fluid or serum).
2. **Cellular immunity**: the protective function of immunization was associated with cell.

Cell mediated immunity (CMI): is the immunity that depends on T lymphocytes and phagocytic cells.

Immunoglobulin's Igs (antibodies) they are soluble glycoproteins that recognize and bind to Antigens (Ags) present in the serum, tissue fluids, or on cell membranes. They are secreted by **plasma cells** that include (IgG, IgM, IgA, IgE, and IgD).

Antigen presenting cells (APC): Specialized cells (macrophages, dendritic cells, and some B cells) that they **digest** the antigen and **present it** to other specialized cells

1. **White Blood Cells (Leucocytes).**

2- Platelets or thrombocytes.

3- mast cell.

4- NK Cells.

5- Dendritic cell.

Antigen presenting cells (APC): Specialized cells (macrophages, dendritic cells, and some B cells) that they **digest** the antigen and **present it** to other specialized cells

1. White Blood Cells (Leucocytes)

A. A granulocyte: are a type of white blood cell that has not large cytoplasmic granules and non-lobed nucleus.

B- Granulocytes or Ploymorphonuclear (PMN) are a type of white blood cell that has large cytoplasmic granules and lobed nucleus.

Antigen presenting cells (APC): Specialized cells (macrophages, dendritic cells, and some B cells) that they **digest** the antigen and **present it** to other specialized cells

1. White Blood Cells (Leucocytes)

A- Macrophages.

B- Lymphpcytes

- **B cells**
- **T Cells**

Antigen presenting cells (APC): Specialized cells (macrophages, dendritic cells, and some B cells) that they **digest** the antigen and **present it** to other specialized cells.

1. **Lymphpcytes**

A- B cells: B cells or B lymphocytes are a type of **lymphocyte** in the humoral immunity of the adaptive immune system.

- **Plasma B cells**
- **Memory B cells**

B- T Cells: T cells or T lymphocytes are a type of **lymphocyte** that plays a central role in cell-mediated immunity (CMI).

- **T helper cells (Th)**
- **Cytotoxic T-cells (Tc)**

Antigen presenting cells (APC): Specialized cells (macrophages, dendritic cells, and some B cells) that they **digest** the antigen and **present it** to other specialized cells.

2- Platelets or thrombocytes: are small, colorless cell fragments in our blood that form clots and stop or prevent bleeding

Antigen presenting cells (APC): Specialized cells (macrophages, dendritic cells, and some B cells) that they **digest** the antigen and **present it** to other specialized cells.

3- mast cell: are found in loose (areolar) connective tissue throughout the body, in virtually every organ. They play an important role in inducing the inflammatory cascade. Innate or adaptive immune mechanisms can induce the mast cell to degranulate, releasing inflammatory mediators into the extracellular space.

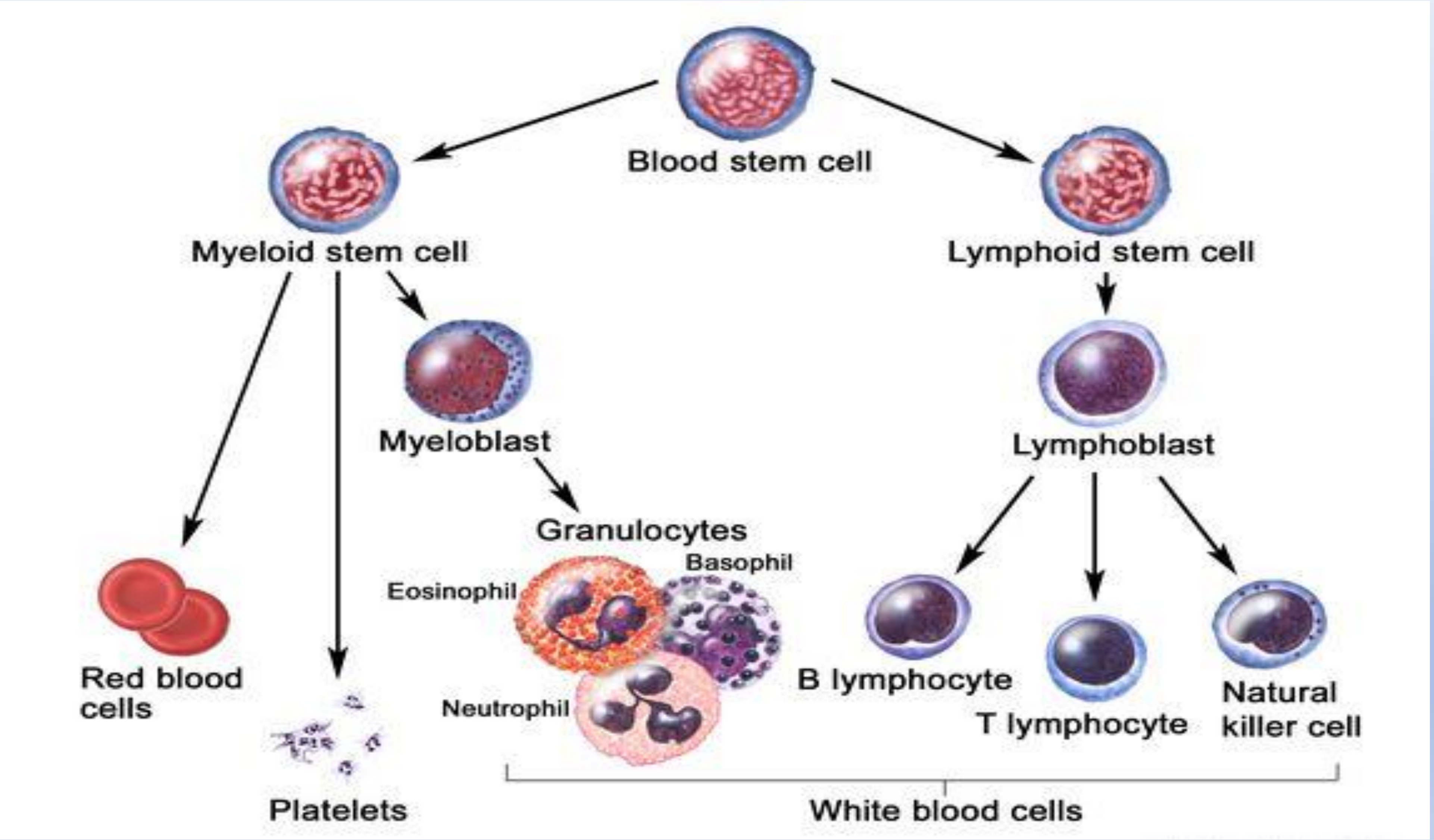
Antigen presenting cells (APC): Specialized cells (macrophages, dendritic cells, and some B cells) that they **digest** the antigen and **present it** to other specialized cells.

4- NK Cells: a specific kind of immune cell that contains granules that contain enzymes that can destroy **cancerous** or **virus-infected cells**.

Antigen presenting cells (APC): Specialized cells (macrophages, dendritic cells, and some B cells) that they **digest** the antigen and **present it** to other specialized cells.

5- Dendritic cell: Dendritic cells are found in tissue that has contact with the outside environment such as the skin and in the linings of the nose, lungs, stomach and intestines.

Antigen presenting cells (APC)



The complement system: it is a set of over 20 different protein molecules always found in the blood. It can be activated by bacterial surface molecules; with an infection, and then activated, leading to a sequence of events on the surface of the pathogen that helps destroy the pathogen and eliminate the infection. Complement is activated by **innate immune response** as well as by **adaptive immune response**.

Function of complements

1. **Opsonization** – enhancing phagocytosis of antigens
2. **Chemotaxis** – attracting macrophages and neutrophils
3. **Cell Lysis** – rupturing membranes of foreign cells
4. **Agglutination** – clustering and binding of pathogens together (sticking)

Complements activation pathways

1. Classical Pathway
2. Alternative Pathway
3. Lectin Pathway

Immune responses to antigens may be categorized as primary or secondary responses

A-Primary response: the first exposure to antigen. The primary immune responses can be subdivided into four phases (lag phase, exponential phase, steady state phase, and declining phase)

A-Primary response:

a. The lag (latent) phase: is the initial exposure of antigen, during this lag phase specific T cells and B cells are activated by their contact with antigen.

b. The exponential phase: is a rapid increase in antibody levels due to secretion of antibodies by many plasma cells.

A-Primary response:

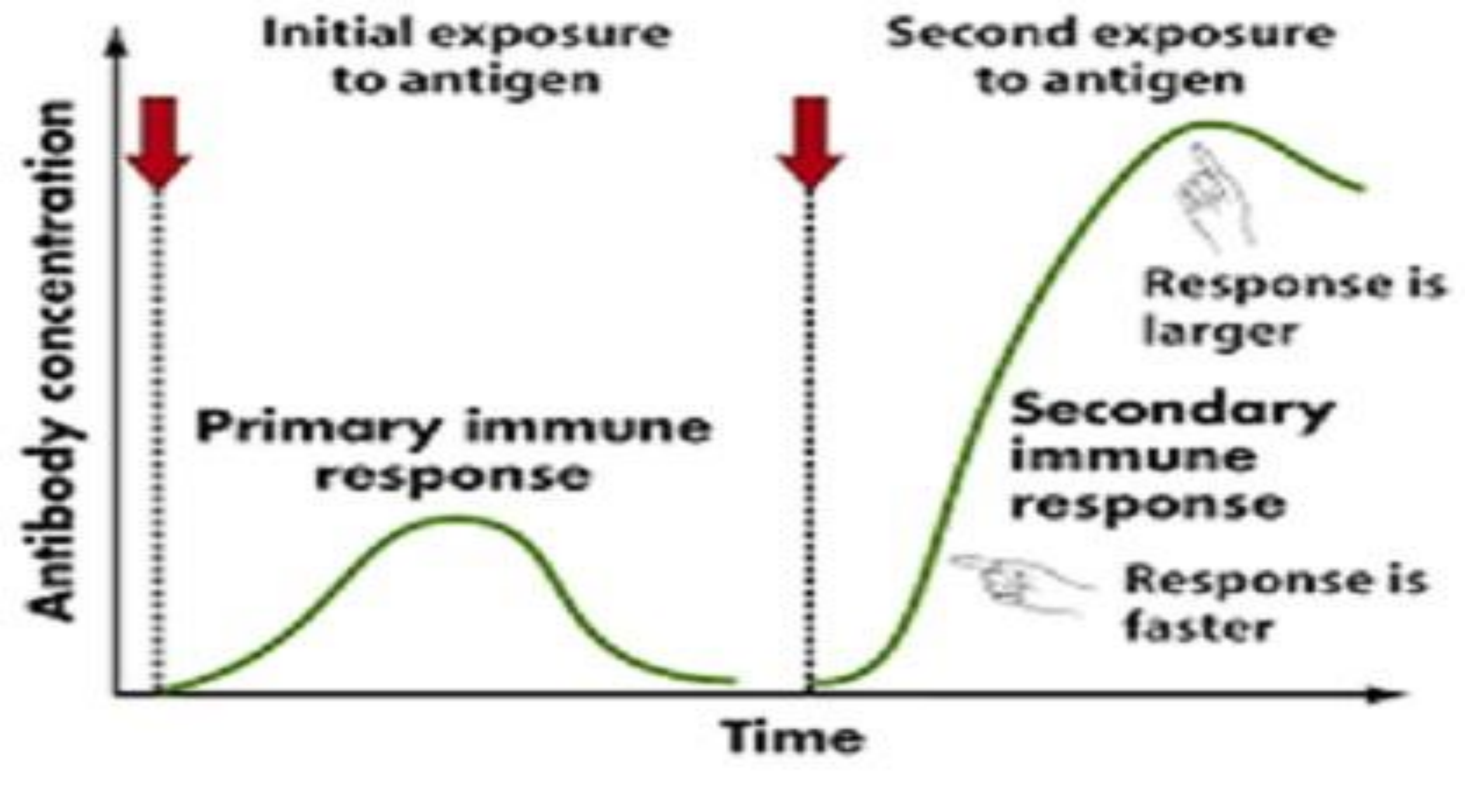
c. Steady state phase (plateau phase): The antibody level remains relatively at a constant level because the secretion and degradation of antibodies occur almost at equal rates.

d. Declining phase: The antibody level gradually declines because new plasma cells are no longer produced and the existing plasma cells are dying.

Immune responses to antigens may be categorized as primary or secondary responses

B-Secondary response: When **a similar antigen** enters the host for the second and subsequent times, the immune responses induced are called secondary immune responses. During secondary immune responses the lag period is shortened and antibody level reaches a very high steady state level within few days.

primary or secondary responses



Comparison between Primary and Secondary response

	Primary response	Secondary response
Exposure to antigen	First exposure to specific antigen	After second exposure to the same antigen
Time of onset	One week delay	Within hours
Strength	Weak potency	More potent
Duration	Short life; a few weeks	Form antibodies for many months
Type of antibody	IgM	IgG

Oral Immune System

The oral cavity is a unique anatomical structure, characterized by the juxtaposition of soft and hard tissues and which is continuously subject to challenge by the external environment and foreign material.

The soft and hard tissues of the oral cavity are under protection by both nonspecific, the function of these protective factors is to:

1. Limit the microbial colonization of the oral surfaces.
2. Prevent the penetration of noxious substances through the surfaces and ensuing damage to the underlying tissues. and specific immune factors.

Oral Immune System

1. Non-specific immune factors

These are factors present in saliva that include lysozyme, the lactoperoxidase system, lactoferrin, high molecular weight glycoproteins and other salivary components that may act as bacterial agglutinins. Unlike antibodies, these nonspecific factors lack any aspect of immunological memory and are not subject to specific stimulation. Several of the non-specific immune factors may interact with the specific salivary immune factors which are immunoglobulins, rsulting in a mutual amplification of their respective activities.

Salivary glands secrete organic molecules that can be categorized into five major groups: amylase, mucins, phospho-proteins, glycoproteins, and immunoglobulins.

Oral Immune System

2. Specific immune factors

These factors include immunoglobulins may be directed at specific bacterial molecules which may be important in the biological activity of the target organisms. The proportion of different Ig classes present in saliva are IgA > IgG > IgM > IgD > IgE.

Post-test Quiz

Give the functions of the complement system

BACTERIA AND ORAL DISEASES
LECTURE (4)

Objective: this lecture study the bacteria and its relationship with oral disease

Pre-test Quiz

List the morphology of bacteria

Bacteria (sing. Bacterium): prokaryotic unicellular microorganisms that were the first forms of life to appear on Earth, about 4 billion years ago.

Morphology Diversity of Bacteria

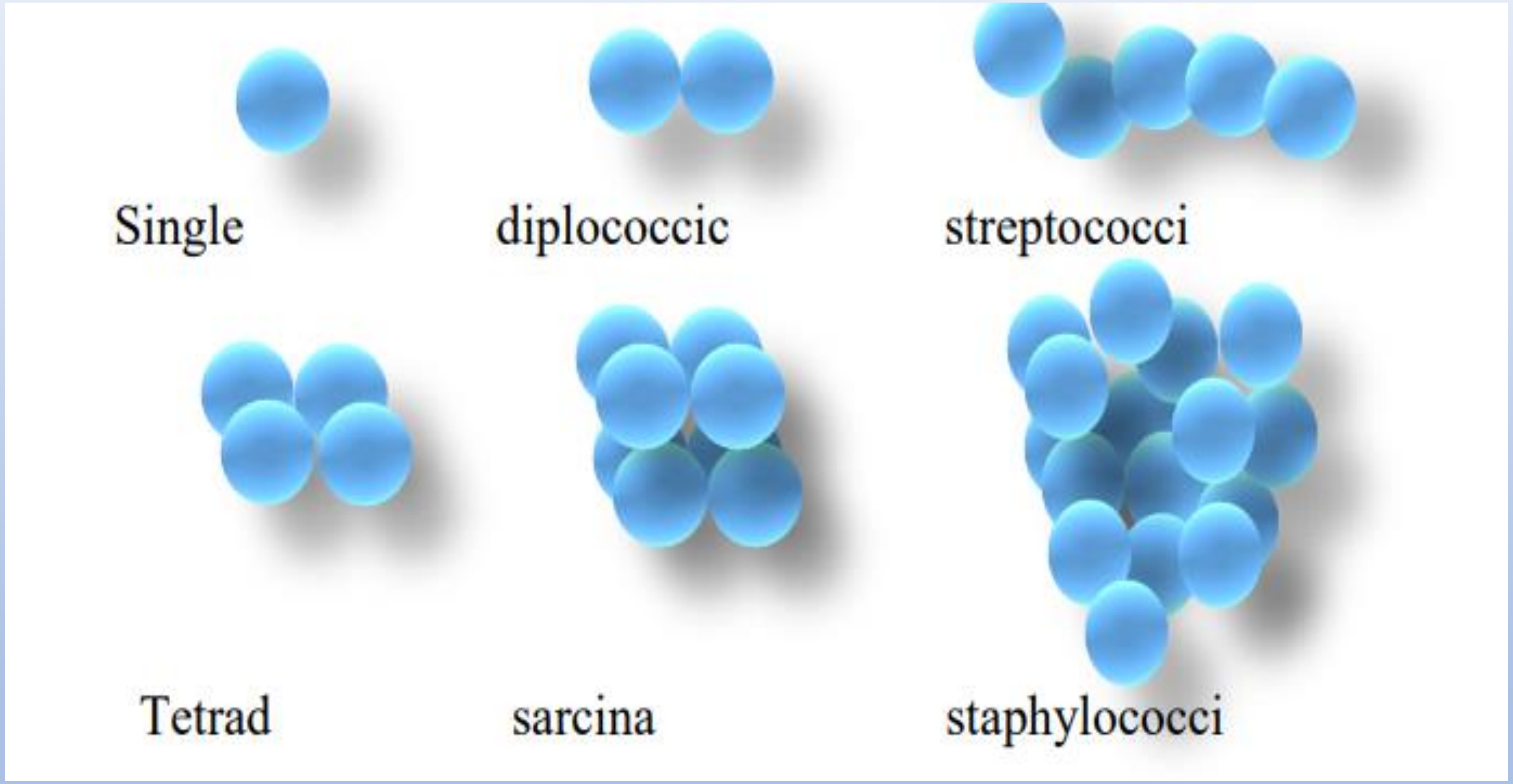
Bacteria display a wide diversity of shapes and sizes. Bacterial cells are about one-tenth the size of eukaryotic cells and are typically 0.5–5.0 micrometers (µm) in length.

Morphology of bacteria: it is describing the external appearance of bacterial cell including shape, arrangement and size.

Bacteria are the smallest organisms that have all machinery required for growth and self-replication, their diameter is usually about 1 µm. The light microscope reveals two principles forms of Eubacteria, spherical organisms called **cocci** and cylindrical ones called **bacilli**.

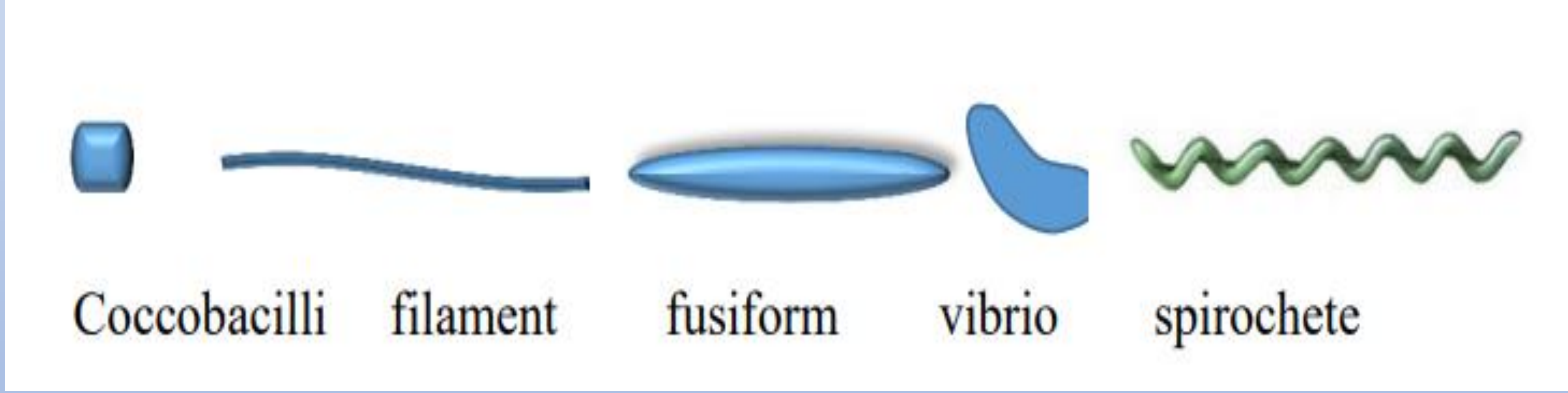
Cocci appear in number of different patterns depending upon the planes in which they divide. When cocci appear in pairs they are known as **diplococci**, while if in chain they are called **streptococci**, and they are called **staphylococci** if they were in cluster. Cocci that remain adherent often splitting successively in two or three perpendicular direction yielding **tetrads** or cubical packets are known as **sarcina**.

Morphology of bacteria



Arrangement of cocci

Bacillus when unusually short are referred as coccobacilli, when tapered at both ends as **fusiform**, when growing in long threads as **filaments** form, when curved as **vibrio** and when spiral as **spirillum** or **spirochete**.



Arrangement of bacilli

In 1981, **square** bacteria had been discovered; they 2-4 µm in diameter.

Pleomorphism

Bacteria appear in number of different forms. Environmental conditions are affecting the size and shape of bacteria, which is seen obviously in bacilli forms other than cocci forms.

Cell structure

The protoplast of the bacterial cell is the whole body of living material (protoplasm) which bounded peripherally cytoplasmic membrane.

1. **Essential structures**
2. **Other Structure (Appendices structures)**

Cell structure

1. Essential structures

a) Nucleoid (nuclear material)

b) Cytoplasm

c) Cytoplasmic Membrane

d) Cell Wall

Cell structure

2. Other Structure (Appendices structures)

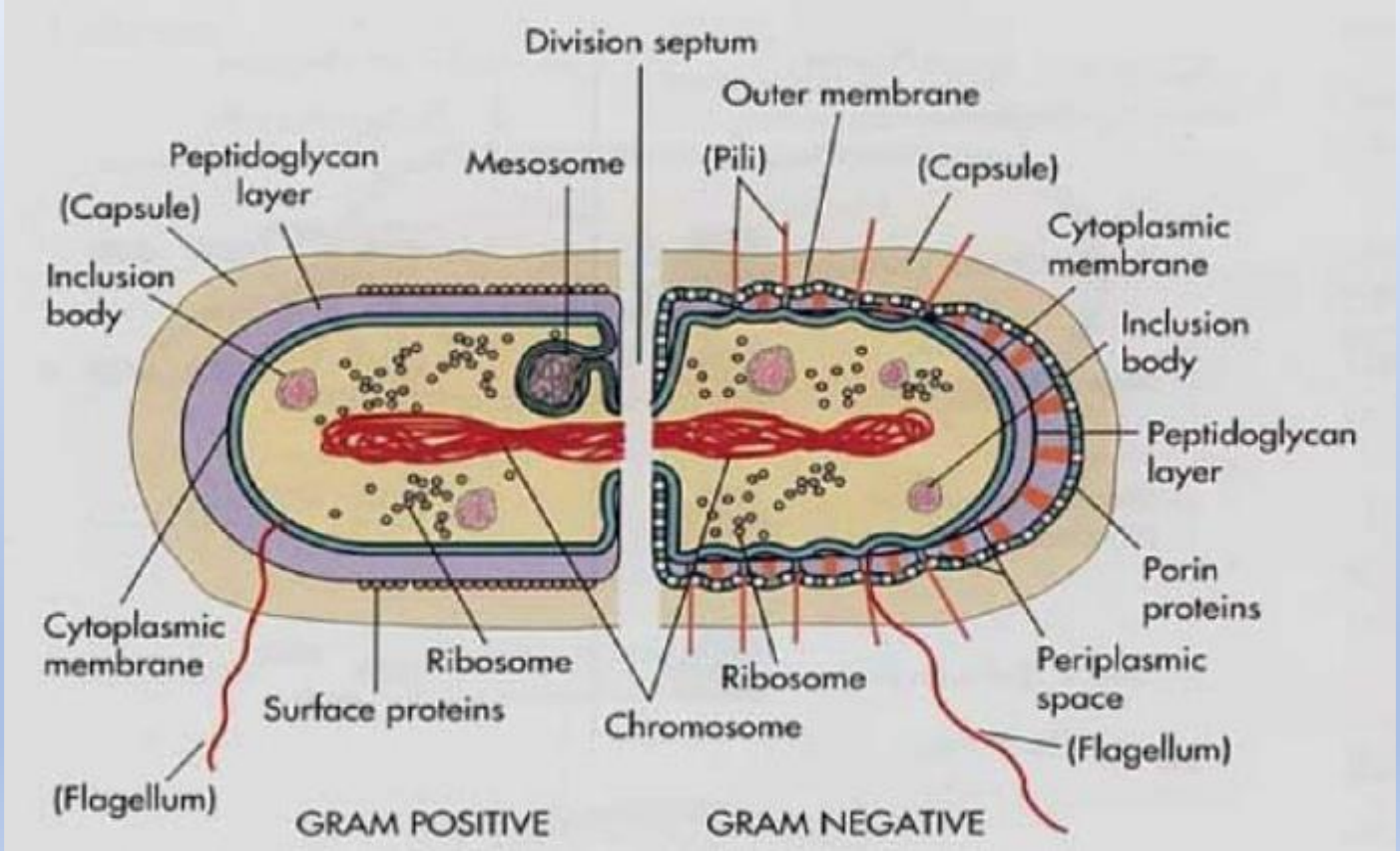
a) Capsule

b) Flagella

c) Pili & Fimbriae

d) Endospore

Cell structure



Bacterial Structure

Bacteria, despite their simplicity, contain a well-developed cell structure which is responsible for many of their unique biological functions. Bacterial cells typically contain the following structures: a cell wall, cell membrane, cytoplasm, ribosomes, plasmids, flagella, and a nucleoid region.

Bacterial Structure

1- Cell Wall - Outer covering of the cell that protects the bacterial cell and gives it shape.

2- Cytoplasm - A gel-like substance composed mainly of water that also contains enzymes, salts, cell components, and various organic molecules.

3- Cell Membrane or Plasma Membrane - Surrounds the cell's cytoplasm and regulates the flow of substances in and out of the cell.

The bacterial cell wall differs from that of all other organisms by the presence of peptidoglycan which is located immediately outside of the cytoplasmic membrane. Peptidoglycan is made up of a polysaccharide backbone consisting of alternating N-Acetylmuramic acid (NAM) and N-acetylglucosamine (NAG) residues in equal amounts.

The major function of the cell wall is to provide rigidity, structural support, protection against mechanical stress and infection. It also aids in diffusion of gases in and out of the cell, Gram-positive cell walls are thick and the peptidoglycan (also known as murein) layer form almost 95% of the cell as well as teichoic acids.

Gram-negative cell walls are thin and unlike the gram-positive cell walls, they contain a thin peptidoglycan layer (5-10%) adjacent to the cytoplasmic membrane. The gram-negative bacterium has thinner cell walls, and is made up of few layers of peptidoglycans and is surrounded by a lipid membrane containing lipopolysacccharides and lipoproteins (outer membrane).

4- Nucleoid Region - Area of the cytoplasm that contains the single bacterial DNA molecule.

5- Inclusions- are nonliving components of the cell that do not possess metabolic activity and are not bounded by membranes. The most common inclusions are glycogen, lipid droplets, crystals, and pigments.

6- Plasmid small independent pieces of DNA that often encode for traits that are advantageous but not essential to their bacterial host. Plasmids can be easily gained or lost by a bacterium and can be transferred between bacteria. So, plasmids can be described as an extra chromosomal DNA in a bacterial cell.

7- Fimbriae - are protein tubes that extend out from the outer membrane they are generally short in length and present in high numbers about the entire bacterial cell surface. That used to facilitate the attachment of a bacterium to a surface.

8- Pili- are similar in structure to fimbriae but are much longer and present on the bacterial cell in low numbers. Pili are involved in the process of bacterial conjugation where they are called conjugation pili or sex pili. Pili are absent in gram-positive bacteria and present in gram-negative bacteria.

9- Ribosomes - Cell structures responsible for protein production.

10- Endospores- are bacterial survival structures that are highly resistant to many different types of chemical and environmental stresses and therefore enable the survival of bacteria in environments that would be lethal for these cells.

11- Flagella- are extracellular bacterial cell structures. Flagella are whip-like structures protruding from the bacterial cell wall and are responsible for bacterial motility (i.e. movement).

The arrangement of flagella about the bacterial cell is unique to the species observed. Common forms include:

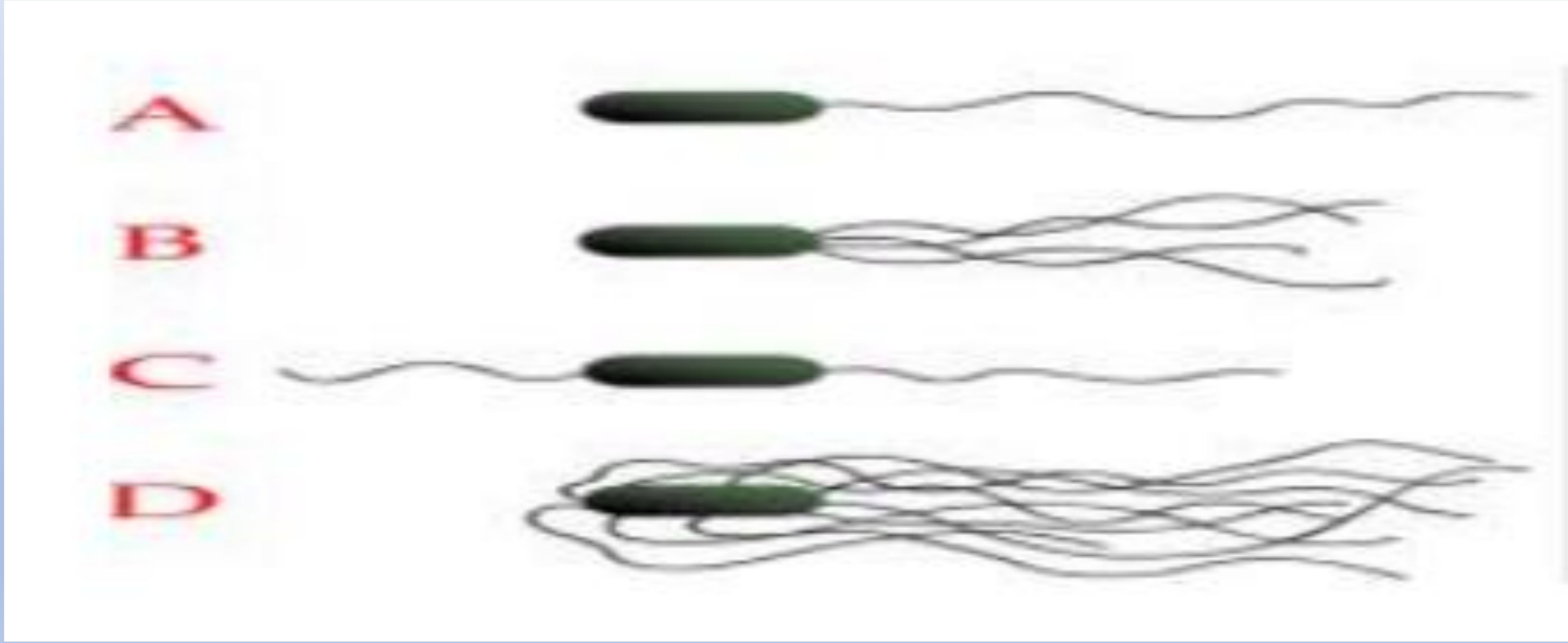
a) Monotrichous - Single flagellum

b) Lophotrichous - A tuft of flagella found at one of the cell poles

c) Amphitrichous - Single flagellum found at each of two opposite poles

d) Peritrichous – Multiple flagella found at several locations about the cell

The arrangement of flagella about the bacterial cell is unique to the species observed. Common forms include:



Bacterial reproduction

1- Asexual reproduction

2- Sexual reproduction

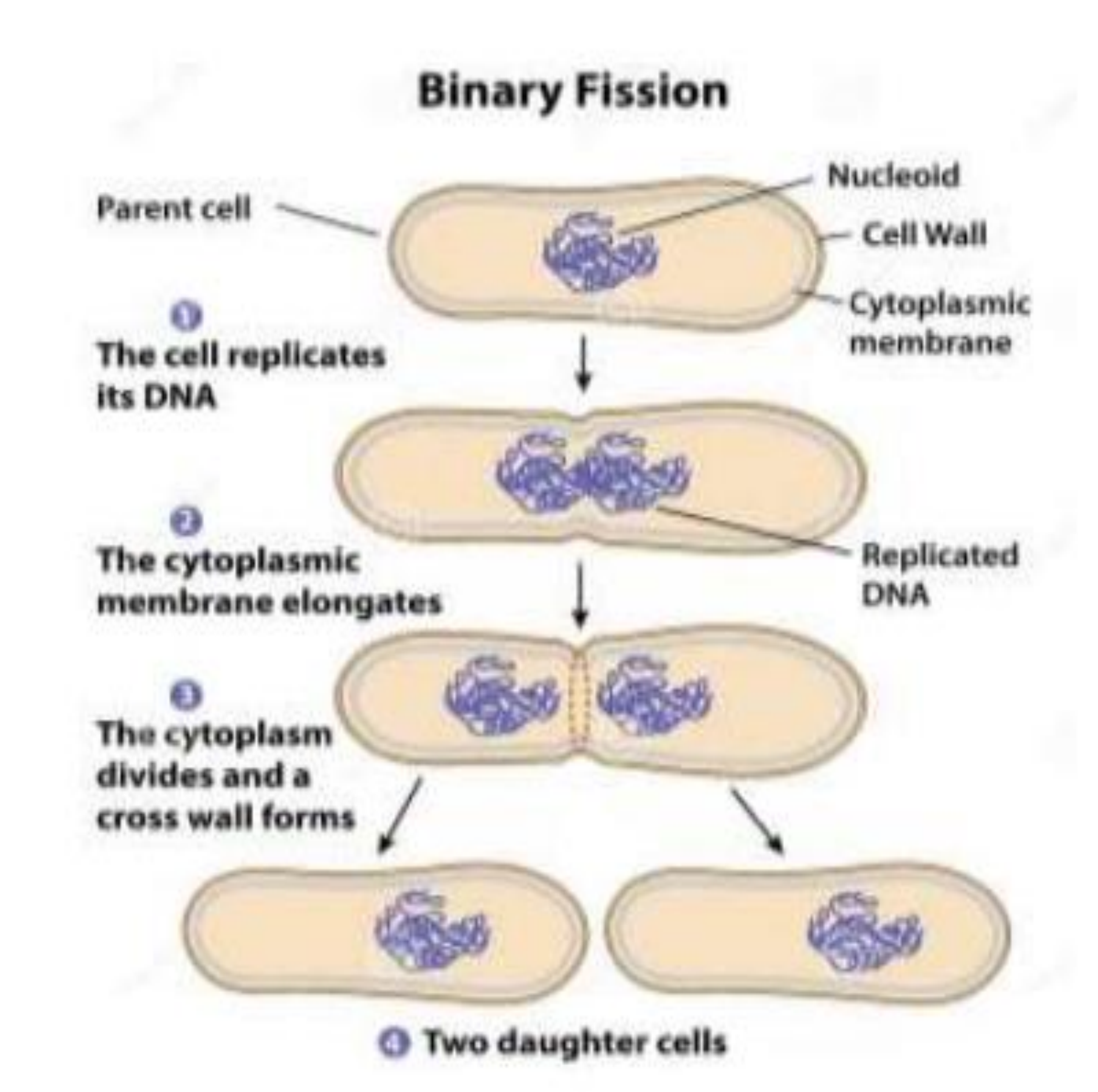
Bacterial reproduction

1- Asexual reproduction

Bacterial reproduction most commonly occurs by a kind of cell division called simple binary fission. Binary fission results in the formation of two bacterial cells that are genetically identical.

Bacterial reproduction

1- Asexual reproduction



Bacterial reproduction

2- Sexual reproduction

In sexual reproduction there is no meiosis (formation of gametes and zygote). Instead, it involves transfer of a portion of genetic material (DNA) from a donor cell to a recipient cell. This process called as genetic recombination, it is occurred in the following three ways:

Bacterial reproduction

2- Sexual reproduction

1- **Transformation** the liberated DNA from a destroyed cell penetrates another one

2- **Transduction** when a bacteriophage carries DNA fragments from one cell to another

3- **Conjugation** the bacterial conjugation occurs through which a donor cell transfers plasmid DNA to recipient cell through a conjugation tube formed between both cells. In the recipient cell, replication starts on the transferred DNA, then the cell moves apart and the plasmid in each cell forms a circle.

Bacterial Growth

Bacterial growth follows four phases. When populations of bacteria first enter a high-nutrient environment that allows growth, the cells need to adapt to their new environment.

Bacterial Growth

1- **lag phase**: During this phase, bacteria exhibit growth in size but no increase in cell

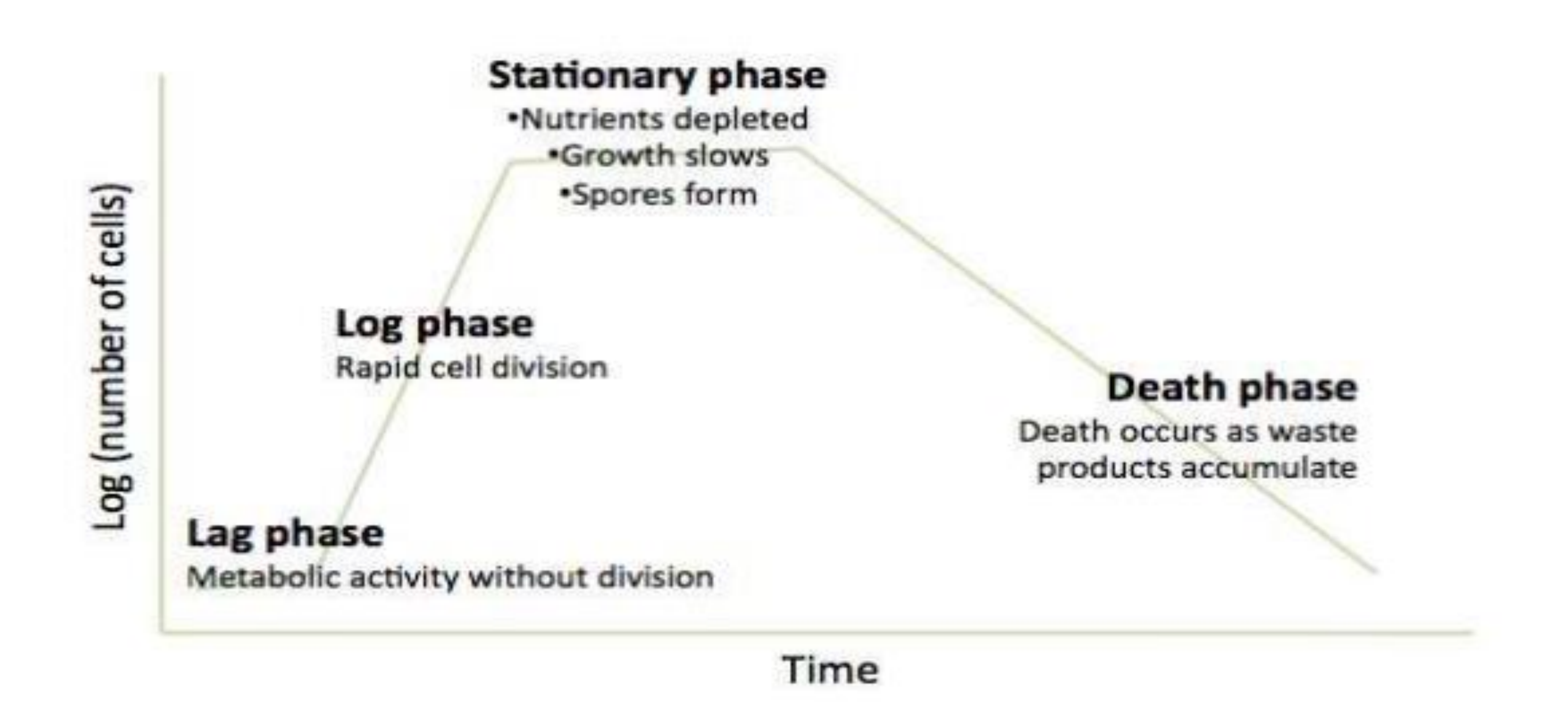
2- **Logarithmic (exponential) phase:** During this period the cells divide steadily at a constant rate. The rate at which cells grow during this phase is known as the growth rate (k), and the time it takes the cells to double is the generation time (g). During log phase, nutrients are metabolized at maximum speed until one of the nutrients is depleted and starts limiting growth.

Bacterial Growth

3- **Stationary phase:** During this phase the growth rate is equal to the death rate.

4- **Death (decline) phase:** Eventually the number of viable Bacterial cells begins to decline, the cells reduce their metabolic activity and consume non-essential cellular proteins. Finally, the bacteria run out of nutrients and die.

Bacterial Growth



Bacterial Metabolism

Classification of Bacteria Based on Oxygen Requirements

1- **Aerobes (aerobic bacteria)** - these can grow only in the presence of oxygen.

2- **Anaerobes (anaerobic bacteria)** - these can only grow if there is no oxygen present.

3- **Facultative anaerobes (facultative anaerobic bacteria)** - these thrive in environments with or without oxygen. However, when given both options, they prefer to use oxygen for respiration.

Bacterial Population as Causative Agent Defer in Capacity to Establishing

Disease. It was Depended on:

1. **Pathogenicity** (ability to cause disease)

2. **Virulence** (degree of pathogenicity)

3. **Invasiveness** (ability to invade the host tissues or fluids)

4. **Toxicity** (ability to create clinical response due to exotoxin or endotoxin)

Bacterial oral diseases

Despite the presence of saliva and the mechanical forces of chewing and eating, some microbes thrive in the mouth. These microbes can cause damage to the teeth and can cause infections that have the potential to spread beyond the mouth and sometimes throughout the body. Below some of the most common oral infection caused by bacterial species.

1. Dental Caries that caused by *Streptococcus*

2. Gingivitis and periodontitis that caused by *Prophyromonas*, *Streptococcus* and *Actinomyces* and others.

Gingivitis

2. Gingivitis and periodontitis that caused by *Prophyromonas*, *Streptococcus* and *Actinomyces* and others.

periodontitis

1. Trench mouth (acute necrotizing ulcerative gingivitis) that caused by *Fusobacterium*, *prevotella intermedia*, *Treponema vincentii* and others

Post-test Quiz

List the arrangement of bacterial flagella

GENETICS AND ITS ROLE IN ORAL DISEASES

LECTURE (5)

Objective: this lecture learn about mutation and its role in oral disease

Pre-test Quiz

Define the mutagen

Genetics is the study of how genes and how traits are passed down from one generation to the next.

Mutation is an alteration in the nucleic acid sequence of the genome of an organism.

A mutagen is a chemical or physical agent capable of inducing changes in DNA.

There are three basic types of mutagens:

- Physical mutagens.
- Chemical mutagens.
- Biological mutagens.

The mutations can be classified into two types

1. Point mutation

- A frameshift mutation

    A- Insertion of point mutation

    B- Deletion of point mutation

- Substitution

    A- A silent mutation

    B- A missense mutation

    C- A nonsense mutation

2. Chromosomal mutation

    A. Deletion chromosomal mutation
    B. Duplication chromosomal mutation
    C. Inversion chromosomal mutation
    D. Translocation chromosomal mutation

The mutations can be classified into two types

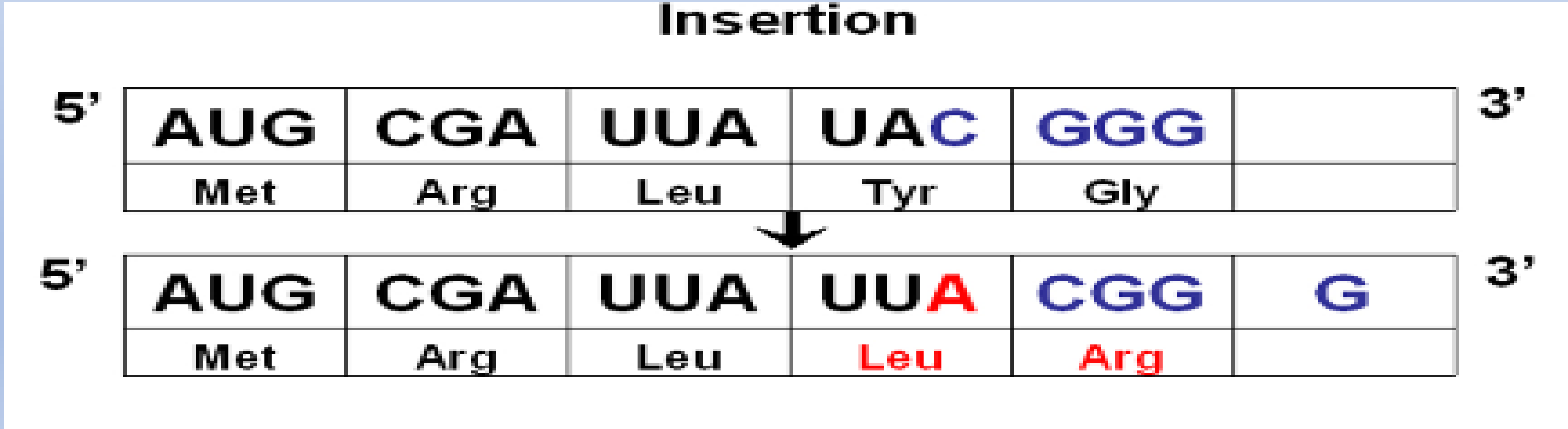
1. **Point mutation** is a mutation affecting only one or very few nucleotides in a gene sequence, and it is can subdivided into three types

- **A frameshift mutation**: it is the **insertion** or **deletion** of nucleotide bases in numbers that are not multiples of three.

The mutations can be classified into two types

- **A frameshift mutation**: it is the **insertion** or **deletion** of nucleotide bases in numbers that are not multiples of three.

a) **Insertion of point mutation:** is a one or more additional nucleotides are added.



The mutations can be classified into two types

- **A frameshift mutation**: it is the **<u>insertion</u>** or **<u>deletion</u>** of nucleotide bases in numbers that are not multiples of three.

b) Deletion of point mutation: is a one or more nucleotides may be “skipped” or removed

Deletion

5’	AUG	CGA	UUA	UAC	GGG	AAA	3’
	Met	Arg	Leu	Tyr	Gly	Lys	

↓

5’	AUG	CGA	UUA	UAG	GGA	AA	3’
	Met	Arg	Leu	Stop			

The mutations can be classified into two types

1. **Point mutation** is a <u>mutation</u> affecting only one or very few <u>nucleotides</u> in a gene sequence, and it is can subdivided into three types.

- **Substitution** is a type of mutation where one base pair is replaced by a different base pair.

Substitution mutations can be good, bad, or have no effect. They cause three specific types of point mutation: **<u>silent</u>**, **<u>missense</u>**, and **<u>nonsense</u>** mutations.

The mutations can be classified into two types

- **Substitution** is a type of mutation where one base pair is replaced by a different base pair.

a) **A silent mutation**: is a point mutation where one nucleotide in a genetic sequence is replaced with another nucleotide, altering the corresponding codon to another codon for the same amino acid.

The mutations can be classified into two types

- **Substitution** is a type of mutation where one base pair is replaced by a different base pair.

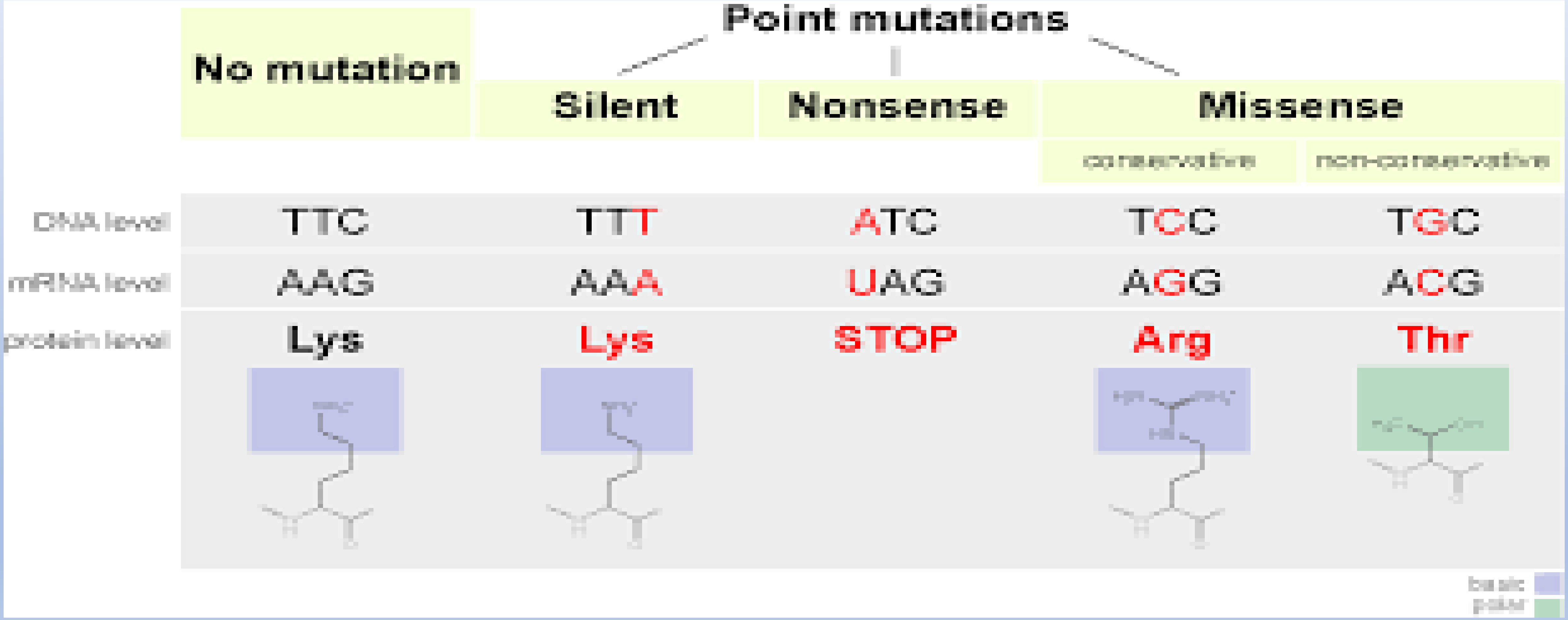
b) A missense mutation is a point mutation in which a single nucleotide changes results in a codon that codes for a different amino acid. It is a type of nonsynonymous substitution.

The mutations can be classified into two types

- **Substitution** is a type of mutation where one base pair is replaced by a different base pair.

c) A nonsense mutation: a severe type of base substitution, result in a stop codon in a position where there was not one before, which causes the premature termination of protein synthesis and, more than likely, a complete loss of function in the finished protein.

The mutations can be classified into two types



The mutations can be classified into two types

2- A chromosomal mutation is the mutation of the chromosomal segments of the DNA strands.

a) **Deletion chromosomal mutation:** a piece of a chromosome accidentally gets removed or deleted.

b) **Duplication chromosomal mutation:** a segment of the chromosome is copied multiple times.

The mutations can be classified into two types

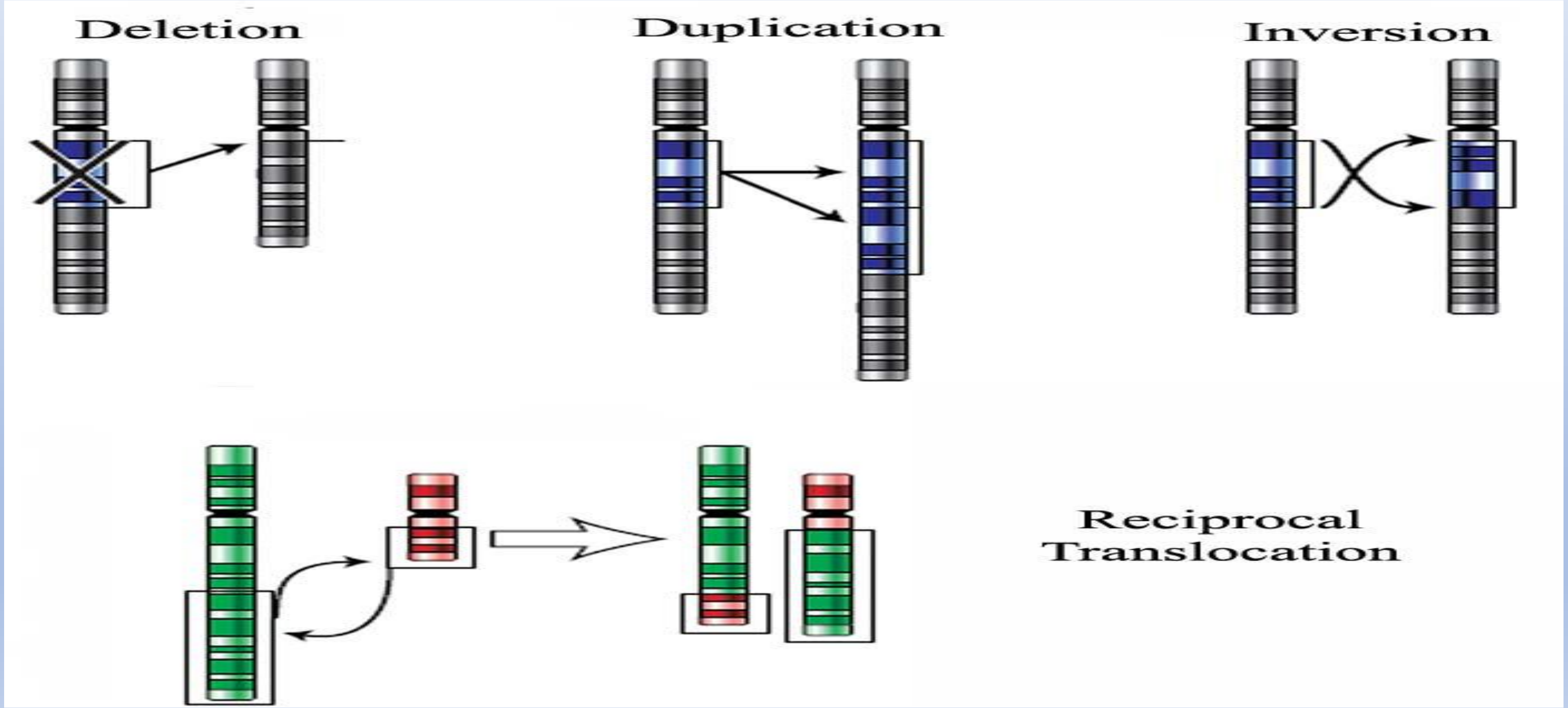
2- A chromosomal mutation is the mutation of the chromosomal segments of the DNA strands.

c) Inversion chromosomal mutation: a segment of the chromosome breaks in two places and is reversed (turned 180 degrees) and then reinserted into its original place in the chromosome.

d) Translocation chromosomal mutation: a segment of one chromosome breaks off and attaches to another chromosome.

The mutations can be classified into two types

2- A chromosomal mutation is the mutation of the chromosomal segments of the DNA strands.



Types of Genetic Oral/Dental Abnormalities

Genetic oral/dental abnormalities (anomalies) are problems, dysfunctions and diseases of oral tissues and dentition caused by defective genes.

Types of Genetic Oral/Dental Abnormalities

1. **Cleft Lip & Cleft Palate**

Types of Genetic Oral/Dental Abnormalities

2- **Anodontia**

Types of Genetic Oral/Dental Abnormalities

3- **Hypodontia**

Types of Genetic Oral/Dental Abnormalities

4- **Hyperdontia**

Types of Genetic Oral/Dental Abnormalities

5- **Amelogenesis Imperfecta**

Types of Genetic Oral/Dental Abnormalities

6- **Dentinogenesis Imperfecta**

Types of Genetic Oral/Dental Abnormalities

6- Supernumerary Teeth

Types of Genetic Oral/Dental Abnormalities

7- Malocclusion

Types of Genetic Oral/Dental Abnormalities

8- **Gingival Fibromatosis**

Types of Genetic Oral/Dental Abnormalities

9- Oral Cancer

Types of Genetic Oral/Dental Abnormalities

10- **Canker Sores**

Post-test Quiz

Define the non-sense mutation

SIMPLE EPITHELIAL TISSUE (TONGUE)
STRATIFIED EPITHELIAL TISSUE

LECTURE (6 and 7)

Objective: this lecture learn about the basic consepts related with epithelial tissue and Tongue

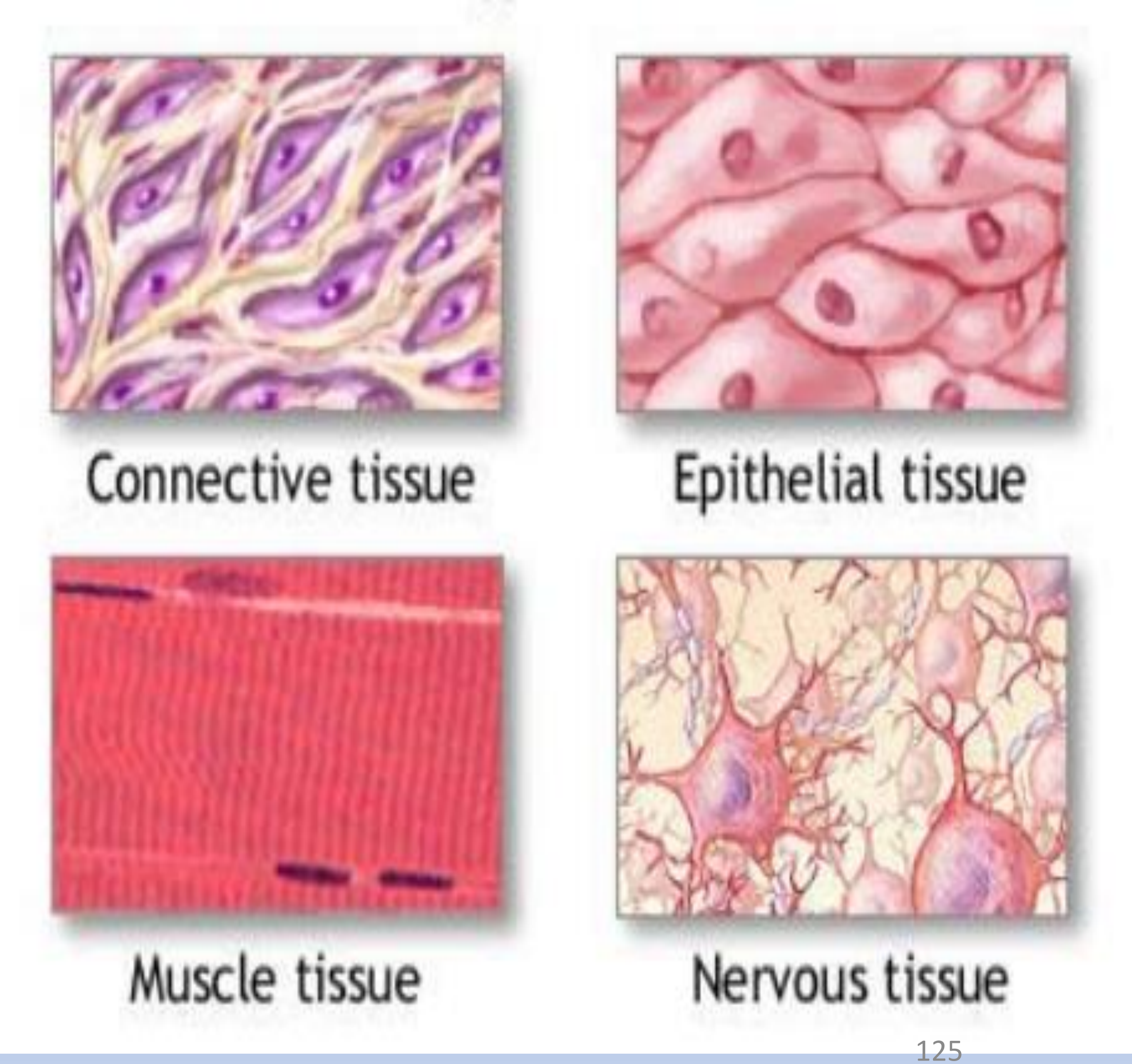
Pre-test Quiz

List the function of Epithelial tissue

Tissue is a group or layers of cells that work together to perform a specific function.

The four main types of tissue:

1. Epithelial tissue (support)
2. Connective tissue (lining, covering, and glandular)
1. Muscle tissue (movement)
2. Nervous tissue (control)



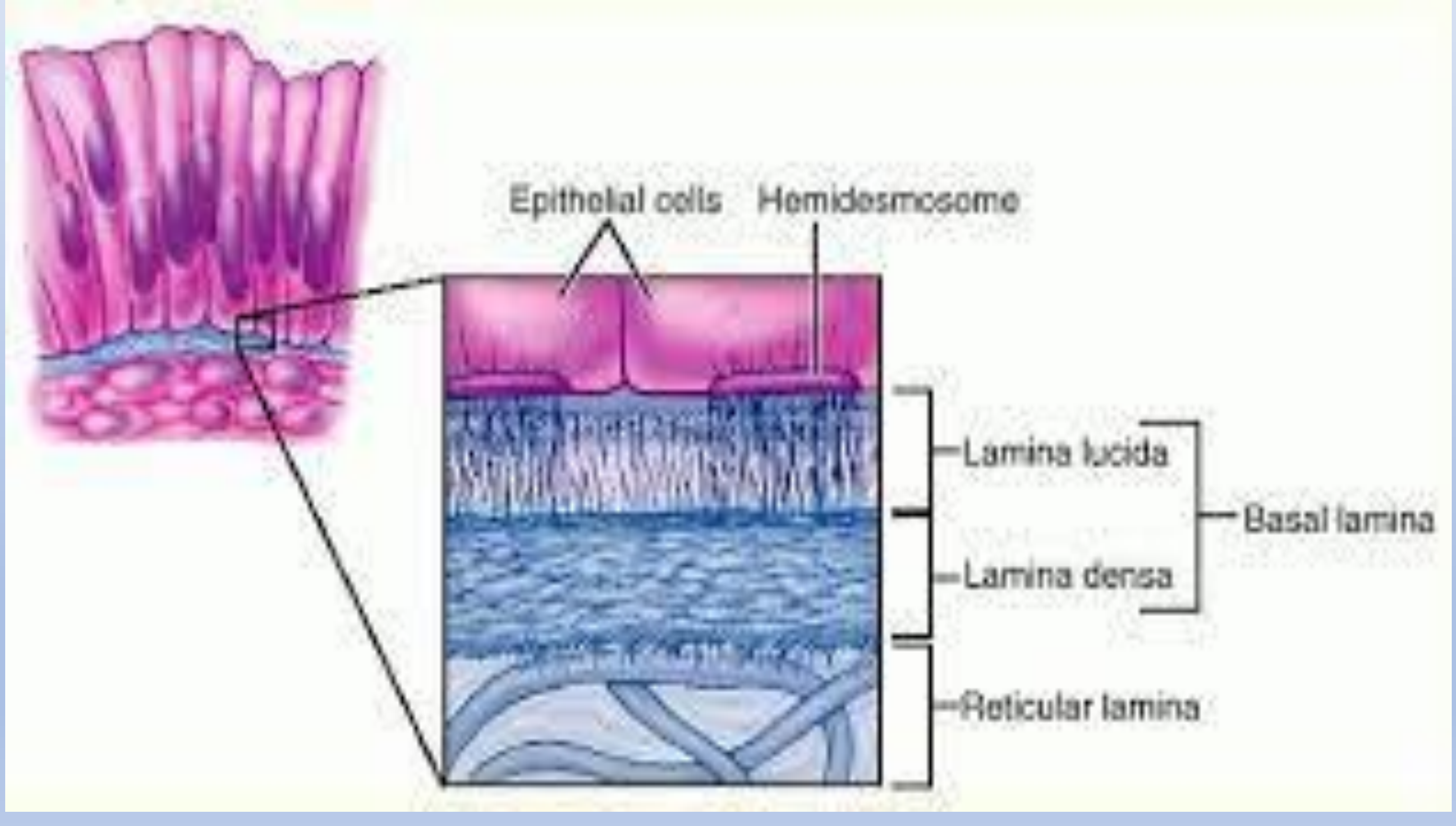
Epithelial tissues: is composed of one or more layers of closely aggregated polyhedral cells with very little extracellular substance (matrix) between these cells. These cells have adhered together due to adhesion molecules, membrane interdigitations, and intercellular junctions that allowing the cells to form cellular sheets that cover the surface of the body and line its cavities and it has not blood vessels penetrate an epithelium.

Functions of epithelial tissues:

a) Physical protection
b) Selective permeability
c) Secretions
d) Sensations

Basement membrane: A thin, fibrous, extracellular matrix that separates the epithelial tissue from underlying connective tissue

1. Basal lamina
    a) The lamina lucida
    b) Lamina densa
2. Reticular lamina



Function of basement membrane:

1. Provides support to the overlying epithelium.
2. Anchoring down the epithelium to its loose connective tissue (the dermis) underneath.
3. Acts as a mechanical barrier, preventing malignant cells from invading the deeper tissues
4. Other roles for basement membrane have been found that include blood filtration and muscle homeostasis

Intercellular junctions: Specialized regions of contact between the plasma membranes of adjacent cells, and there are four types:

1. **Tight junctions (zonula occludens):** Encircles epithelial cells near their exposed apical surface. The plasma membrane of adjacent cells fuse, nothing passes.

Intercellular junctions: Specialized regions of contact between the plasma membranes of adjacent cells, and there are four types:

2. Adherens junction (zonula adherens): Protein complexes that occur at cell-to-cell junctions in epithelial and endothelial tissues. They are deeper in position than tight junctions.

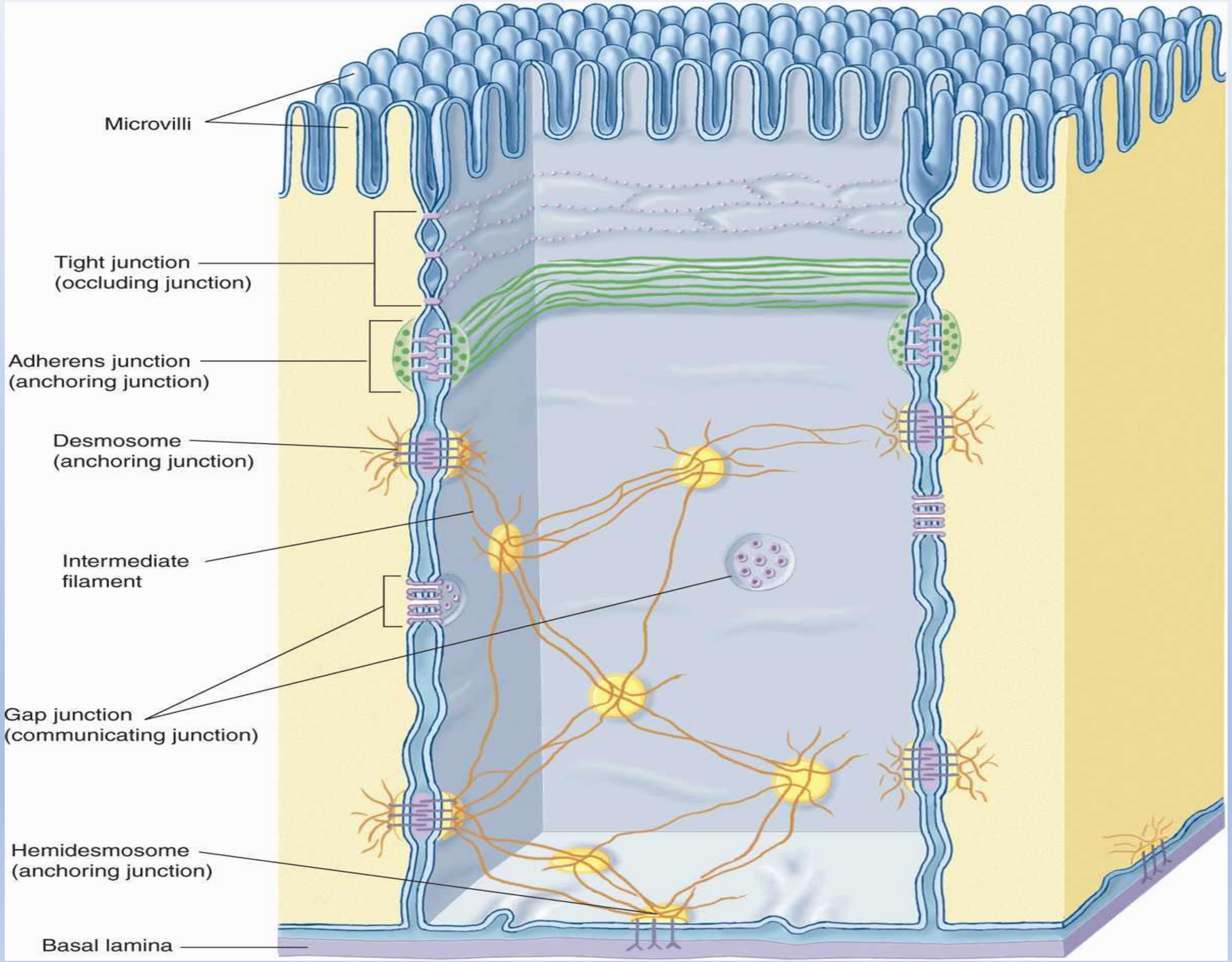
Intercellular junctions: Specialized regions of contact between the plasma membranes of adjacent cells, and there are four types:

3. Gap junctions (macula communicans): organized collections of protein channels in cell membranes that allow ions and small molecules to pass between adjacent cells.

Intercellular junctions: Specialized regions of contact between the plasma membranes of adjacent cells, and there are four types:

4. Desmosomes (macula adhaerens): A complex disk-shaped structure at the surface of one cell that is matched with an identical structure at the surface of the adjacent cell

Intercellular junctions



Classification of Epithelial Tissue: Epithelia are divided into two main groups according to their <u>structure</u> and <u>function</u>: Covering & Lining Epithelia and Glandular Epithelia

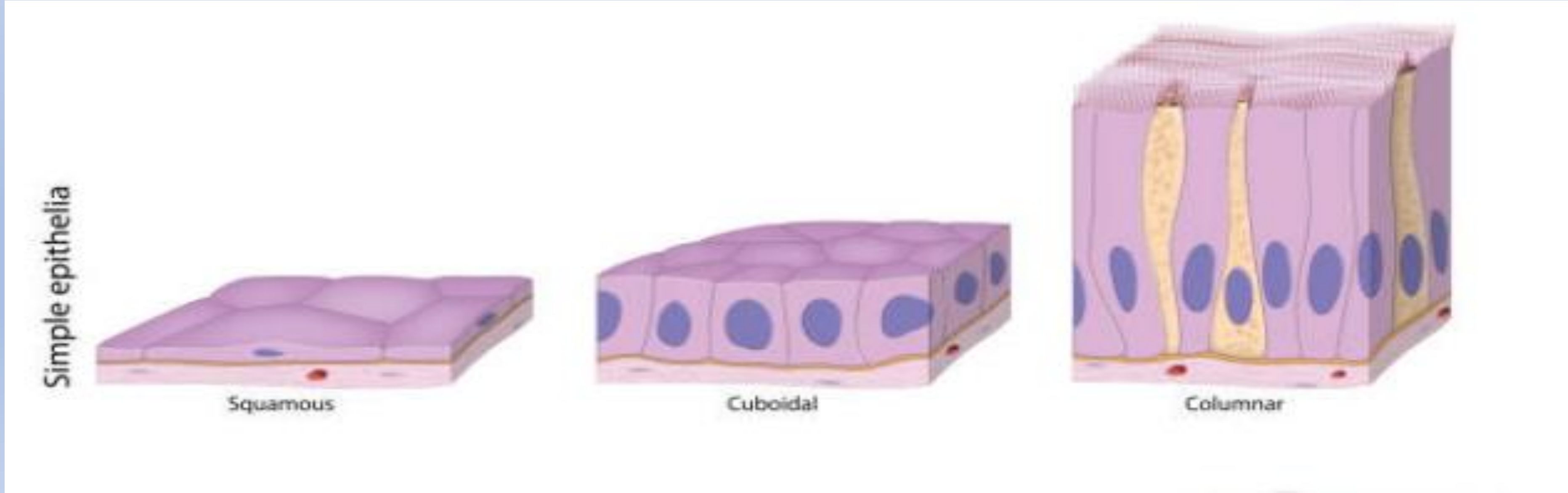
1. **Covering & lining epithelia form the outer layer of the skin; lines open cavities**

2- Glandular Epithelial Tissue

Classification of Epithelial Tissue:

1- Covering & lining epithelia form the outer layer of the skin; lines open cavities

- **A- Simple epithelium**
- **B- Stratified epithelium**
- **C- Pseudostratified epithelium**



Classification of Epithelial Tissue:

1- Covering & lining epithelia form the outer layer of the skin; lines open cavities

A- Simple epithelium : is one cell layer thick, and all the epithelial cells are in direct contact with the basement membrane, the lining of the air sacs of the lung, the intestines, and blood vessels.

Classification of Epithelial Tissue:

1- Covering & lining epithelia form the outer layer of the skin; lines open cavities

B- Stratified epithelium Contains two or more layers of epithelial cells. Only the cells in the deepest (basal) layer are in direct contact with the basement membrane, skin, internal lining of the pharynx and esophagus.

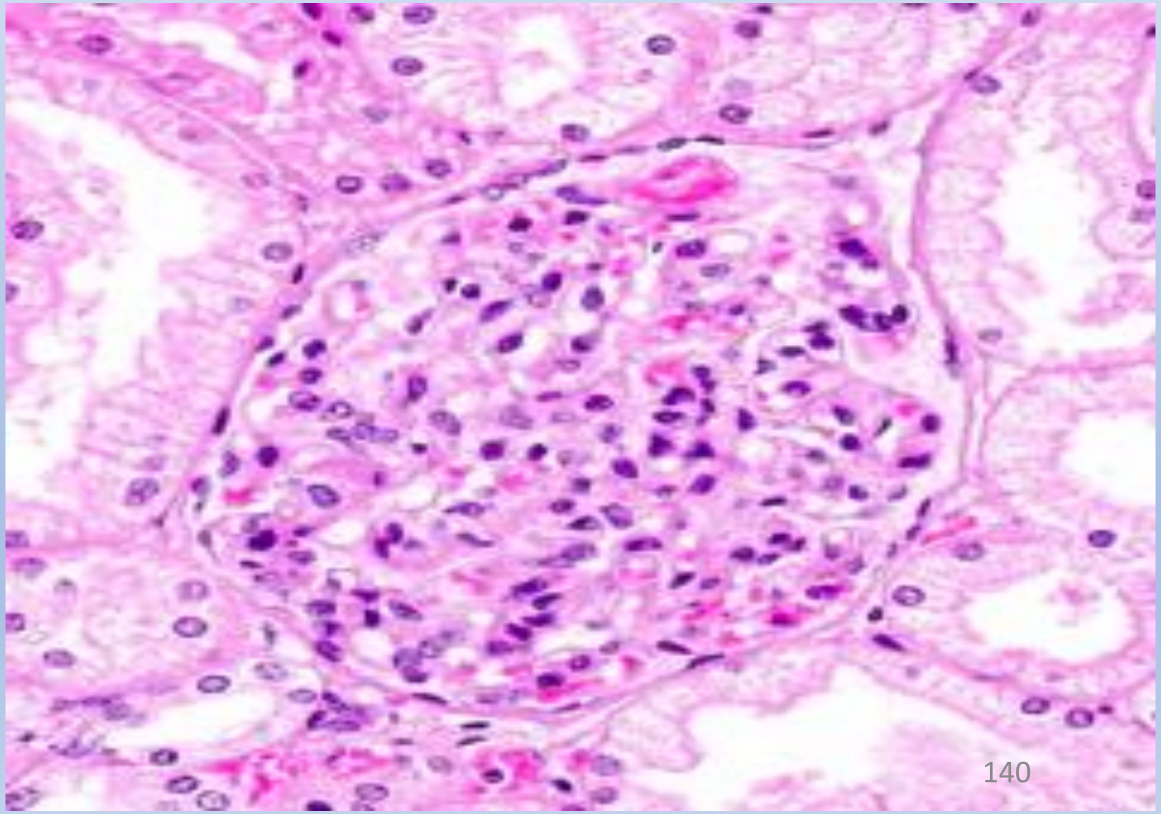
Classification of Epithelial Tissue:

1- Covering & lining epithelia form the outer layer of the skin; lines open cavities

C- Pseudostratified epithelium Looks layered (stratified) because the cells' nuclei are distributed at different levels between the apical and basal surfaces, pseudostratified epithelium has been classified as a type of simple epithelium, because all the cells are attached to the basement membrane.

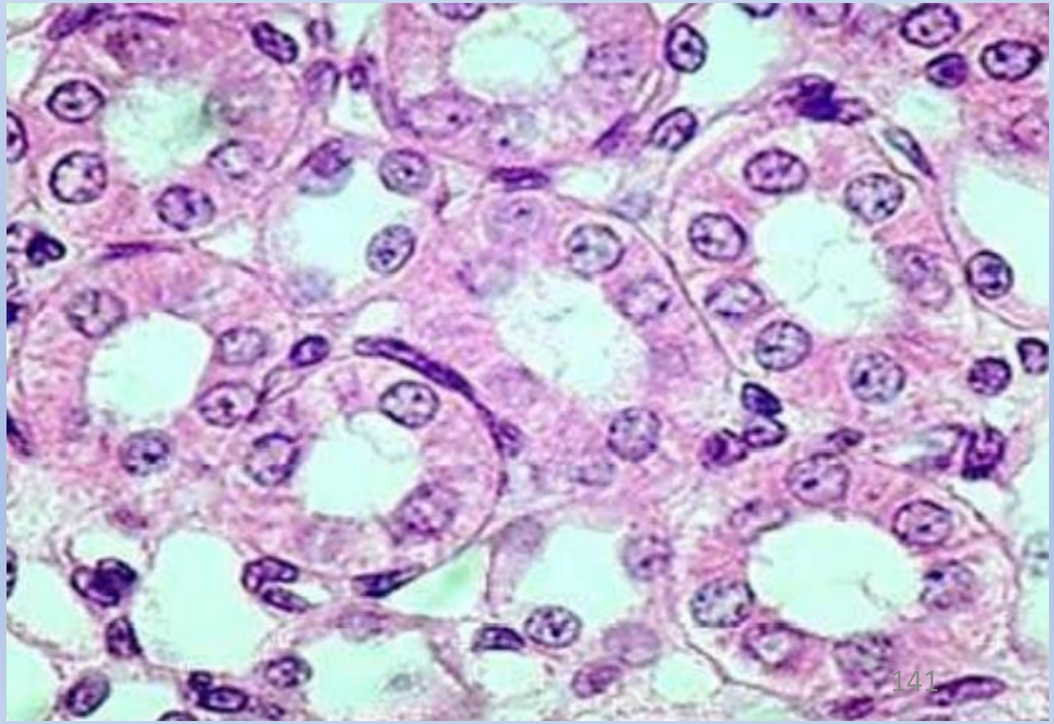
Classification Simple epithelial tissues cell shape:

1. **Simple Squamous Epithelium**: are flat in shape (scales) and arranged in a single layer, the cell is irregular in shape and has a disk-shaped flattened nucleus. the endothelial lining of blood vessels



Classification Simple epithelial tissues cell shape:

2-Simple Cuboidal Epithelium: Simple cuboidal epithelium consists of single layer cells that are as tall as they are wide (appear to be square shaped in cross section). This epithelial type is found in the small collecting ducts of the kidneys, pancreas, and salivary glands.



Classification Simple epithelial tissues cell shape:

3. Simple columnar epithelium: Simple columnar epithelium is a single layer of tall, closely packed cells, aligned in a row. Each cell has an oval nucleus that located close to the basal region of the cell, scattering unicellular glands (goblet cells) as in the small intestine.

A- **Non-ciliated columnar epithelium**

B- **Ciliated columnar epithelium**

Classification Simple epithelial tissues cell shape:

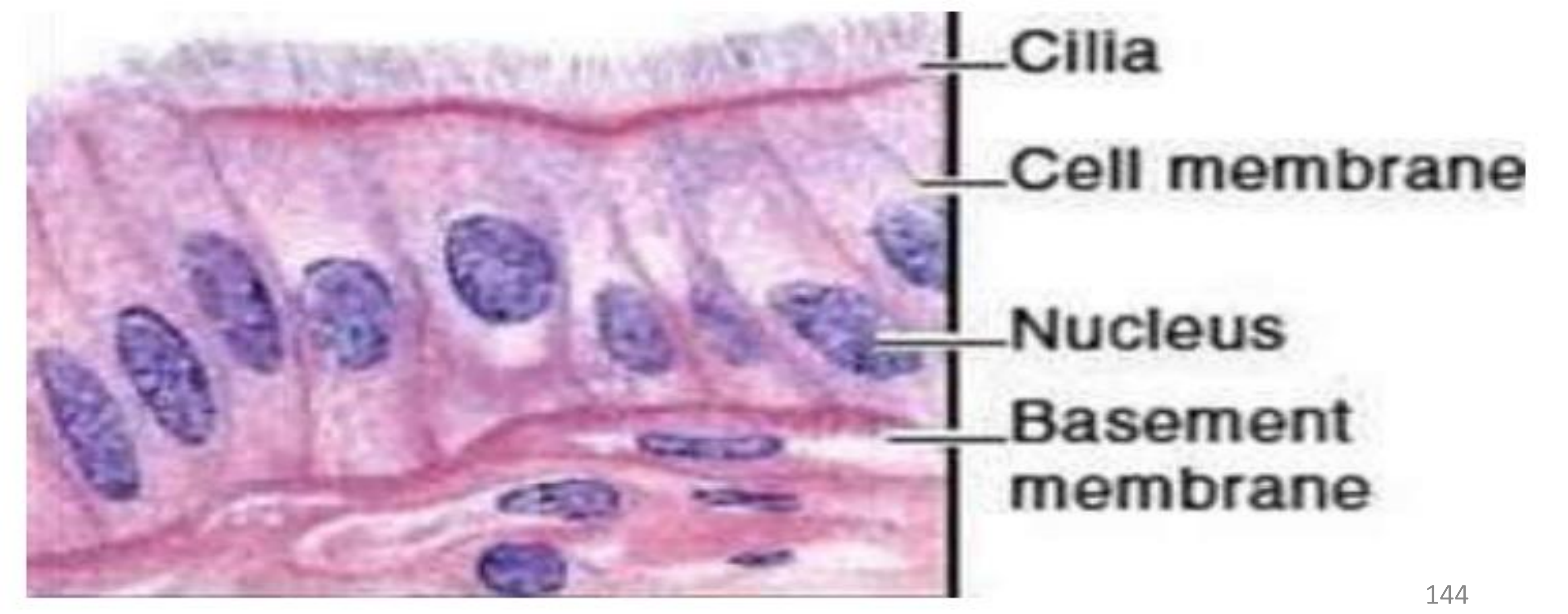
3. Simple columnar epithelium:

A- **Non-ciliated columnar epithelium:** often contains cellular extensions (microvilli) and scattering unicellular glands (goblet cells) as in the small intestine.

Classification Simple epithelial tissues cell shape:

3. Simple columnar epithelium:

B- Ciliated columnar epithelium : contains cilia and found within bronchioles of the respiratory tract and in the oviduct of the female reproductive tract.



4. Pseudostratified Columnar Epithelium: It may look stratified because the nuclei are scattered at different distances from the basal surface, but not all of the cells reach the apical surface in this epithelium.

A. **pseudostratified ciliated columnar epithelium**: This type is found in the larger air passageways of the respiratory system

B. **pseudostratified non-ciliated columnar epithelium** occurs primarily in part of the male urethra and epididymis.

4. Pseudostratified Columnar Epithelium

A. **pseudostratified ciliated columnar epithelium**: This type is found in the larger air passageways of the respiratory system

4. Pseudostratified Columnar Epithelium: ysem

B. pseudostratified non-ciliated columnar epithelium occurs primarily in part of the male urethra and epididymis.

2-Stratified Epithelial Tissues\classification by cell shape: It can be classified according to <u>the shape of cells of its superficial layer</u> into:

1. **Stratified Squamous Epithelium**
   A. **Non-keratinized stratified squamous epithelium**
   B. **Keratinized stratified squamous epithelium**

2. Stratified Cuboidal Epithelium

3. Stratified Columnar Epithelium

4. Transitional Epithelium

2-Stratified Epithelial Tissues\classification by cell shape:

1. **Stratified Squamous Epithelium:** This tissue has multiple cell layers, and only the deepest layer of cells is in direct contact with the basement membrane. Stratified squamous epithelium is so named because of its multiple cell layers and the shape of the apical cells.
   - A. **Non-keratinized stratified squamous epithelium**
   - B. **Keratinized stratified squamous epithelium**

2. Stratified Cuboidal Epithelium

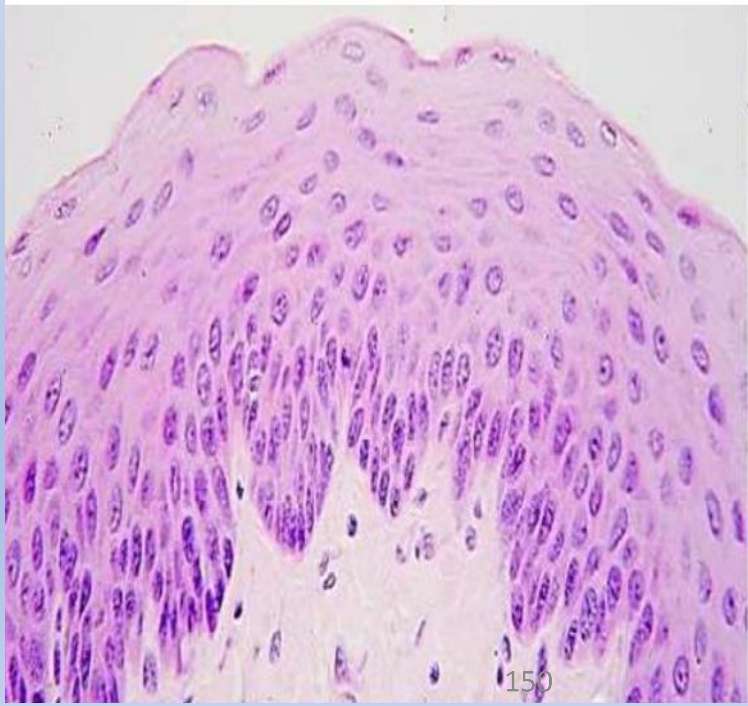
3. Stratified Columnar Epithelium

4. Transitional Epithelium

2-Stratified Epithelial Tissues\classification by cell shape:

1. **Stratified Squamous Epithelium**

A. **Non-keratinized stratified squamous epithelium:** The cells remain alive all the way to the tissue's apical surface, and they are kept moist with secretions such as saliva or mucus. These cells lack keratin; a tough protective protein that is abundant in the keratinized form of this epithelium. Ex: (the oral cavity - mouth)



B. **Keratinized stratified squamous epithelium**

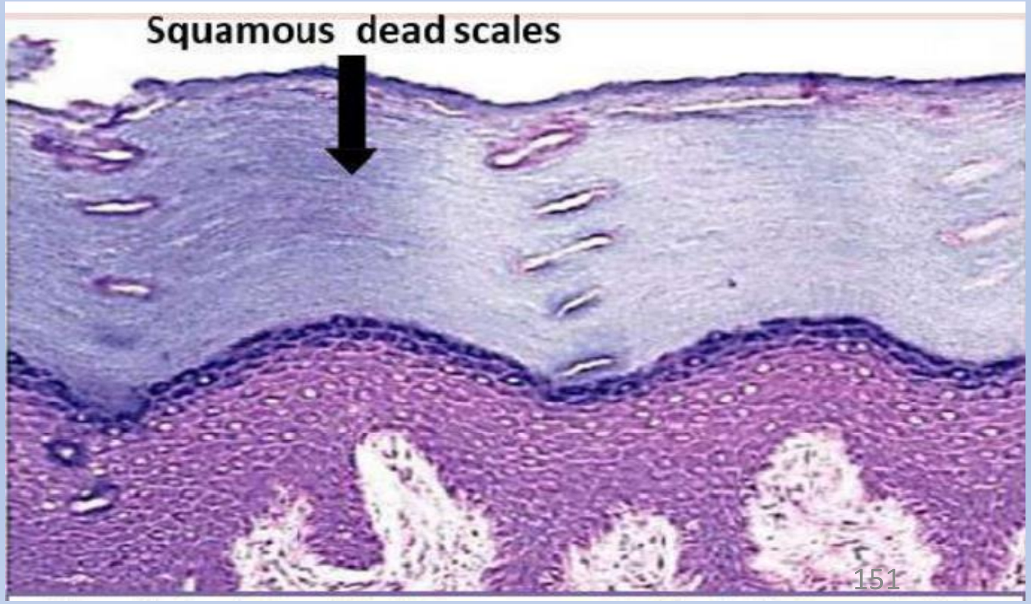
2. **Stratified Cuboidal Epithelium**
3. **Stratified Columnar Epithelium**
4. **Transitional Epithelium**

2-Stratified Epithelial Tissues\classification by cell shape:

1. Stratified Squamous Epithelium

A. Non-keratinized stratified squamous epithelium

B. Keratinized stratified squamous epithelium: The superficial layers are composed of cells that are dead. These cells lack nuclei and all organelles when observed under the microscope, and instead are filled with the protein keratin. Ex: (The epidermis (outer layer) of the skin)



2. Stratified Cuboidal Epithelium

3. Stratified Columnar Epithelium

4. Transitional Epithelium

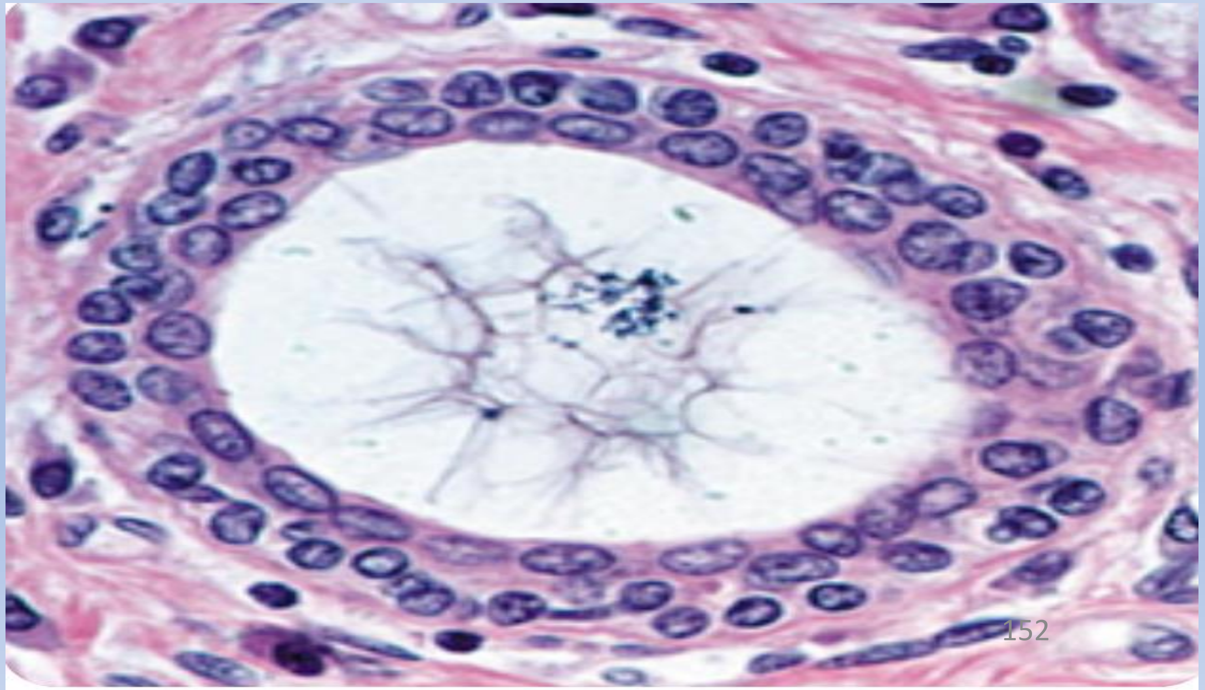
2-Stratified Epithelial Tissues\classification by cell shape:

1. **Stratified Squamous Epithelium**
   A. **Non-keratinized stratified squamous epithelium**
   B. **Keratinized stratified squamous epithelium**

2. Stratified Cuboidal Epithelium:this epithelium contains two or more layers of cells, and the superficial cells tend to be cuboidal in shape. Ex: (This tissue forms the walls of the large ducts of most exocrine glands, such as the ducts of the sweat glands in the skin)

3. Stratified Columnar Epithelium

4. Transitional Epithelium



2-Stratified Epithelial Tissues\classification by cell shape:

1. **Stratified Squamous Epithelium**
   A. **Non-keratinized stratified squamous epithelium**
   B. **Keratinized stratified squamous epithelium**

2. Stratified Cuboidal Epithelium

3. Stratified Columnar Epithelium: It consists of two or more layers of cells, but only the cells at the apical surface are columnar in shape. Ex: It is found in the large ducts of salivary glands.

4. Transitional Epithelium

2-Stratified Epithelial Tissues\classification by cell shape:

1. **Stratified Squamous Epithelium**
    A. **Non-keratinized stratified squamous epithelium**
    B. **Keratinized stratified squamous epithelium**

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3. Stratified Columnar Epithelium: It consists of two or more layers of cells, but only the cells at the apical surface are columnar in shape. Ex: It is found in the large ducts of salivary glands.

4. Transitional Epithelium

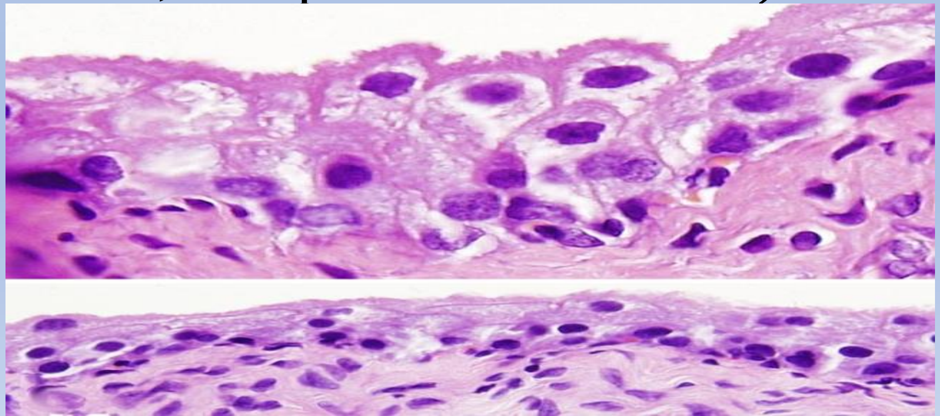
2-Stratified Epithelial Tissues\classification by cell shape:

1. **Stratified Squamous Epithelium**
   A. **Non-keratinized stratified squamous epithelium**
   B. **Keratinized stratified squamous epithelium**

2. Stratified Cuboidal Epithelium

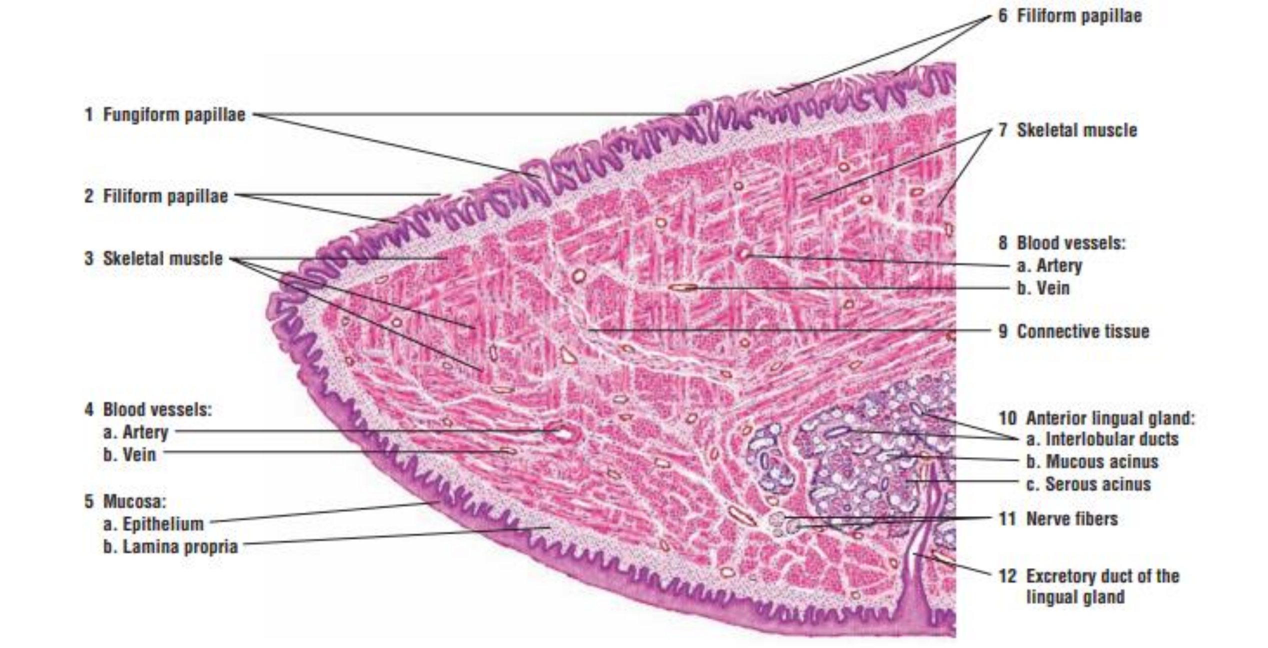
3. Stratified Columnar Epithelium

4. Transitional Epithelium: It varies in appearance, depending upon whether it is in a relaxed state or a stretched state. In a relaxed state, the basal cells appear cuboidal or polyhedral, and the apical cells are large and rounded. When transitional epithelium stretches, it thin and the apical cells flatten and become almost squamous in shape. Ex: This epithelium is limited to the urinary tract (urinary bladder, ureters, and part of the urethra).



The Tongue

It is a muscular organ located in the oral cavity. The core of the tongue consists of connective tissue and interlacing bundles of skeletal muscle fibers. The distribution and random orientation of individual skeletal muscle fibers in the tongue allows for increased movement during chewing, swallowing, and speaking.



Post-test Quiz

List the layers of basement membrane

GLANDULAR EPITHELIAL TISSUE

LECTURE (8)

Objective: this lecture learn about general concepts of glandular epithelial tissue

Pre-test Quiz

Define endocrine gland

Glandular Epithelial Tissue: Formed by cells specialized to produce secretion. As epithelial tissue develops in the embryo, small invaginations from this epithelium into the underlying connective tissue give rise to specialized structures called glands.

Glands perform a secretory function by producing substances either for use elsewhere in the body or for elimination from the body. Glandular secretions include mucin, hormones, enzymes, and waste products. According to the number of the cellular layers it could be an Individual cell (unicellular) a Multicellular organ.

Glands are classified as **endocrine** &**exocrine** depending upon whether they have a duct connecting the secretory cells to the surfaces of an epithelium.

1- Endocrine glands

2- Exocrine glands

1- Endocrine glands lack ducts and secrete their products directly into the interstitial fluid and bloodstream. The secretions of the endocrine glands, called hormones, act as chemical messengers to influence cell activities elsewhere in the body, for example pituitary, thyroid, and adrenal glands.

2- Exocrine glands originate from an invagination of the epithelium that burrows into the deeper connective tissues. These glands usually maintain their contact with the epithelial surface by means of **<u>a duct</u>** (an epithelium-lined tube through which secretions of the gland are discharged onto the epithelium surface)

Multicellular exocrine glands may be classified according to three criteria:

1. Form and structure (Morphology)
2. Type of secretion
3. Method of secretion

First - Form and structure (Morphology)

Based on the structure and complexity of their ducts, exocrine glands are considered either simple or compound.

a)**Simple Glands** have a single, unbranched duct.

b)**Compounds Glands** have ducts that branch repeatedly.

First - Form and structure (Morphology)

a) **Simple Glands** are classified according to the shape or organization of their secretory portions:

If the secretory portion and the duct are of uniform diameter, the gland is called Tubular. It can be further subdivided into

1. simple tubular
2. simple coiled tubular
3. simple branched tubular

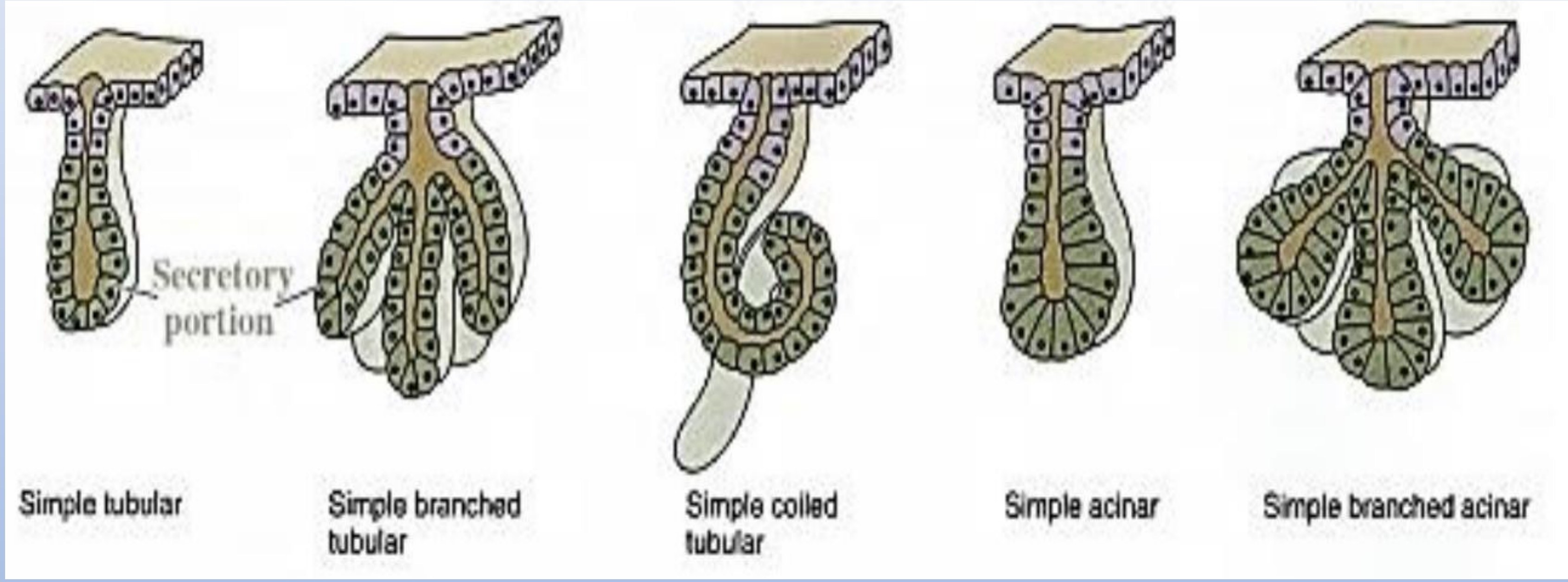
First - Form and structure (Morphology)

a) **Simple Glands** are classified according to the shape or organization of their secretory portions:

If the secretory cells form an expanded sac the gland is called Acinar (alveolar). It can be further subdivided into:

1. simple acinar or alveolar
2. simple branched acinar

Simple exocrine glands



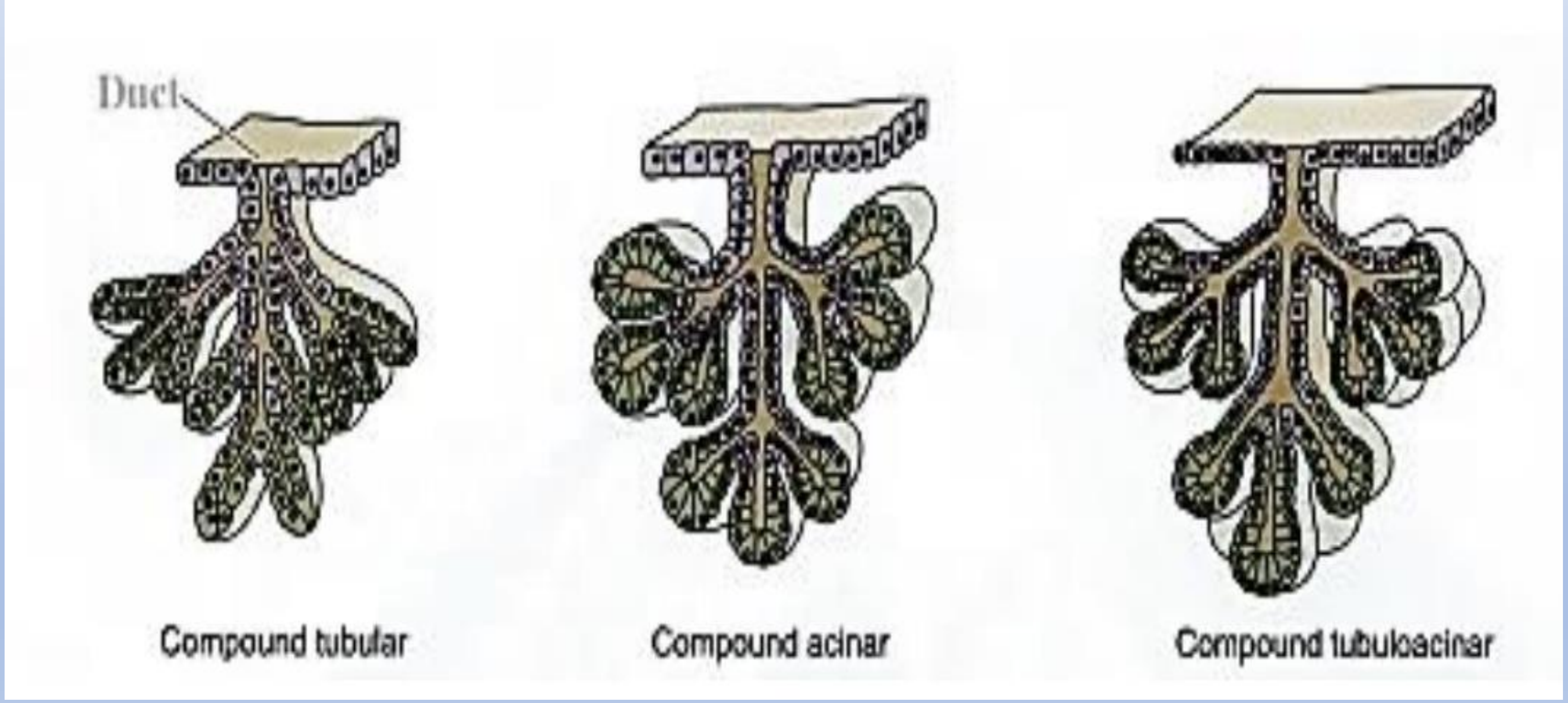
First - Form and structure (Morphology)

2- Compound exocrine glands: consist of a varying number of simple glands whose small excretory ducts join to form progressively larger and larger ducts which carry the secretion onto an epithelial surface.

They are also classified according to the shape or organization of their secretory portions:

1. compound tubular.
2. compound acinar(alveolar).
3. compound tubule-acinar

Compound exocrine glands



Second- Types of Secretion:

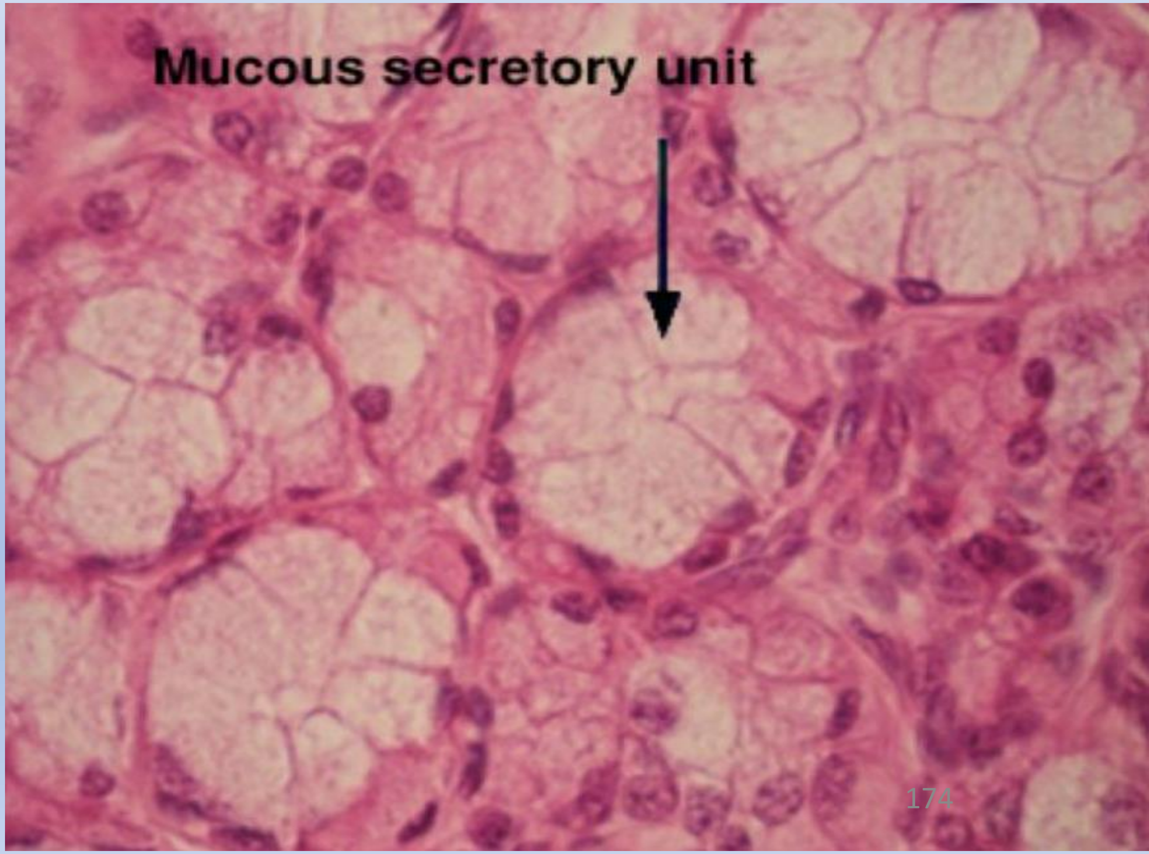
Exocrine Glands are classified by the nature of their secretions as serous glands, mucous glands, or mixed glands (seromucous).

Second- Types of Secretion:

A. Serous Glands: produce and secrete a non-viscous, watery fluid, such as sweat, milk, tears, or digestive juices.

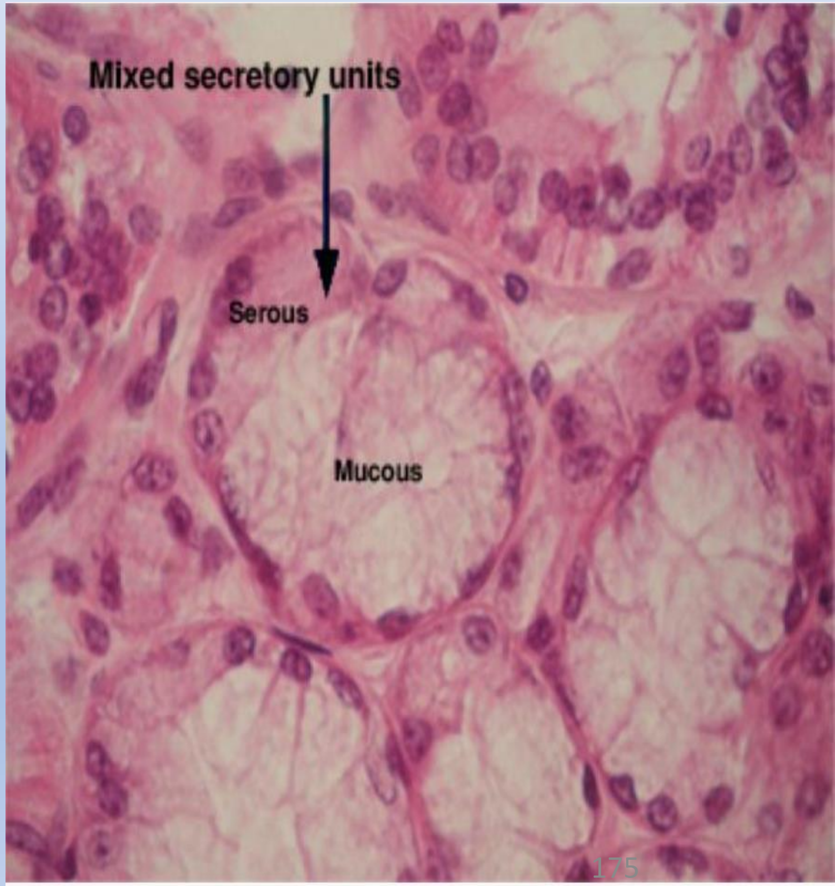
Second- Types of Secretion:

B. Mucous Glands: secrete mucins, which forms mucus when mixed with water. Found in such places as the roof of the oral cavity and the surface of the tongue.



Second- Types of Secretion:

C. Mixed Glands (seromucous): contains both serous and mucous cells and produce a mixture of the two types of secretions, they consist primarily of mucous secretory units with crescent-shaped clusters of serous cells (serous demilunes) located at the periphery of the mucous units, for example submandibular and sublingual salivary glands.



Third- Methods of Secretion:

Glands also can be classified by their mechanism of discharging secretory product.

A. Merocrine Glands:

B. Holocrine Glands:

C. Apocrine Glands:

Third- Methods of Secretion:

A.Merocrine Glands:

They package their secretions in structures called secretory vesicles. The secretory vesicles travel to the apical surface of the glandular cells and leave the cell by exocytosis with no loss of other cellular material. Lacrimal (tear) glands, salivary glands, some sweat glands.

Third- Methods of Secretion:

B. Holocrine Glands:

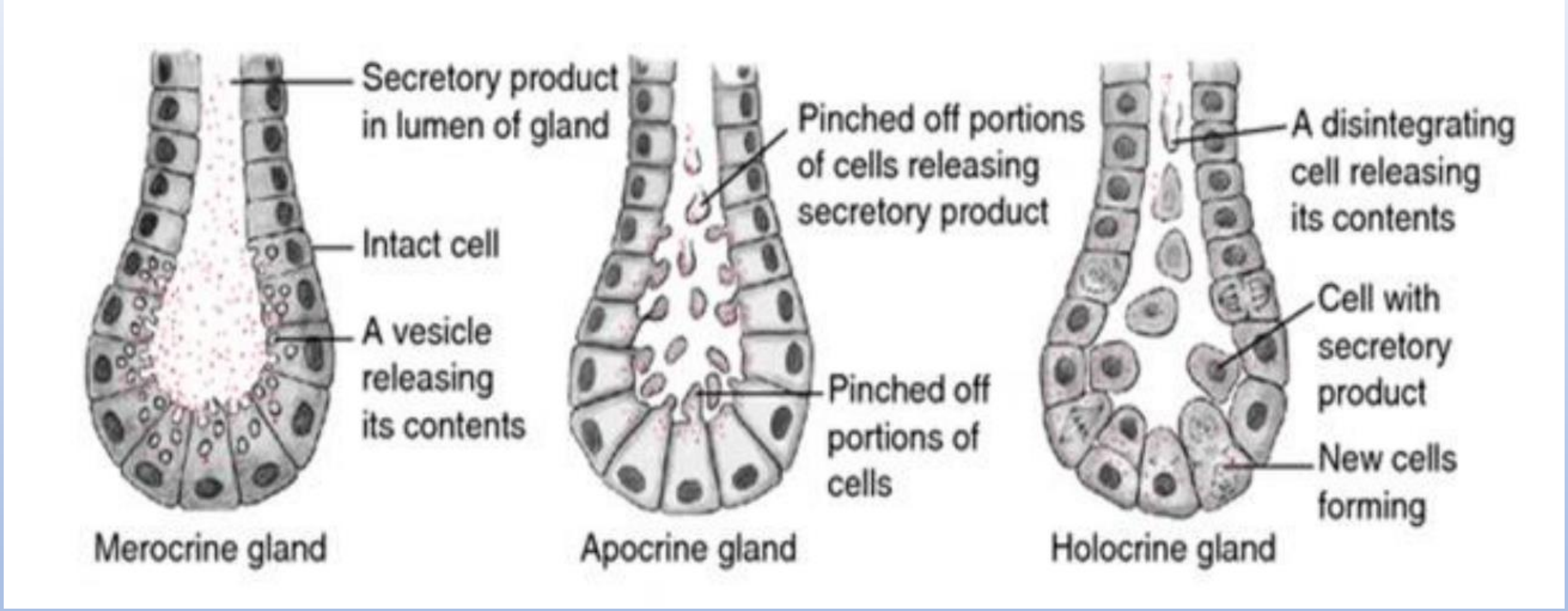
Formed from cells that accumulate a product and then the entire cell disintegrates. Thus, a holocrine secretion is a mixture of cell fragments and the product the cell synthesized prior to its destruction. The ruptured dead cells are continuously replaced by other epithelial cells undergoing mitosis. The oil-producing glands (sebaceous glands) in the skin.

Third- Methods of Secretion:

C. Apocrine Glands:

Composed of cells that accumulates their secretory products within the apical portion of their cytoplasm. The secretion follows as this apical portion decapitates. So, their mode of secretion is a decapitation. The apical portion of the cytoplasm begins to pinch off into the lumen of the gland for the secretory product to be transported to the skin surface. Mammary glands are apocrine gland.

Third- Methods of Secretion:



Post-test Quiz

Give one differences between simple and compound gland

GENERAL CONNECTIVE TISSUE (BLOOD)
LECTURE (9)

Objective: this lecture learn about study the general connective tissue

Pre-test Quiz

Give the function of connective tissue

Connective tissue is specialized to physically support and connect other tissues and maintain the water required for metabolite diffusion to and from cells.

Function of the CT:

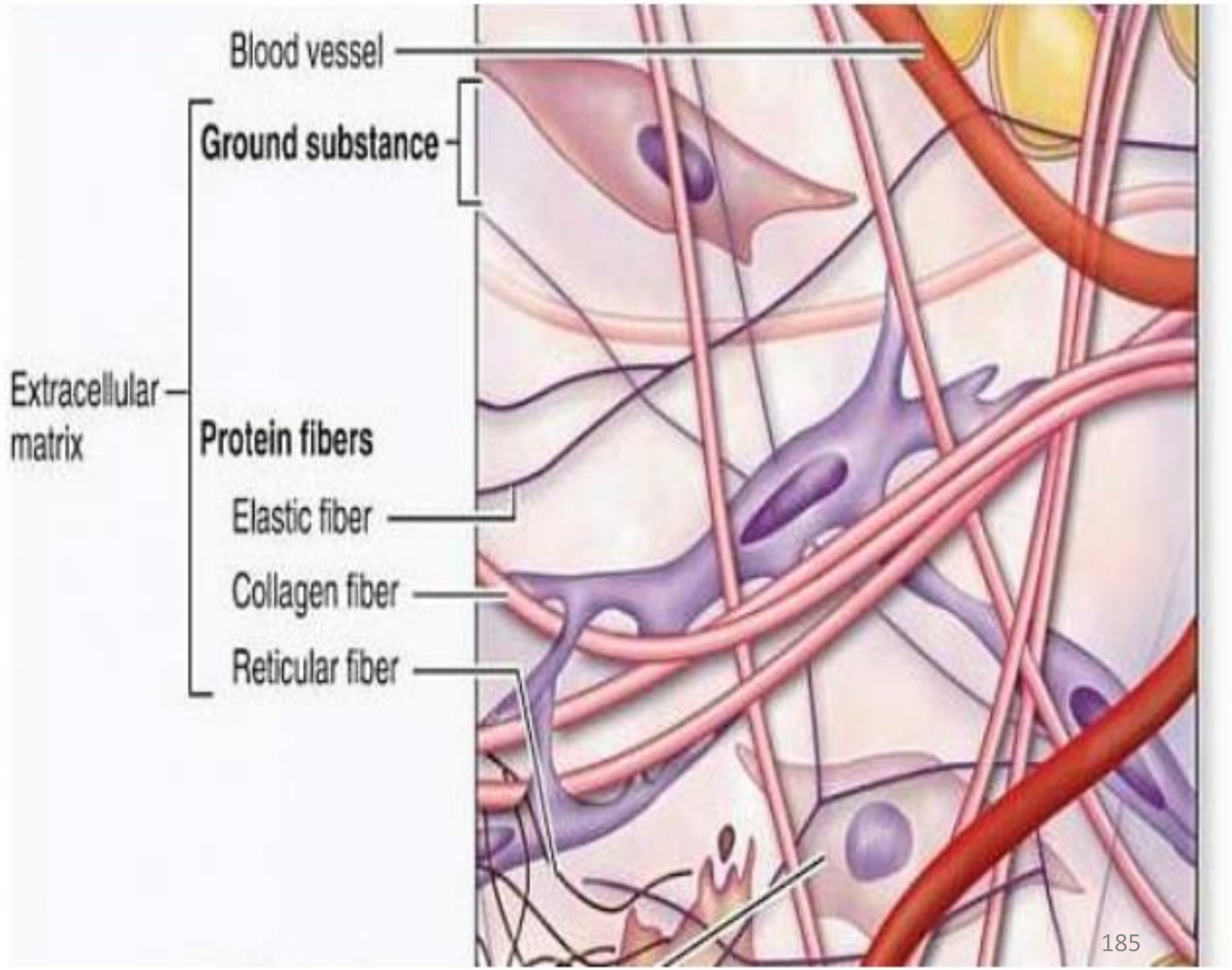
1. Binding and supporting, like bones and cartilages
2. Protection like skin and adipose tissue
3. Insulation like adipose tissue
4. Storing reserve fuel
5. Transporting substances within the body like blood.

Connective tissue is formed by three components:

A. Cells

B. Fibers

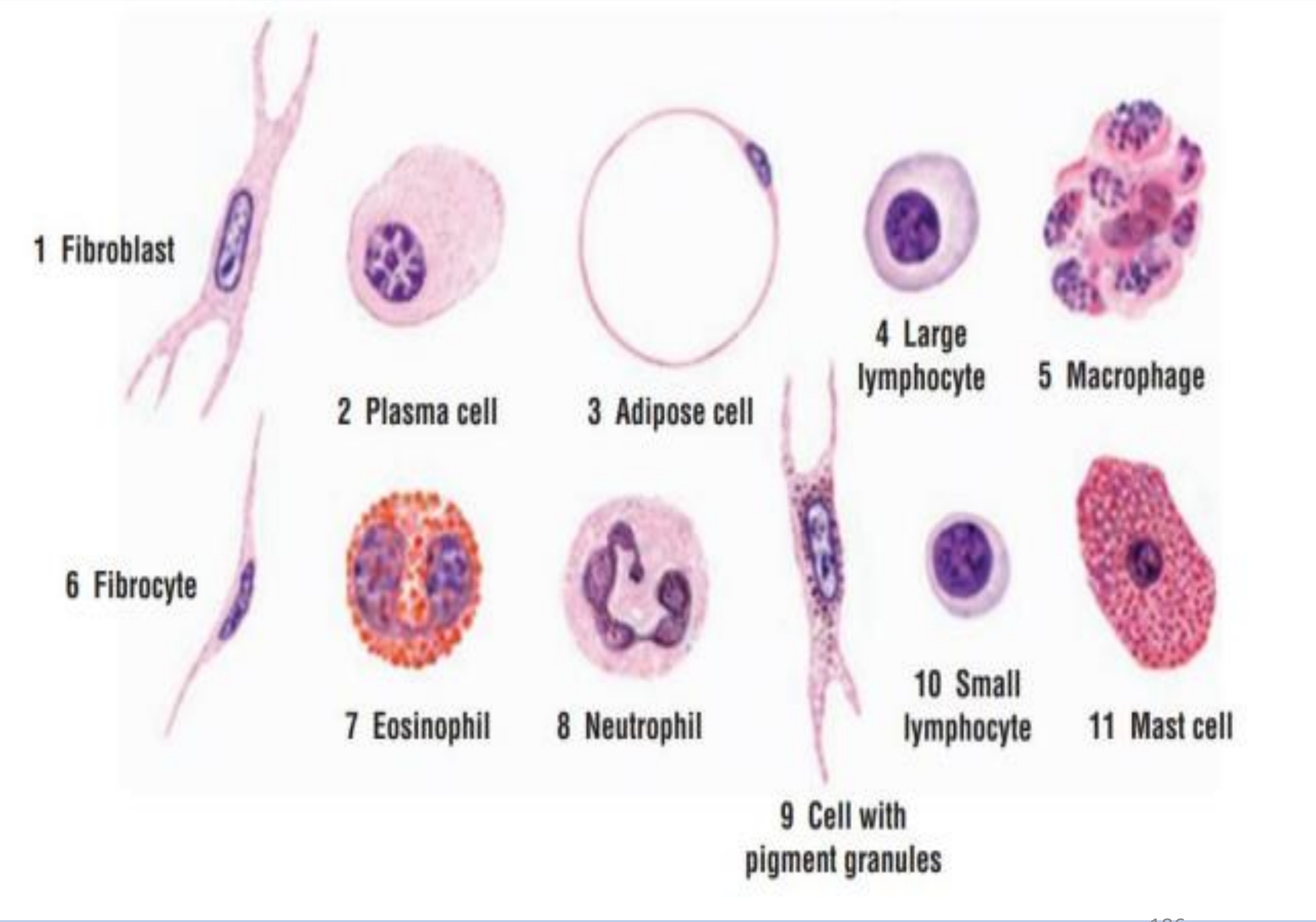
C. Ground Substance



Connective tissue is formed by three components:

A. Cells

- Fibroblast
- Plasma cell
- Adipose cell
- Large lymphocyte
- Macrophage
- Fibrocyte
- Eosinophil
- Neutrophil
- Cells with pigment granules
- Small lymphocyte
- Mast cell



Connective tissue is formed by three components:

B. Fibers of connective tissue involved:

Three main types of fibers are secreted by fibroblasts

- **White (collagenous) fibers:**
- **Yellow (elastic) fibers:**
- **Reticular fibers**

Connective tissue is formed by three components:

B. Fibers of connective tissue involved:

Three main types of fibers are secreted by fibroblasts

- **White (collagenous) fibers:** Are constructed primarily of the fibrous protein (collagen) subunits linked together to form a long and straight fiber. These fibers are extremely tough and provide high tensile strength (that Is, the ability to resist longitudinal stress) to the matrix.

Connective tissue is formed by three components:

B. Fibers of connective tissue involved:

Three main types of fibers are secreted by fibroblasts

- **Yellow (elastic) fibers:** Contains the protein elastin along with lesser amounts of other proteins and glycoproteins. The main property of elastin is that after being stretched or compressed, it will return to its original shape. Elastic fibers are prominent in elastic tissues found in skin and the elastic ligaments of the vertebral column.

Connective tissue is formed by three components:

B. Fibers of connective tissue involved:

Three main types of fibers are secreted by fibroblasts

- **Reticular fibers:** Are fine collagenous fibers, they branch extensively, forming delicate networks that surround small blood and support the soft tissue of organs.

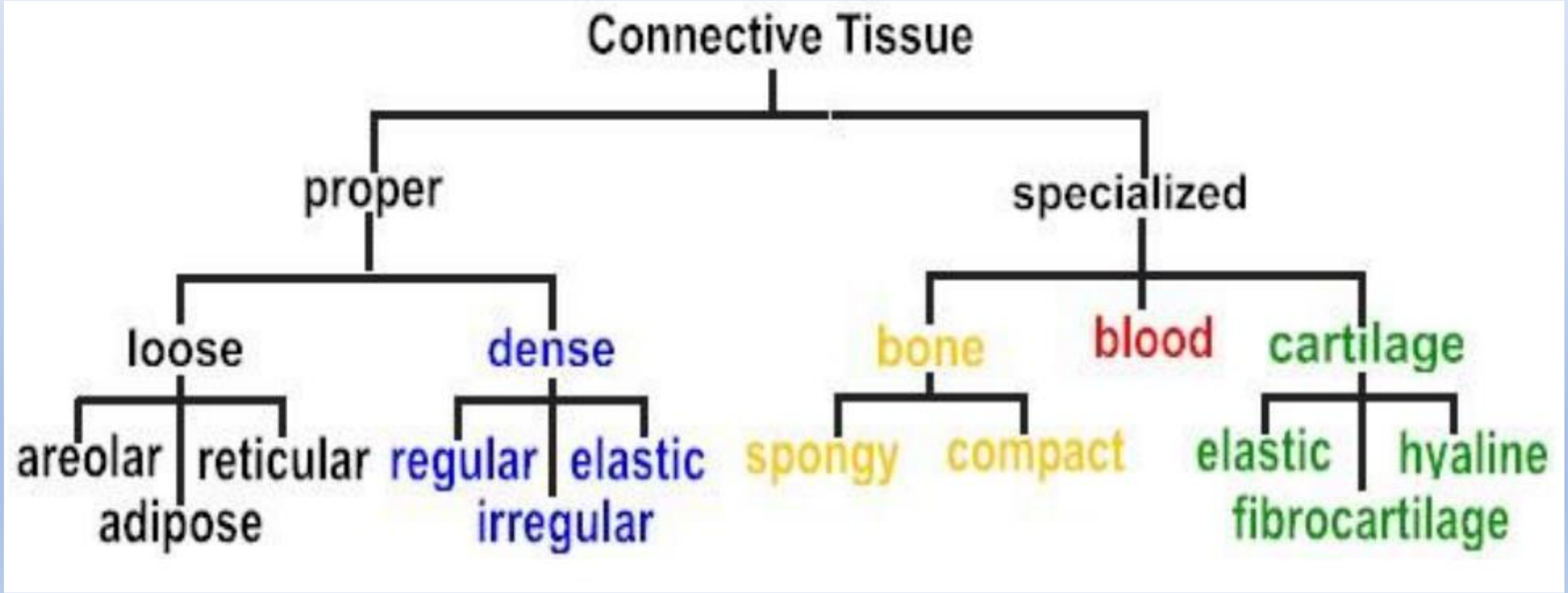
Connective tissue is formed by three components:

C. Ground Substance: Is a clear, colorless, viscous, unstructured material that fills the space between the cells and contains the fibers It is composed of proteoglycans and cell adhesion proteins that allow the connective tissue to act as glue for the cells to attach to the matrix.

The ground substance functions as a molecular sieve or medium for substances to travel between blood capillaries and cells. The fibers embedded in the ground substance impede diffusion somewhat and make it less pliable.

Types of connective tissues

Connective tissue can be divided into two main type



1- **Connective tissue proper**: according to the concentration of fibers, this type is divided into:

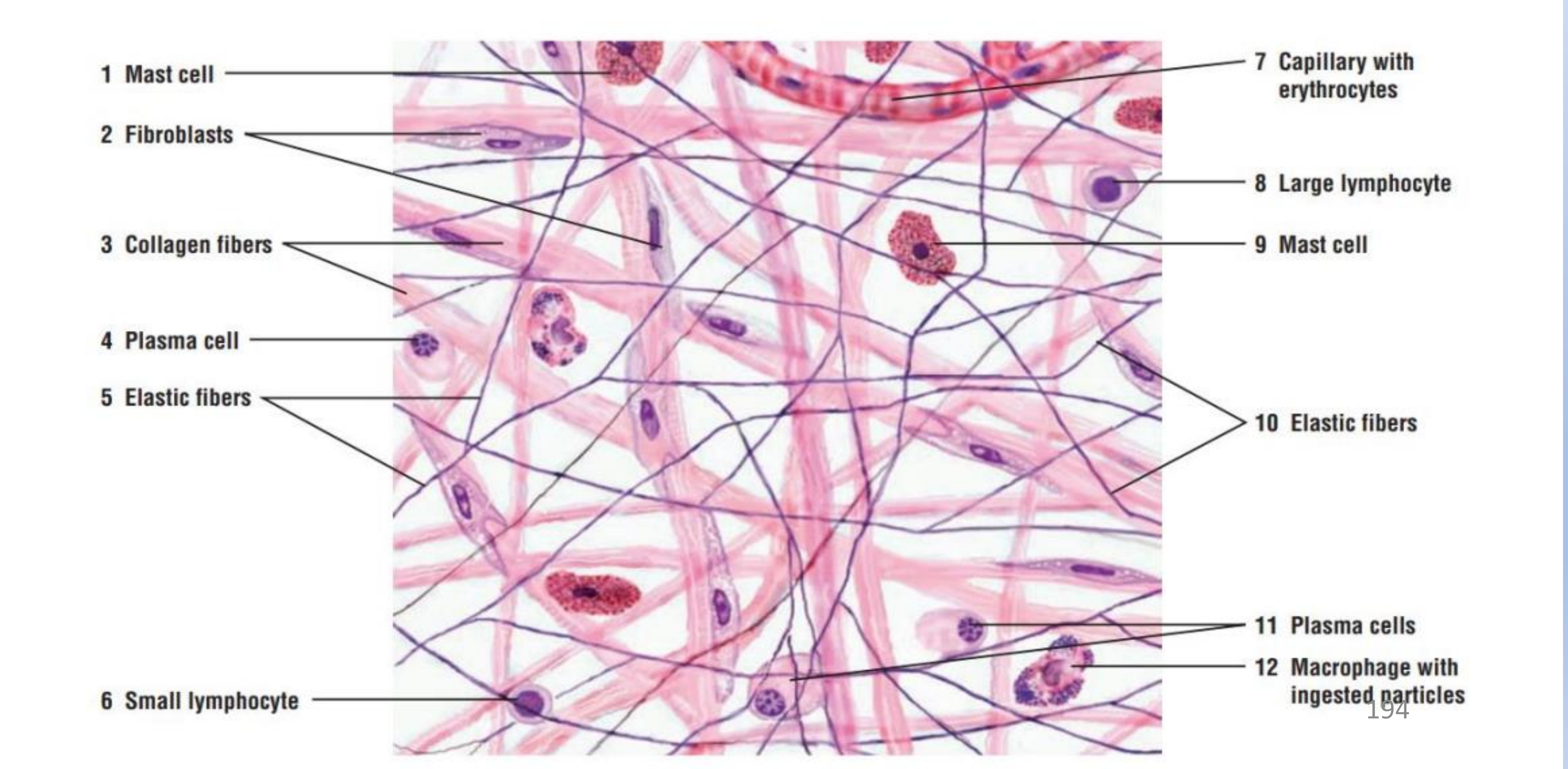
A. Loose connective tissue

B. Dense connective tissue:

1- **Connective tissue proper**:

A. Loose connective tissue

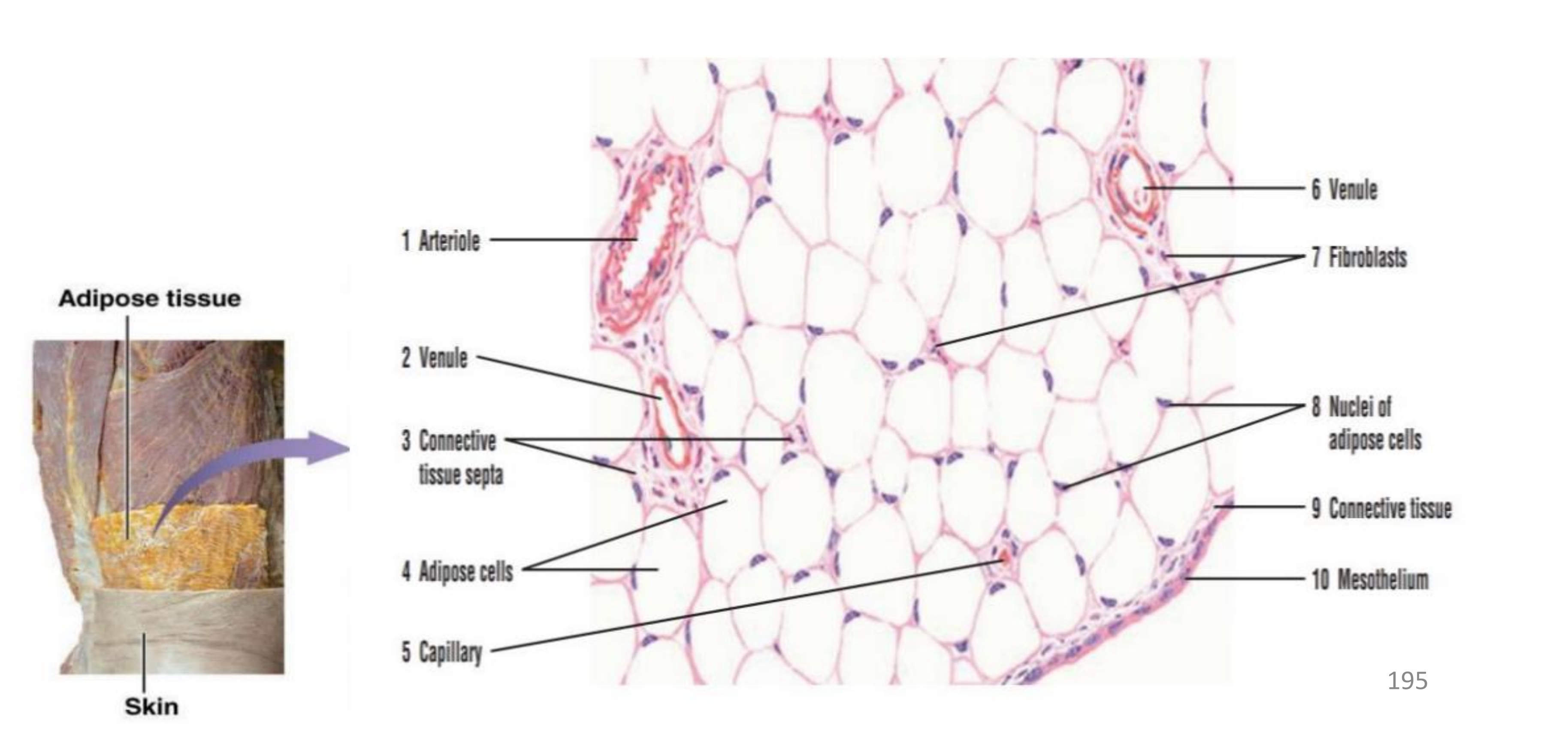
1. Areolar loose connective tissue found in most body tissues.



1- **Connective tissue proper**:

A. Loose connective tissue

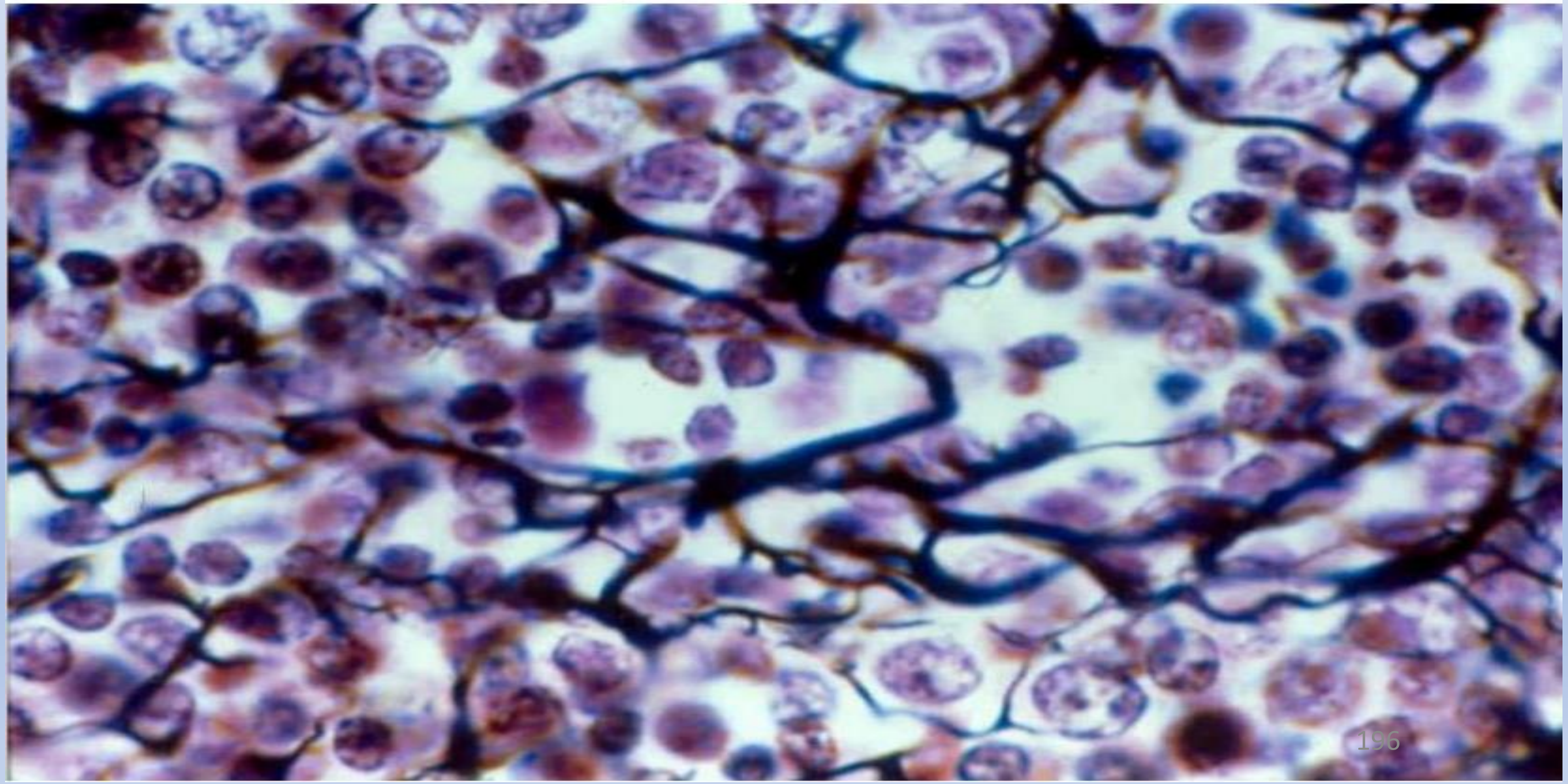
2. Adipose loose connective tissue found in hypodermis superficial fascia of skin.



1- **Connective tissue proper**:

A. Loose connective tissue

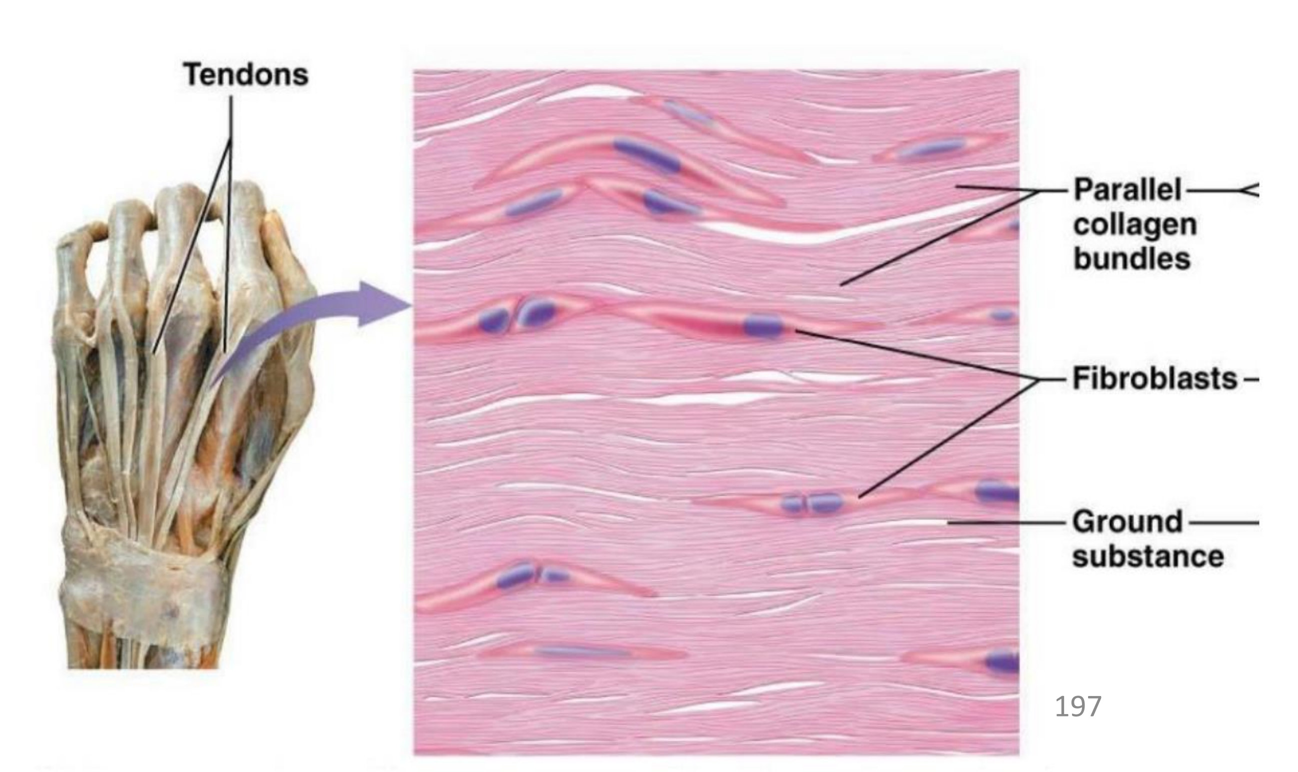
3. Reticular loose connective tissue found in lymph nodes.



1- **Connective tissue proper**:

B. Dense connective tissue: According to the arrangement of fiber, this type is divided into:

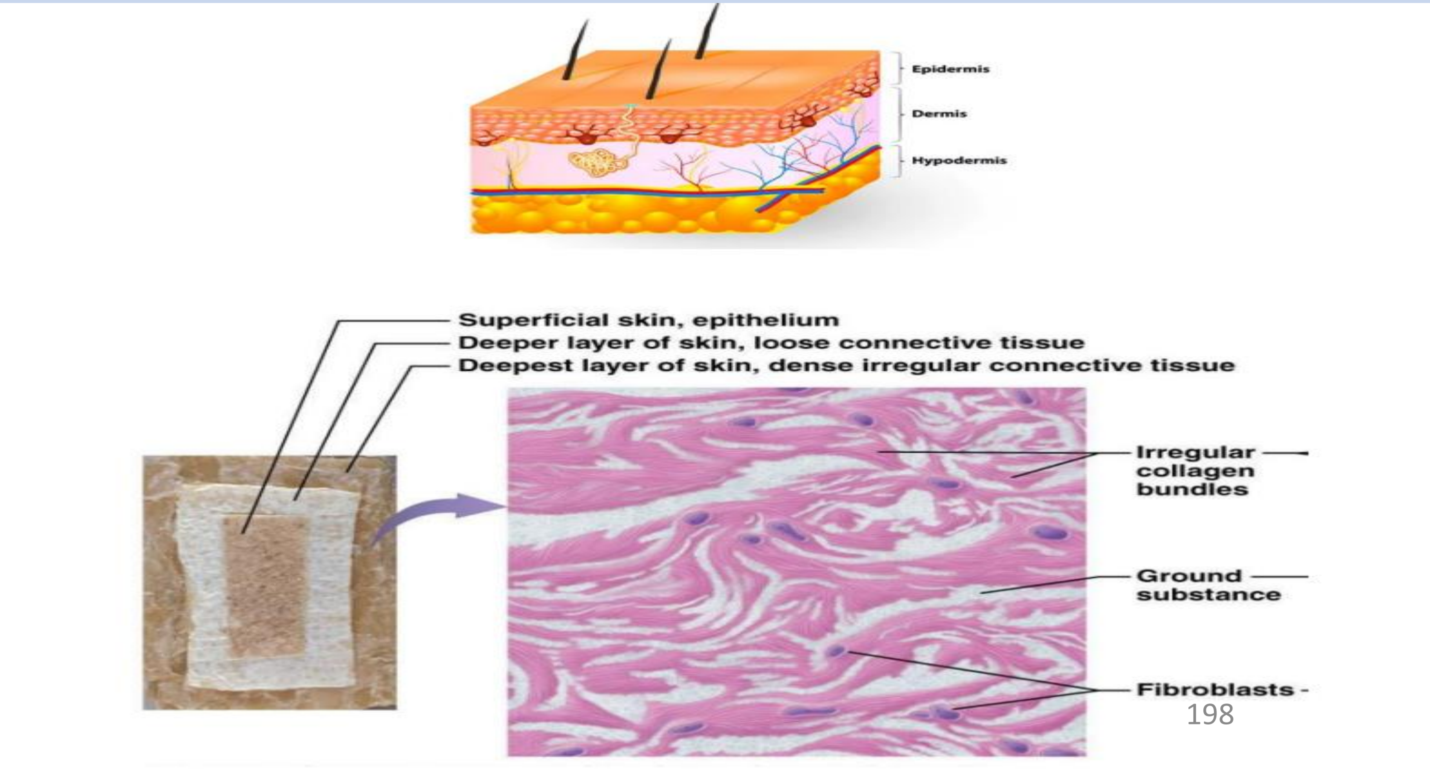
1. Regular dense connective tissue (White fibrous regular dense connective tissue) found in Tendon.



1- **Connective tissue proper**:

B. Dense connective tissue: According to the arrangement of fiber, this type is divided into:

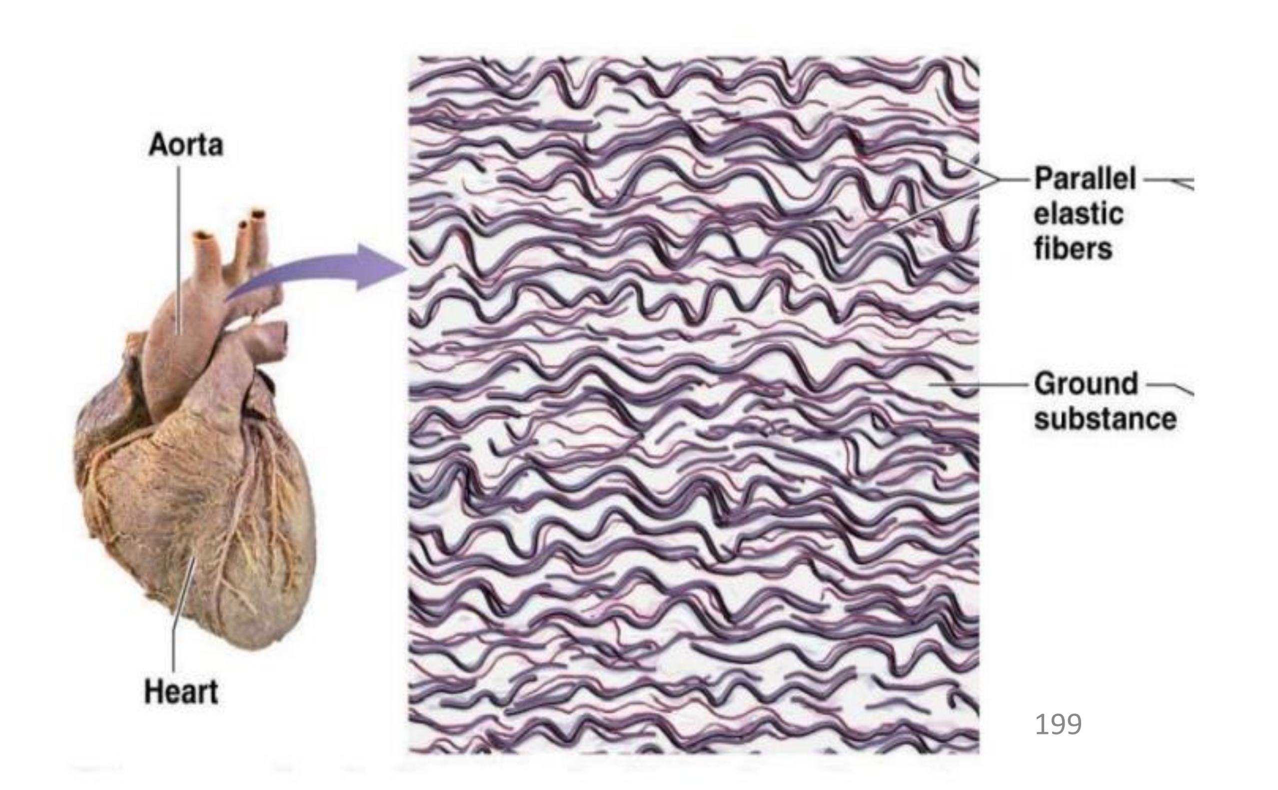
2. Irregular dense connective tissue found in dermis of human skin.



1- **Connective tissue proper**:

B. Dense connective tissue: According to the arrangement of fiber, this type is divided into:

3. Elastic dense connective tissue found in aorta



Specialized Connective Tissue

(Supporting Connective Tissue)

Cartilage is a special form of connective tissue that also develops from the mesenchyme. Like the connective tissue, cartilage consists of cells and extracellular matrix composed of connective tissue fibers and ground substance. In contrast to connective tissue, cartilage is nonvascular (avascular) and receives its nutrition via diffusion through the extracellular matrix

Cartilage exhibits tensile strength, provides firm structural support for soft tissues, allows flexibility without distortion, and is resilient to compression. Cartilage consists mainly of cells called chondrocytes and chondroblasts that synthesize the extensive extracellular matrix, and the cells themselves are located in matrix cavities called lacunae. There are three main types of cartilage in the body: hyaline, elastic, and fibrocartilage. Their classification is based on the amount and types of connective tissue fibers that are present in the extracellular matrix.

Cartilage usually has a covering sheath called Perichondrium; composed of two distinct layers:

1. **The outer fibrous region (fibrous perichondrium)** of dense irregular connective tissue provides protection and mechanical support.
2. **The inner cellular layer (chondrogenic perichondrium)** contains stem cells (chondroblasts) necessary for the growth and maintenance of the cartilage.

Types of Cartilage

1- Hyaline Cartilage

2- Elastic Cartilage

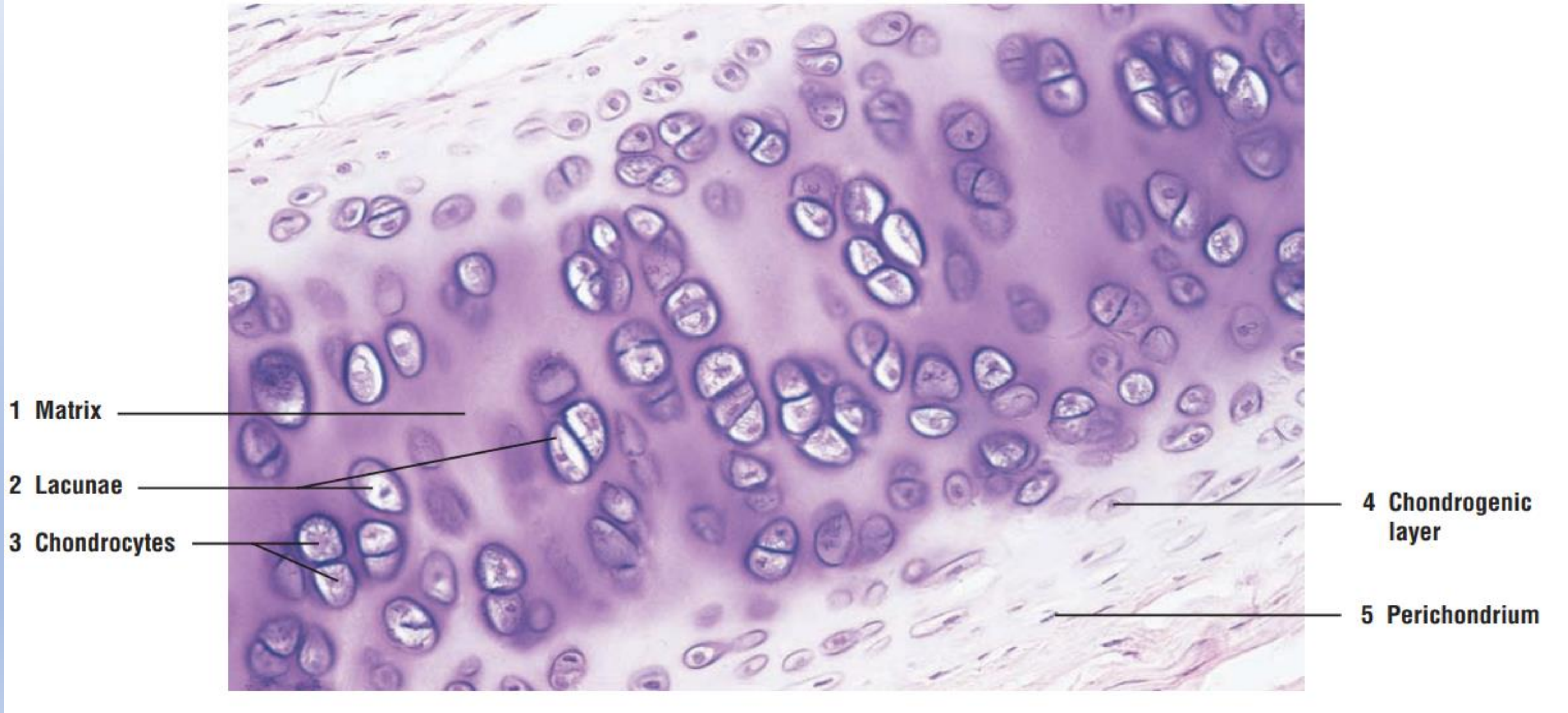
3- Fibrocartilage

Types of Cartilage

1- Hyaline Cartilage: The most common type of cartilage and also the weakest. It is named for its clear glassy appearance under microscope, the chondrocytes within their lacunae are irregularly scattered throughout the extracellular matrix. The collagen within the matrix is not readily observed by light microscopy because it is primarily in the form of submicroscopic fibrils. It provides support through flexibility and resilience. Hyaline cartilage is found in many other areas of the body including the nose, the trachea, most of the larynx, coastal cartilage (cartilage attached to ribs) and the articular ends of long bones.

Types of Cartilage

1- Hyaline Cartilage

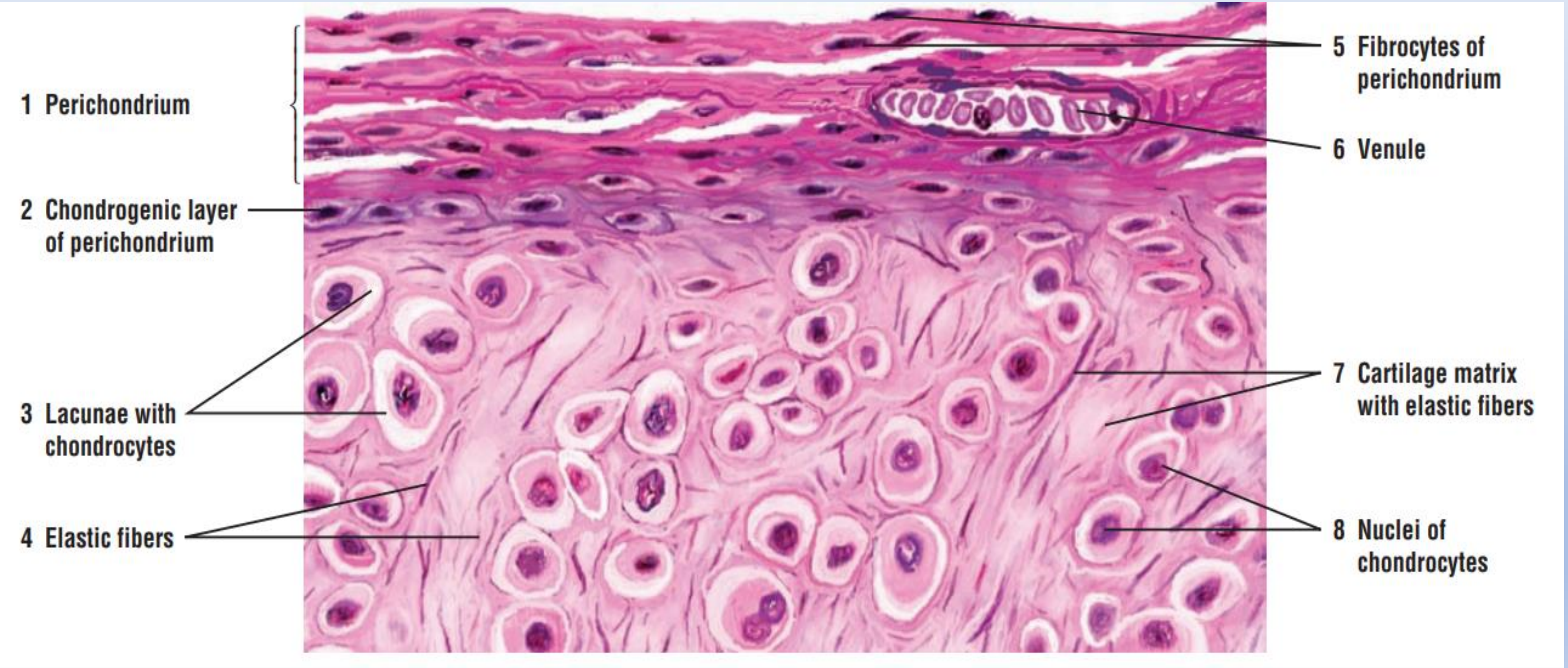


Types of Cartilage

2- Elastic Cartilage: It is so named because it has numerous elastic fibers in its matrix. The higher concentration of elastic fibers in this cartilage causes it to appear yellow in fresh sections. The chondrocytes of elastic cartilage are almost indistinguishable from those of hyaline cartilage. They are typically closely packed and surrounded by only a small amount of extracellular matrix. Elastic cartilage is found in epiglottis and in the external ear.

Types of Cartilage

2- Elastic Cartilage

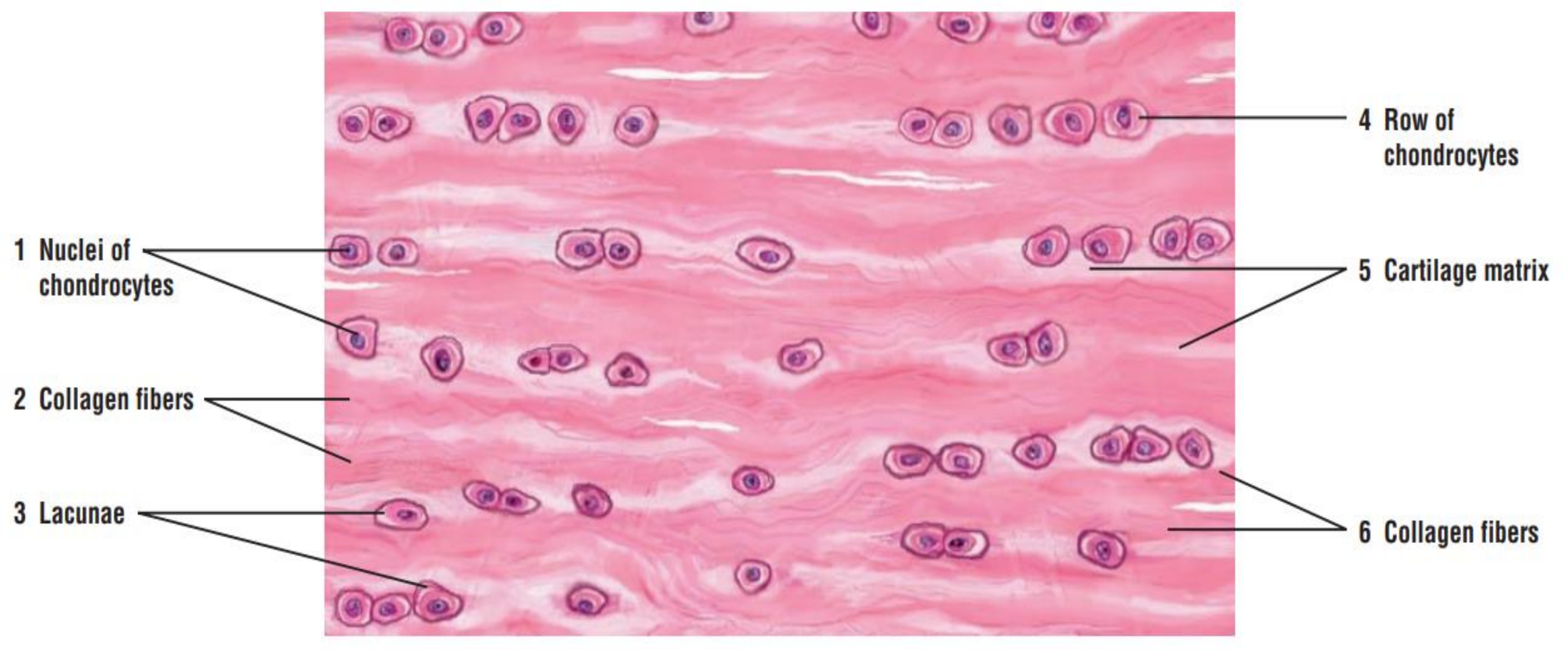


Types of Cartilage

3- Fibrocartilage: is a tissue intermediate between dense connective tissue and hyaline cartilage. the strongest type of cartilage; it has numerous courses, readily visible fibers in its extracellular matrix. The fibers are arranged as irregular bundles between large chondrocytes. There is only a sparse amount of ground substance, and often the chondrocytes are arranged in parallel long rows separated by coarse collagen type I fibers. Fibrocartilage is found in the intervertebral discs where it acts as a shock absorber and resists compression.

Types of Cartilage

3- Fibrocartilage



The Bone: Bone is a specialized connective tissue composed of intercellular calcified material, the bone matrix, and three cell types: osteocytes, osteoblasts, and osteoclasts. Because metabolites are unable to diffuse through the calcified matrix of bone, the exchanges between osteocytes with one another and with blood capillaries depend on communication through minute passageways in the matrix called **canaliculi** which are defined as thin, cylindrical spaces that perforate the matrix.

There are two forms of bone connective tissue:

1- Compact bone

2- Spongy bone

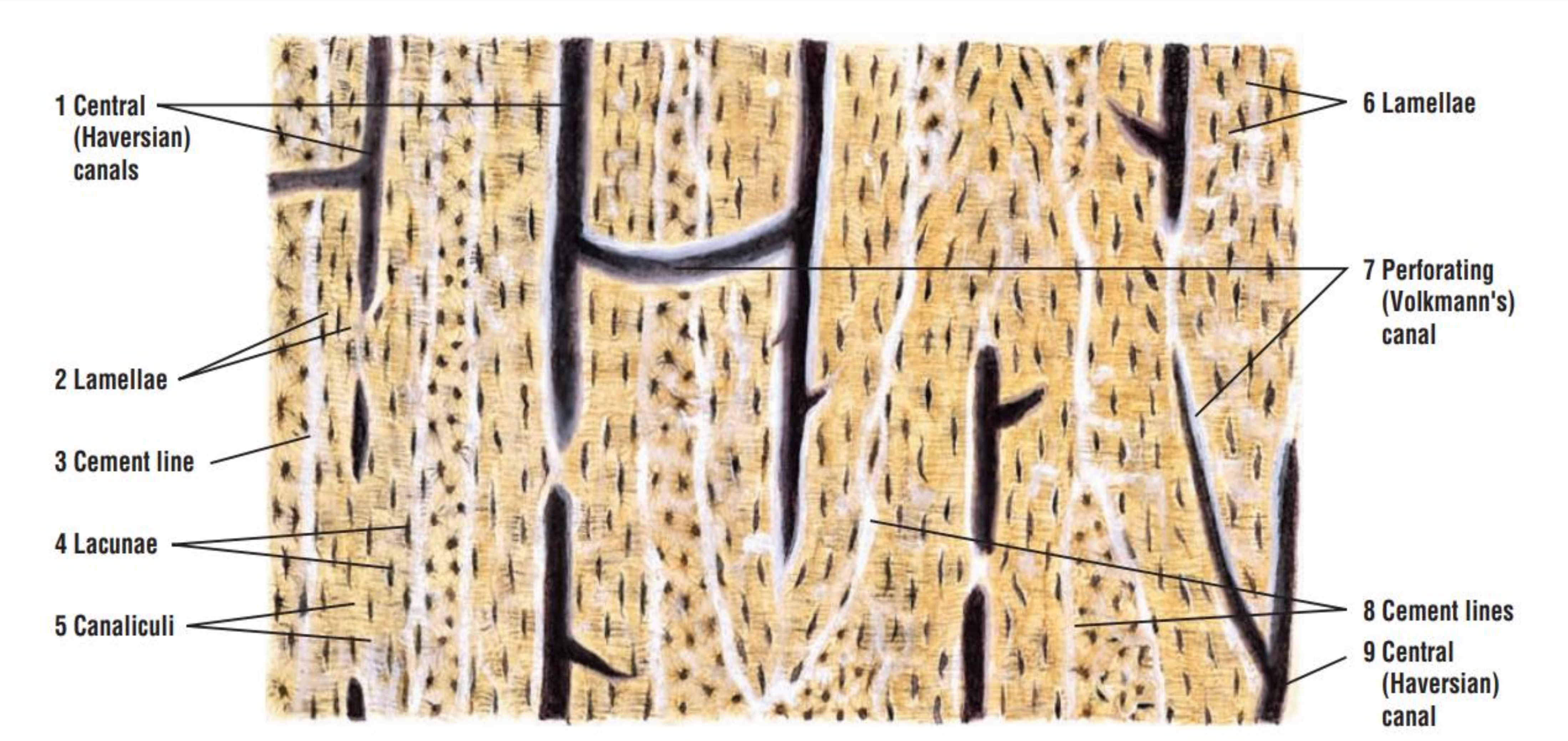
1- Compact bone: Appears solid but is in fact perforated by several vascular canals. It usually forms the hard-outer shell of the bone. A cylindrical osteon or Haversian system is the basic functional and structural unit of mature compact bone. Osteons run parallel to the diaphysis of the long bone. It was found in shaft of long bone (Diaphysis).

Compact Bone Microscopic Anatomy: An osteon composed of the following components:

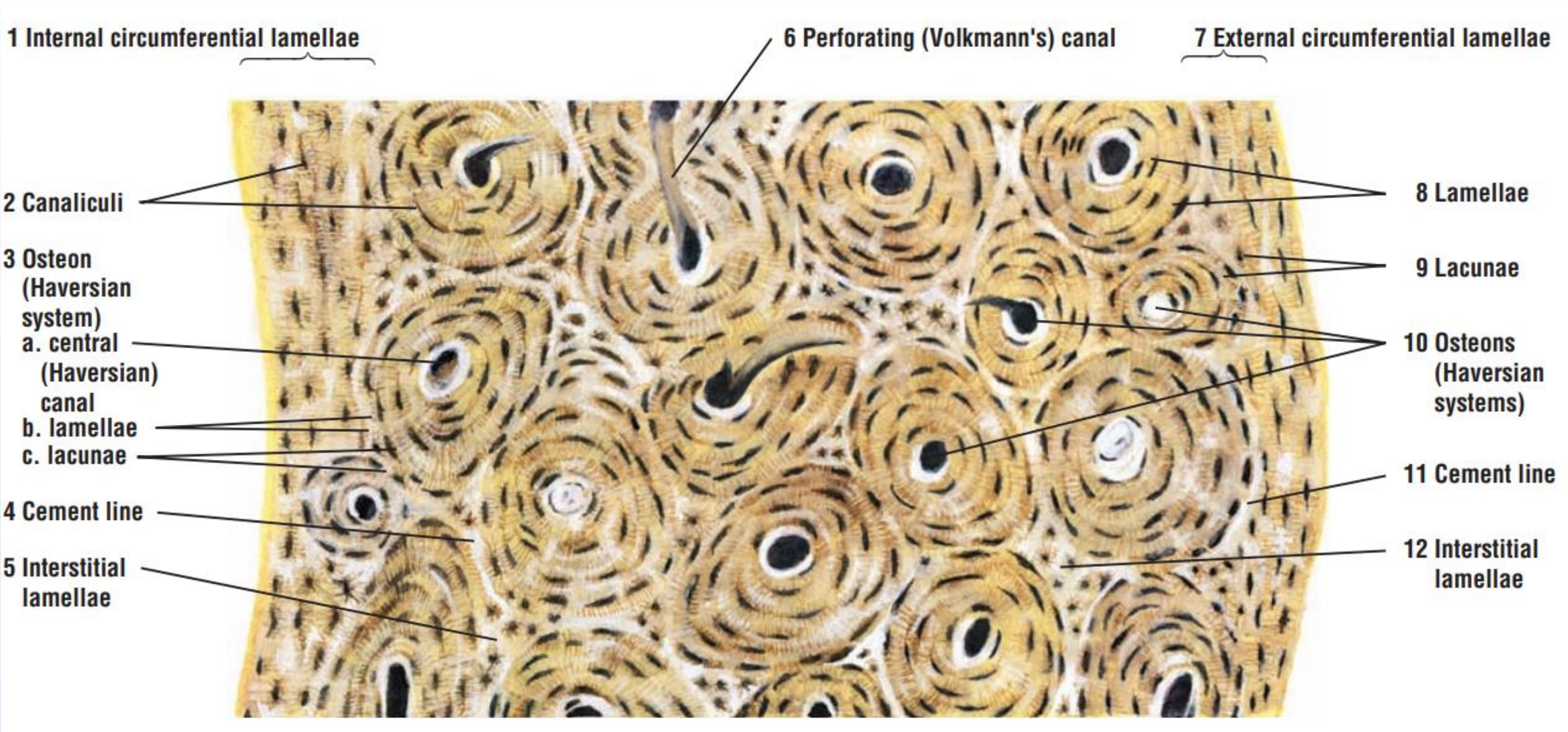
- **The central canal (Haversian canal):** is a cylindrical channel that lies in the center of the osteon.
- **Concentric lamellae:** are rings of bone connective tissue that surround the central canal and form the bulk of the osteon.
- **Osteocytes:** are housed in lacunae and are found between adjacent concentric lamellae.

- **Canaliculi:** are tiny, interconnecting channels within the bone connective tissue that extend from each lacuna, travel through the lamellae, and connect to other lacunae and the central canal.
- **Perforating canals (Volkmann canals):** resemble central canals in that they also contain blood vessels and nerves, perforating canals run perpendicular to the central canals and help connect multiple central canals, thus creating a vascular and innervation connection among the multiple osteons.

- **Circumferential lamellae:** are rings of bone immediately internal to the periosteum of the bone (external circumferential lamellae) or internal to the endosteum (internal circumferential lamellae). These two distinct regions appear during the original formation of the bone.
- **Interstitial lamellae:** are the leftover parts of osteons that have been partially resorbed.



Longitudinal section of compact bone



Transverse section of compact bone

compact bone: an osteon, transverse section

2- Spongy bone: Spongy Bone: Also called cancellous or trabecular bone, appears more porous, like a sponge, forms an open lattice of narrow plates of bone, called trabeculae. spongy bone is located internally, in the head of long bones (Epiphysis).

Spongy Bone Microscopic Anatomy: Spongy bone contains no osteons. Instead, the trabeculae of spongy bone are composed of parallel lamellae. Between adjacent lamellae are osteocytes resting in lacunae, with numerous canaliculi radiating from the lacunae. Nutrients reach the osteocytes by diffusion through canaliculi that open onto the surfaces of the trabeculae. The trabeculae often form a meshwork of crisscrossing bars and plates of bone pieces. This structure provides great resistance to stresses.

Spongy Bone: cancellous or trabecular bone

Fluid Connective Tissue

Blood is a fluid connective tissue, approximately 8% of an adult's body weight made up of blood (about 5.5 L in a man). It has a pH of (7.35-7.45), making it slightly basic. Blood in the arteries is a brighter red than blood in the veins because of the higher levels of oxygen found in the arteries.

Composition of blood:

Blood is classified as a connective tissue and consists of two main components: plasma and formed elements.

1- Plasma

2- Formed elements

Composition of blood:

1- Plasma

Proteins consist of the following:

1. Albumins
2. Globulins
3. Fibrinogen
4. Regulatory proteins

Composition of blood

2- Formed elements: Which are made up of the blood cells and platelets.

Functions of blood

1. **Transport**: Blood transports the following substances (Gases including oxygen (O2) and carbon dioxide (CO2) ets)
2. **Protection**: Blood contains leukocytes, plasma proteins, and various molecules that help protect the body against potentially harmful substances. They are part of the immune system.
3. **Regulation**: Blood participated in the regulation of:

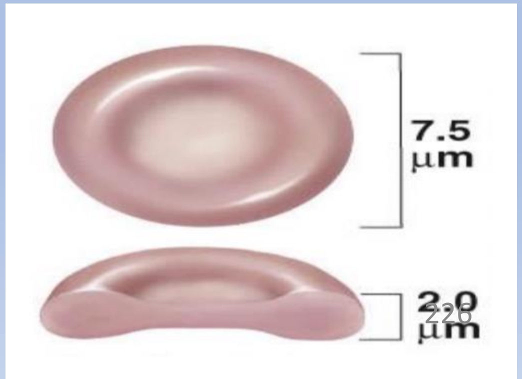
a) Body temperature

b) Body pH- Blood

c) Fluid balance

Blood elements consist of the following:

I. **Erythrocytes (Red Blood Cells)**: Transport oxygen and carbon dioxide to and from the tissues and lungs. Life span in blood: About 120 days. biconcave disc structure allows respiratory gases to be loaded and unloaded efficiently. Erythrocytes which are anucleate, are packed with the O2-carrying protein hemoglobin. The plasma membrane of a mature RBC has glycoproteins and glycolipids that determine a person’s blood type.



Hemoglobin: Every erythrocyte is filled with about 280 million molecules of the red-pigmented protein called hemoglobin that Makes up 33% of RBC cytoplasm. It transports oxygen and carbon dioxide and is responsible for the characteristic color of blood.

Main Functions of Hemoglobin:

1. Helps maintain homeostatic balance by facilitating cellular respiration.

2. Delivers oxygen from lungs to the body's tissues.

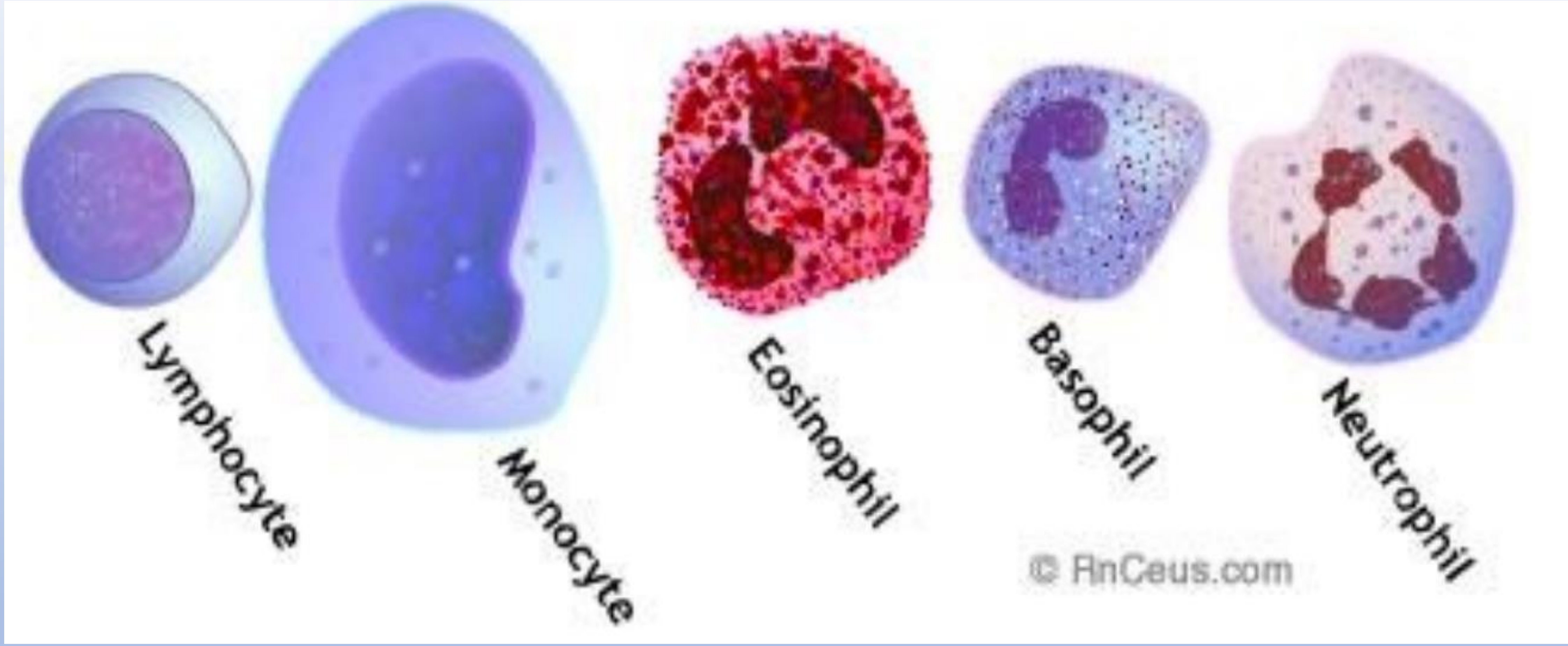
3. Pulls carbon dioxide away from tissues.

4- Keeps blood in balanced pH.

II. Leukocytes (white blood cells):

They are the least abundant formed elements, totaling only 5,000 to 10,000 WBCs/microliter. Very motile and flexible, most leukocytes function in the body tissues. leukocytes Very motile and flexible, the nucleus is very noticeable. Help initiate an immune response and defend against pathogens.

1. **Granulocytes**: they have various types of specific granules that stain conspicuously and distinguish each cell type from the others. They include Neutrophils, Eosinophils and Basophils.
2. **Agranulocytes**: Lack specific granules. Two types of Agranulocytes: Lymphocytes and Monocytes.



Leukocytes (white blood cells)

III. Platelets, or thrombocytes: are small, colorless cell fragments in our blood that form clots and stop or prevent bleeding. Platelets are made in our bone marrow, the sponge-like tissue inside our bones. Bone marrow contains stem cells that develop into red blood cells, white blood cells, and platelets.

Post-test Quiz

Give the main function of blood

MUSCULAR TISSUE
LECTURE (10)

Objective: this lecture learn about study the muscular tissue of human body

Pre-test Quiz

Classify the muscles

The muscular system is responsible for the movement of the human body. Muscle tissue is composed of differentiated cells containing contractile proteins. Muscle contraction is accomplished by the reciprocating sliding of intracellular filaments composed of actin and myosin.

Due to its high degree of specialization, unique terms are used for certain structures in muscle cells:

- Individual muscle cell is called **muscle fiber**.
- The cytoplasm of muscle fiber is called **sarcoplasm**.
- The muscle fiber plasma membrane (plasmalemma)is called the **sarcolemma**.
- The smooth endoplasmic reticulum is called the **sarcoplasmic reticulum**.

Classification of Muscles:

1. Functional classification
2. Structural classification
3. Combined functional and structural classification:

Classification of Muscles:

1. Functional classification is based on the type of neural control:

- Voluntary
- Involuntary

Classification of Muscles:

2. Structural classification is based on the presence or absence of cross striations:

- Striated
- Non striated (smooth)

Classification of Muscles:

3. Combined functional and structural classification:

A. Skeletal muscle:

- Striated and voluntary
- Found mostly attached to the skeleton.

B. Cardiac muscle:

- Striated and involuntary
- Composes most of the heart wall (myocardium)

C. Smooth (visceral) muscle

- Non striated and involuntary
- Found mostly in the walls of hollow organs and vessels.

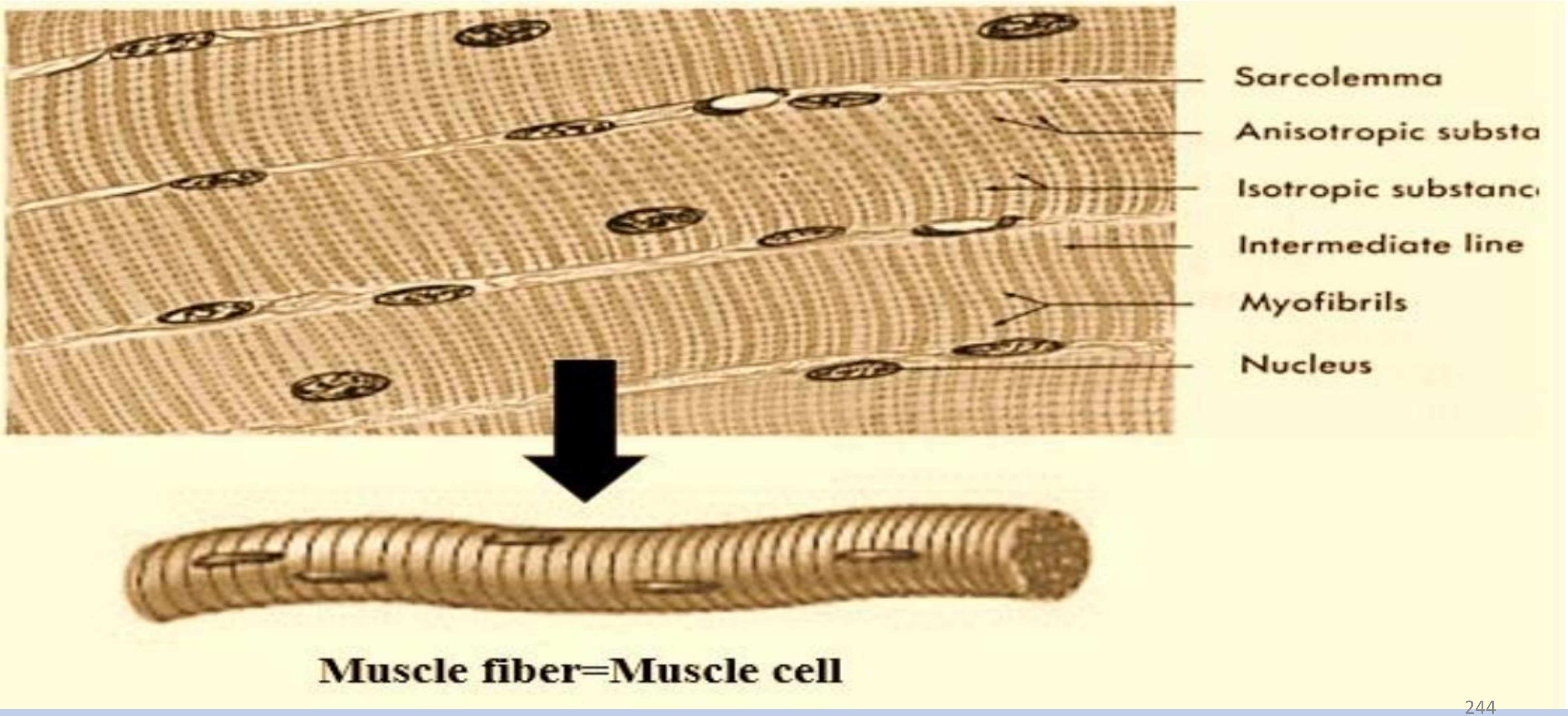
1.Skeletal muscle tissue:

Structure & characteristics of skeletal muscle:

Composed of bundles of long, cylindrical, unbranched multinucleated cells (muscle fibers) that show cross striations. The oval nuclei are usually found at the periphery of the cell under the cell membrane (sarcolemma). Skeletal muscle fiber considered largest fiber type, (1–30mm) in length and (10–100) microns in diameter. Fibers can increase in size but not in number.

The contraction of skeletal muscle is quick, forceful, and usually under voluntary control. The contraction is caused by the interaction of thin **actin** filaments and thick **myosin** filaments, whose molecular configuration allows them to slide upon one another. The forces necessary for sliding are generated by weak interactions in the bridges that bind actin to myosin. This movement of actin filaments in relation to myosin filaments is called **Sliding Filament Theory**

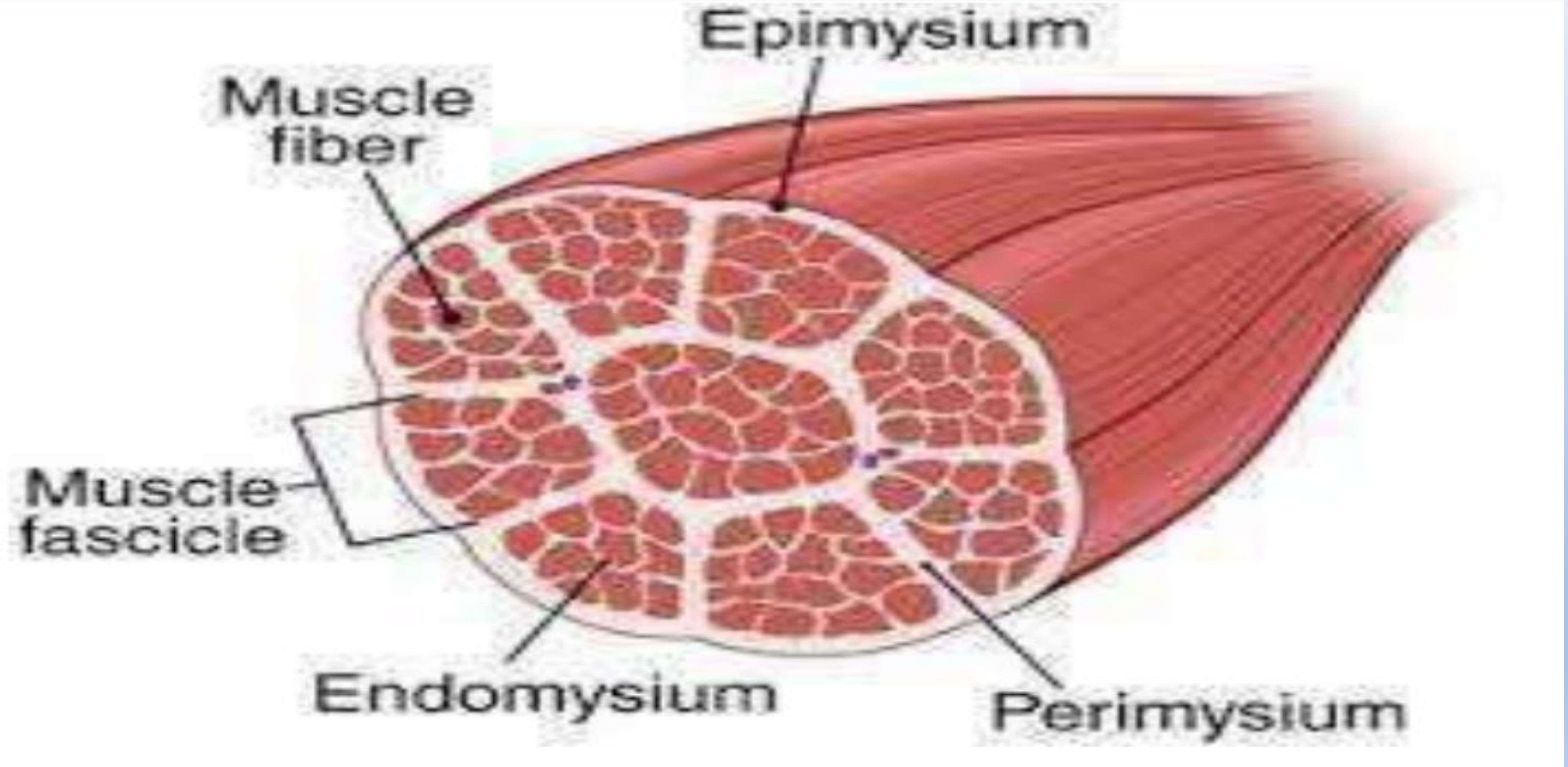
1.Skeletal muscle tissue:



Organization of Skeletal Muscle: The masses of fibers that make up the muscle are not grouped in random fashion but are arranged in regular bundles surrounded by connective tissue investments(sheathes). Three types of sheathes are found:

A. **Epimysium**: an external sheath of dense connective tissue surrounding the entire muscle.
B. From the epimysium, thin septa of connective tissue extend inward, surrounding the bundles of fibers within a muscle. The connective tissue around each bundle of muscle fibers is called the **Perimysium**.
C. Each muscle fiber is itself surrounded by a delicate layer of connective tissue, the **Endomysium**, composed mainly of a basal lamina and reticular fibers.

Organization of Skeletal Muscle:



Organization of Skeletal Muscle Fibers

As observed with the light microscope, the longitudinally sectioned muscle fibers show cross-striations of alternating light and dark bands: The darker bands are called **A bands** composed mainly of thick filaments in addition to portions of overlapping thin filaments. (i.e., Contain **actin** and **myosin**).

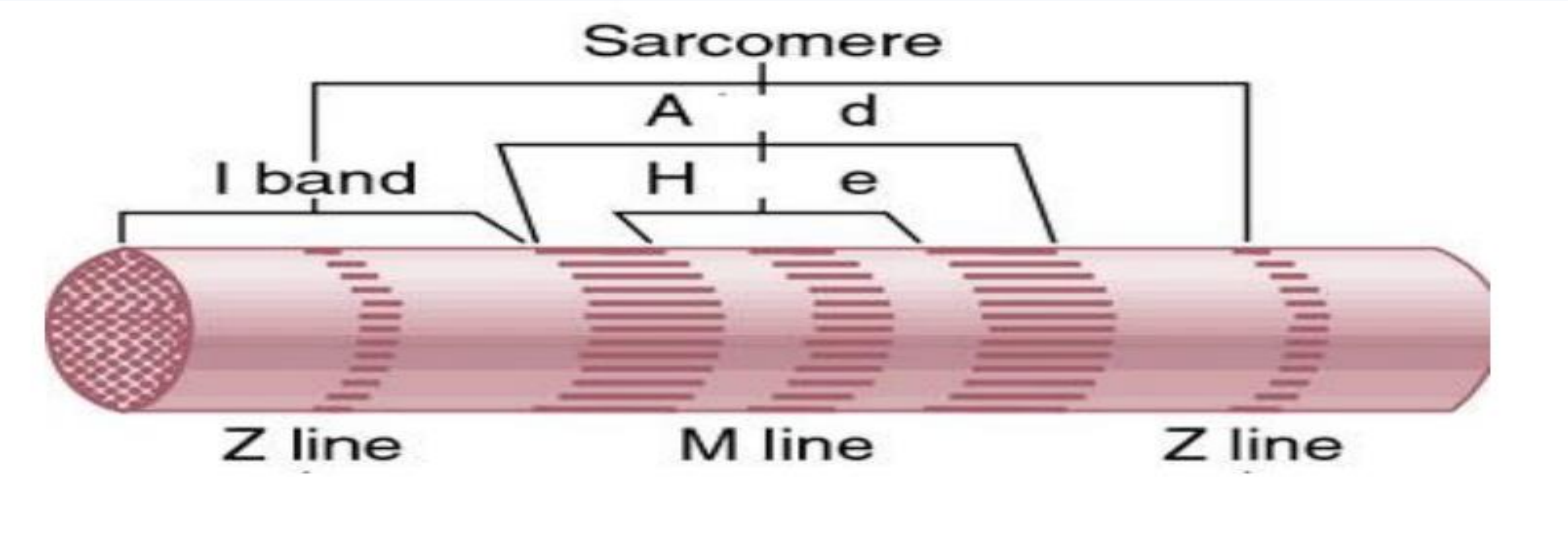
Organization of Skeletal Muscle Fibers

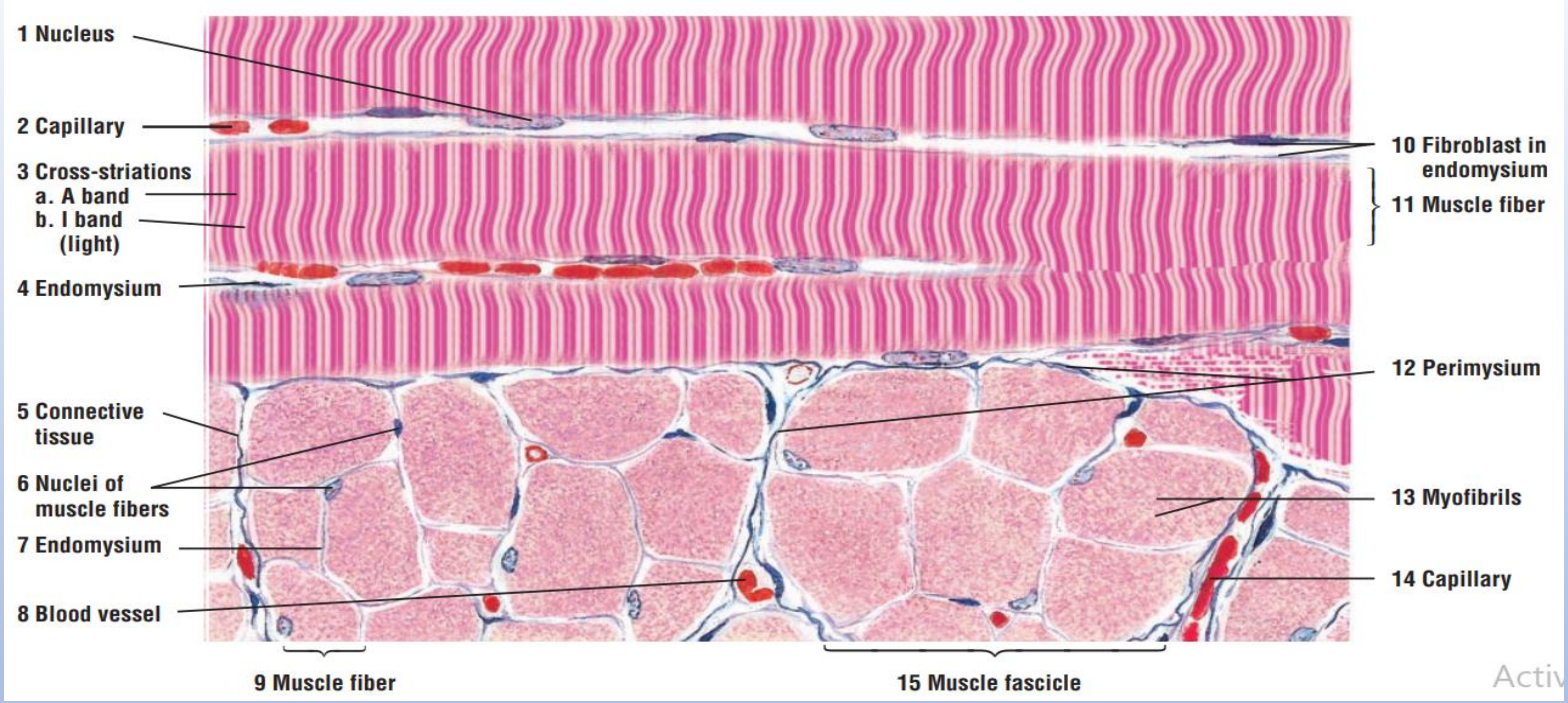
The lighter bands are called **I bands** contains actin only. In the electron microscope, each **I band** is bisected by a dark transverse line, the **Z line**, which composed of alpha-actinin protein, and located in the center of the **I band**.

Organization of Skeletal Muscle Fibers

Close observation of the **A band** shows the presence of a lighter zone in its center, the **H band**, which represents the area where actin is not present, consisting only of the rod-like portions of the myosin molecule. Bisecting the **H band** is the **M line**; a region at which lateral connections are made between adjacent thick filaments (myosin filaments).

Sarcomere: The smallest repetitive subunit of the contractile apparatus of striated muscle fibers. Seen in both skeletal and cardiac muscle fibers. Extends from z-line to z-line.





Longitudinal and transverse sections of Skeletal Muscles of the Tongue

1. Cardiac Muscle Tissue:

Structure & characteristics of cardiac Muscle:

Cardiac muscle occurs only in the myocardium of the heart and in the roots of large vessels where they join the heart. Fibers are cylindrical, branch, and form interwoven bundles. Usually, one nucleus per fiber located in the center (mononucleated) Organelles are clustered at the poles of the nucleus. Myofilament organization into myofibrils is identical to skeletal muscle; cross-striations and bands which identical to skeletal muscle are present, but not as prominent.

Intercalated discs: Microscopic identifying features of cardiac muscle. Dark-staining transverse lines that cross the chains of cardiac cells at irregular intervals. Junctional complexes that are unique to cardiac muscle fibers, consist of specialized cell junctions and interdigitations of the sarcolemma at the ends of the fibers.

Purkinje fibers:

One of the specialized cardiac muscle fibers, they are often binucleated cells. They are part of the impulse-conducting network of the heart, that rapidly transmit impulses from the atrio-ventricular node to the ventricles. They are larger than cardiac muscle cells, but have fewer myofibrils, lots of glycogen and mitochondria. These cells are connected by **desmosomes** and **gap junctions**, but not by intercalated discs.

Longitudinal and transverse sections of Cardiac Muscle

1. Smooth Muscle Tissue:

Structure & characteristics of smooth muscle:

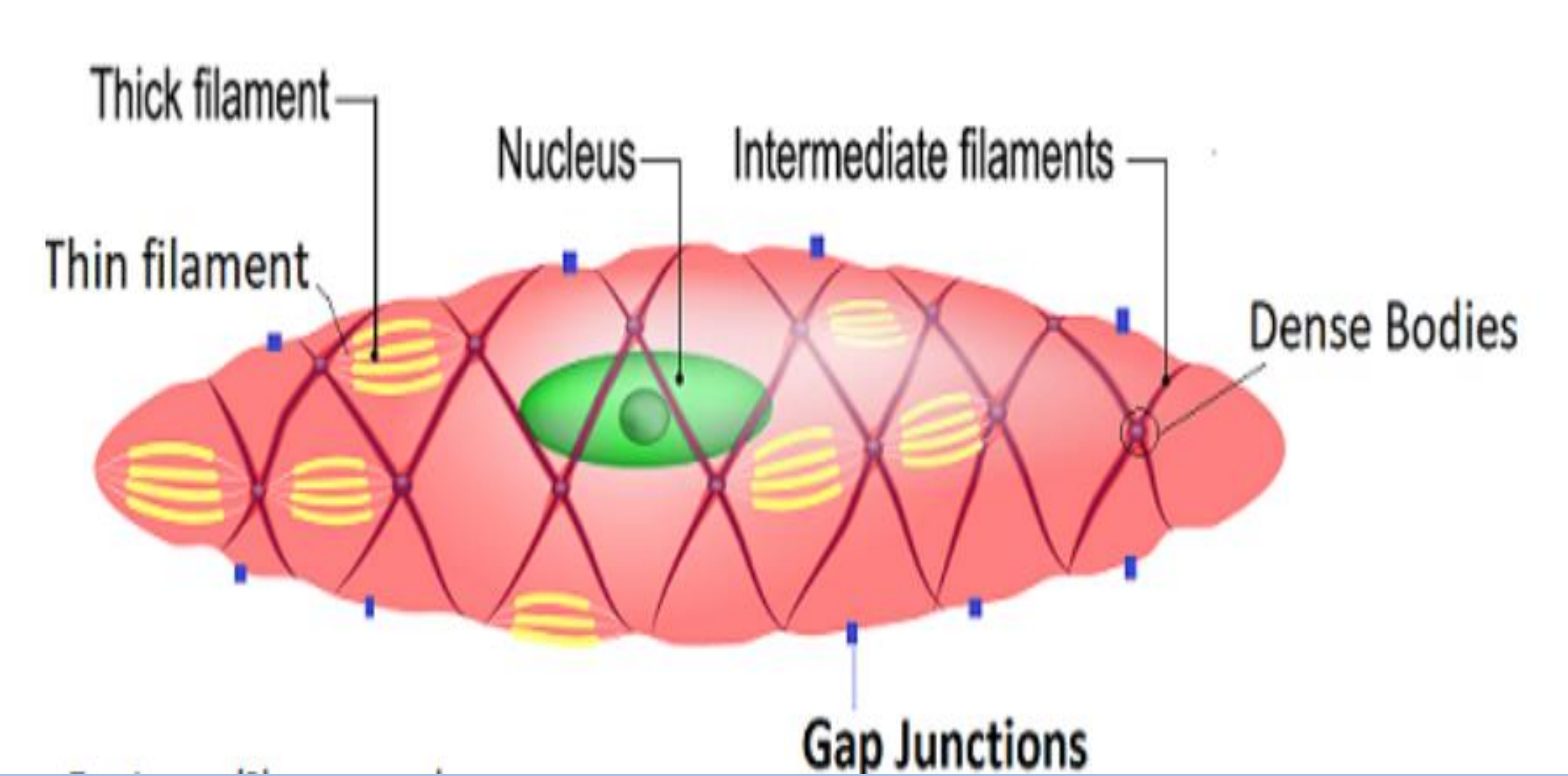
Spindle-shaped cells with central nuclei, no striations, occurs mostly as sheets, which form the walls of most hollow organs with the exception of the heart. Prominent in the walls of blood vessels, many respiratory passageways, and some genital ducts. Smooth muscle usually has spontaneous activity in the absence of nervous stimuli. Therefore, its nerve supply has the function of modifying activity rather than initiating it as in skeletal muscle.

Organization of the contractile proteins

Actin and myosin myofilaments are present, but they are not organized into myofibrils. Myofilaments overlap as in striated muscle and crisscross throughout the sarcoplasm, forming a reticulum.

Dense bodies:

Two types of dense bodies appear in smooth muscle cells; One is membrane associated; the other is cytoplasmic. Both contain alpha-actinin and are thus like the Z lines of striated muscles. Serve as insertion points for myofilaments to transmit the force of filament sliding. i.e., myofilaments insert into dense bodies transmit contractile force to adjacent smooth muscle cells and their surrounding network of reticular fibers.



Smooth Muscle Cell

Longitudinal and transverse sections of smooth muscle in the wall of the small intestine

Post-test Quiz

List the sheathes of skeletal muscles

THE NERVOUS TISSUE

LECTURE (11)

Objective: this lecture learn about study the nervous tissue of human body

Pre-test Quiz

Give the types of Synapse

Nerve tissues develop from embryonic ectoderm. The human nervous system, the most complex system in the human body, is formed by a network of more than 100 million nerve cells (neurons), assisted by many more glial cells. Each neuron has, on average, at least 1000 interconnections with other neurons, forming a very complex system for communication. The nervous system consists of the brain, spinal cord, sensory organs, and all of the nerves that connect these organs with the rest of the body.

Together, these organs are responsible for the control of the body and communication among its parts. The Cells of Nervous tissue including neurons that are the functional units of the nervous system and supportive cells that are support and protect neurons, and participate in neural activity, neural nutrition, and the defense processes of the central nervous system including:

- Astrocytes, Oligodendrocytes, Microglia, and Ependymal cells in the **CNS**.
- Schwann cells and Satellite Cells in the **PNS**.

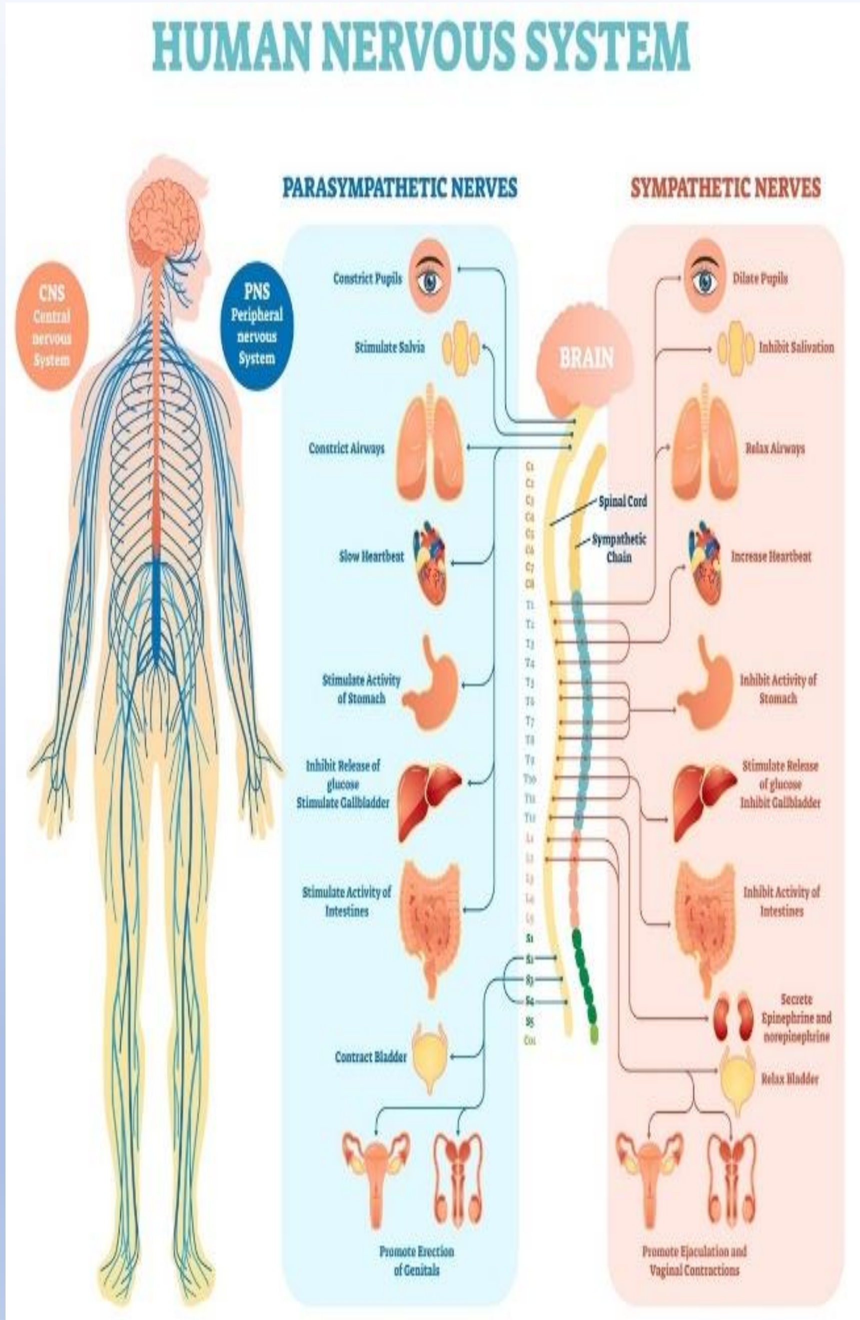
Anatomical subdivisions of nervous tissue:

1. Central nervous system (CNS) includes:

- Brain
- Spinal cord

2. Peripheral nervous system (PNS) includes:

- Nerves
- Ganglia (singular: ganglion)

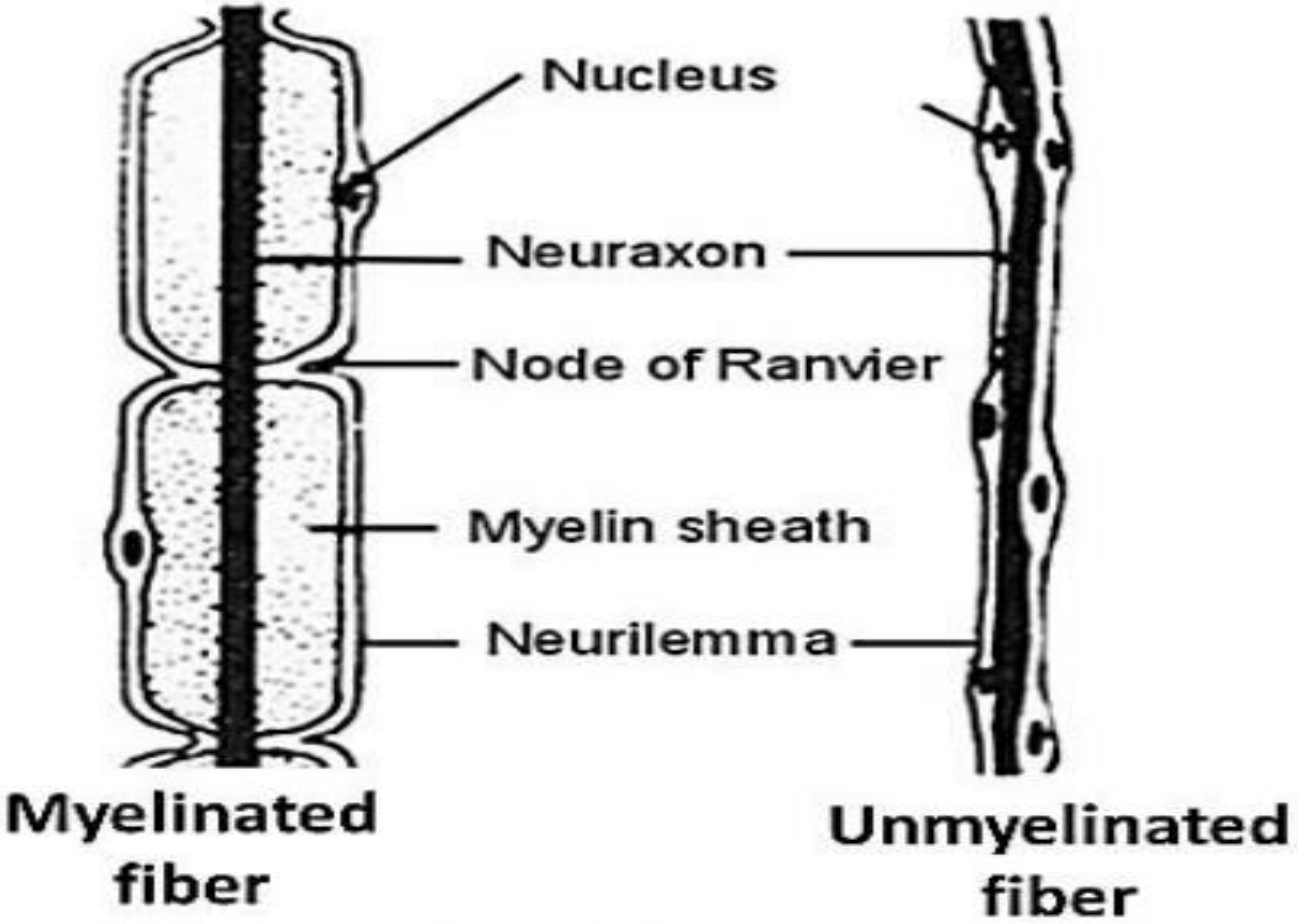


Nerve Fibers:

Nerve fibers consist of axons enveloped by a special sheath derived from cells of ectodermal origin. Groups of nerve fibers constitute the tracts of the brain, spinal cord, and peripheral nerves. Nerve fibers exhibit differences in their enveloping sheaths, related to whether the fibers are part of the central or the peripheral nervous system. Single or multiple folds of a sheath cell cover most axons in adult nerve tissue.

Nerve Fibers:

In peripheral nerve fibers, the sheath cell is the Schwann cell, while in central nerve fibers it is the oligodendrocyte. Axons of small diameter are usually unmyelinated nerve fibers. Progressively thicker axons are generally sheathed by increasingly numerous concentric wrappings of the enveloping cell, forming the myelin sheaths. These fibers are known as myelinated nerve fibers.



Nerve fibres

Myelin: An insulating layer around a nerve, formed by oligodendrocytes in CNS and Schwann cells in PNS. It is composed of a lipoprotein with phospholipids, glycolipids and cholesterol. Myelin allows nerve conduction to be 150 x faster than unmyelinated nerves. Myelination is the process of myelin formation.

1- Myelinated Fibers: In myelinated fibers of the peripheral nervous system, the plasmalemma of the covering Schwann cell winds and wraps around the axon. The layers of membranes of the sheath cell unite and form myelin. The myelin sheath shows gaps along its path called the nodes of Ranvier; these represent the spaces between adjacent Schwann cells along the length of the axon. The distance between two nodes is called an internode and consists of one Schwann cell. The length of the internode varies between 1 and 2 mm.

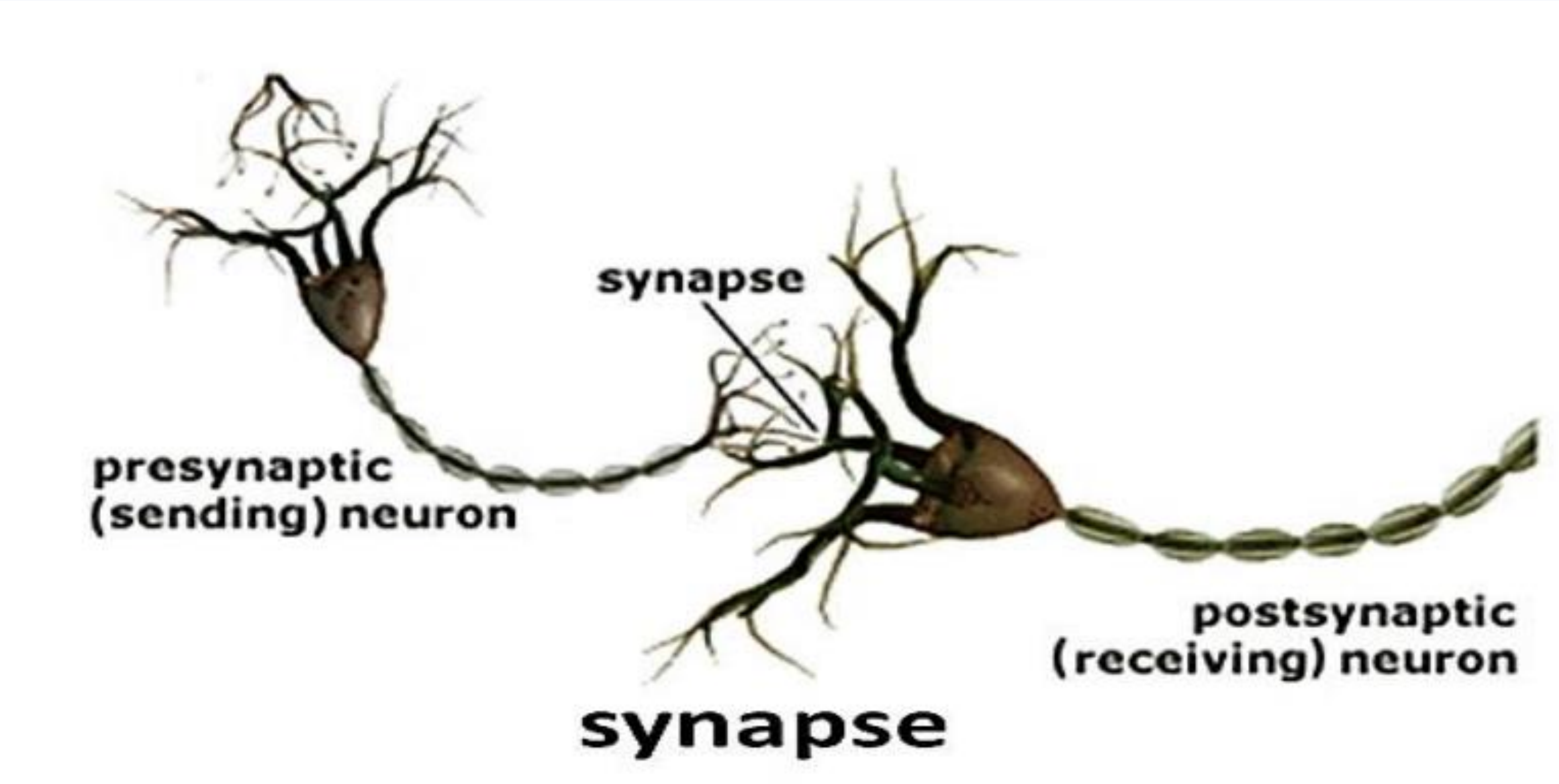
2- Unmyelinated Fibers: In both the central and peripheral nervous systems, not all axons are sheathed in myelin. In the peripheral system, all unmyelinated axons are enveloped within simple clefts of the Schwann cells Unmyelinated nerve fibers do not have nodes of Ranvier, because neighboring Schwann cells are united to form a continuous sheath. The central nervous system is rich in unmyelinated axons; unlike those in the peripheral system.

The Ganglia:

Ganglia are ovoid structures containing neuronal cell bodies and glial cells supported by connective tissue. Because they serve as relay stations to transmit nerve impulses, one nerve enters, and another exits from each ganglion.

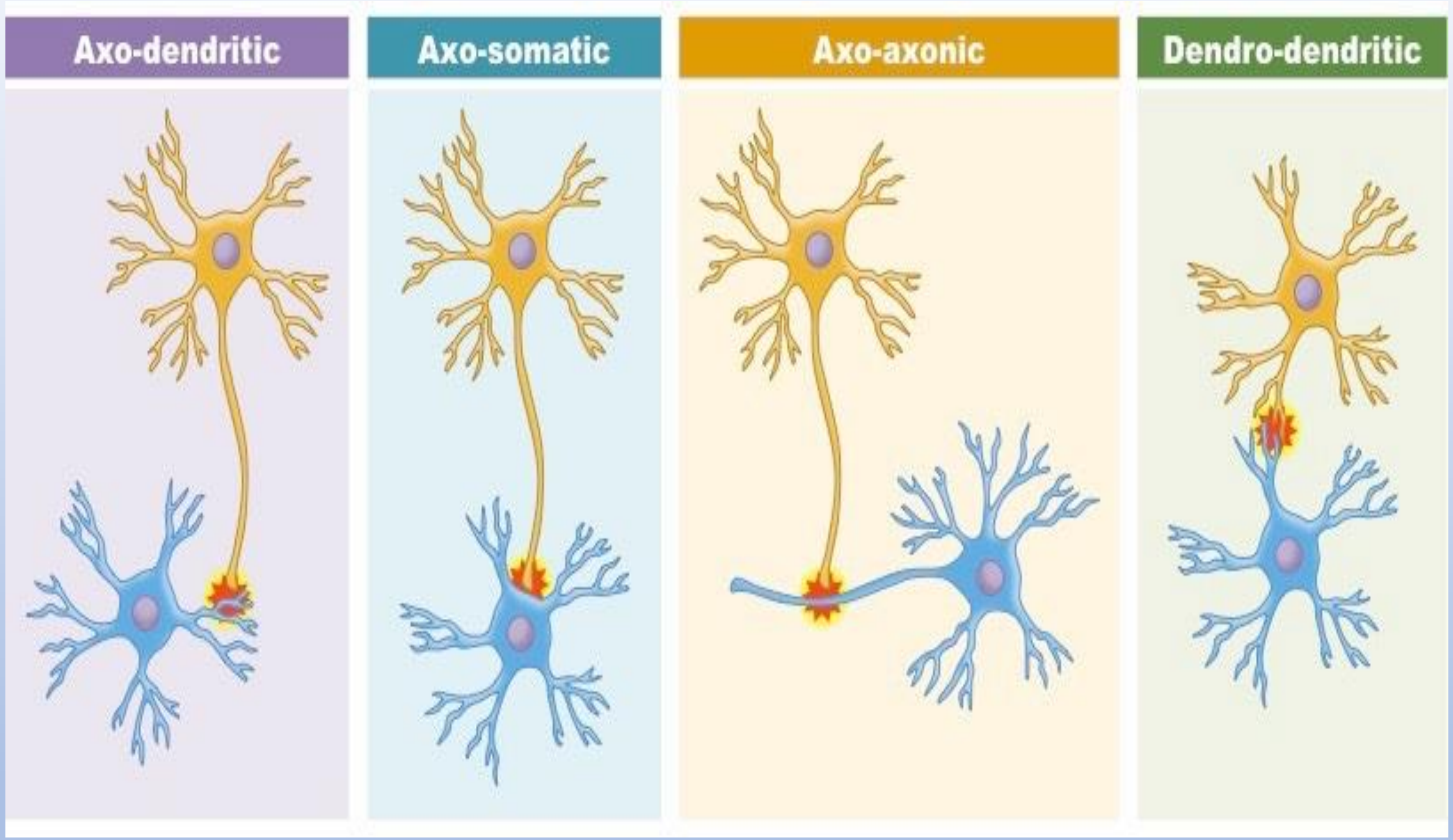
Synapse:

A synapse is a structure that permits a neuron to pass an electrical or chemical signal to another neuron. The synapse is responsible for the unidirectional transmission of nerve impulses. Synapses are sites of functional contact between neurons or between neurons and other effector cells (eg, muscle and gland cells). The function of the synapse is to convert an electrical signal (impulse) from the presynaptic cell into a chemical signal that acts on the postsynaptic cell.


synapse
presynaptic
(sending) neuron
postsynaptic
(receiving) neuron
synapse

Types of synapses

1. Axo-somatic
2. Axo-dendritic
3. Axo-axonic
4. Dendro-dendritic



Nerve Endings

There are several structural types of receptors in the skin (cutaneous receptors).

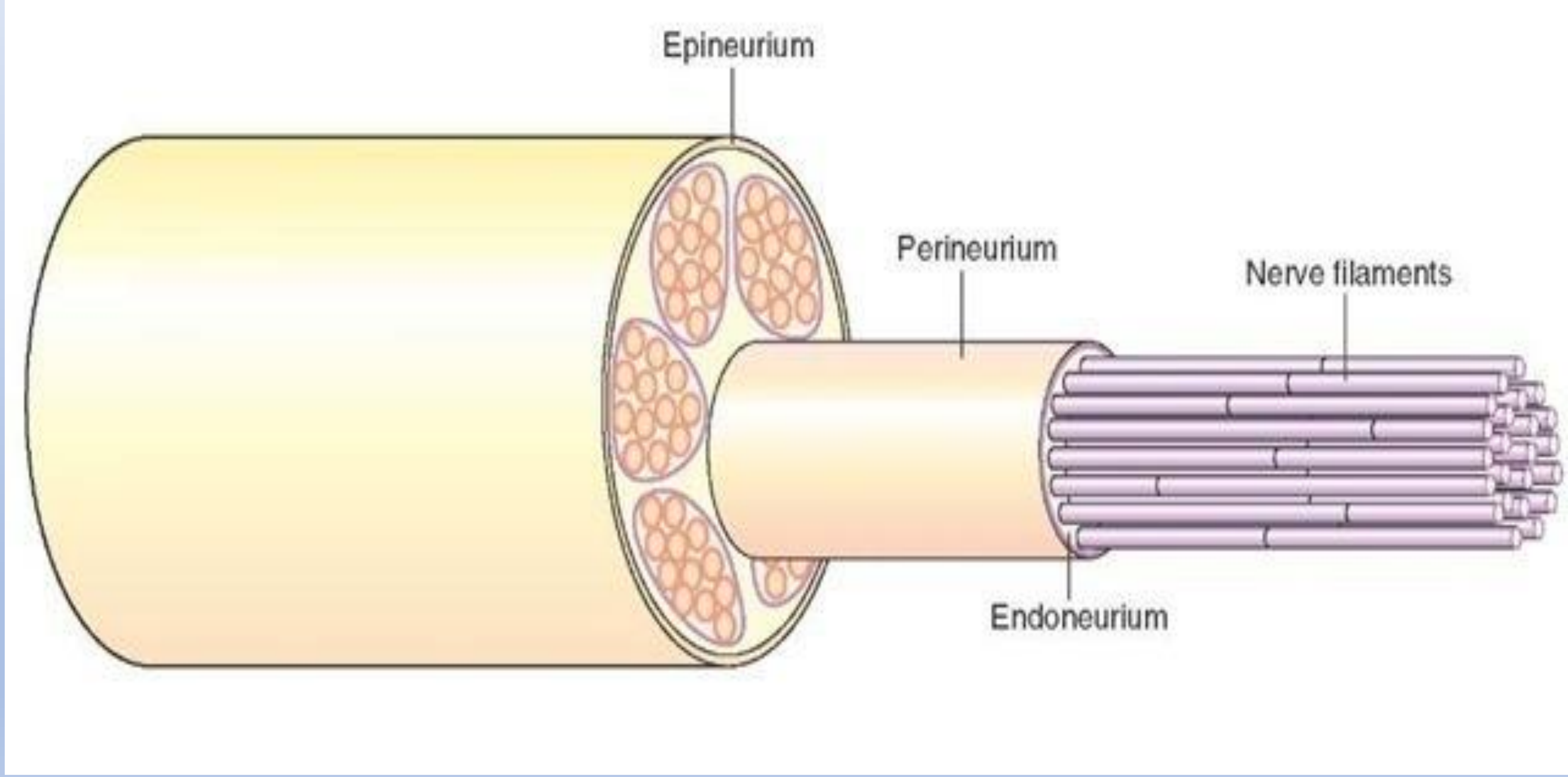
These fall into the category of

1. **Encapsulated Receptors**: Meisner's corpuscles, Pacinian corpuscles and Ruffini endings.
2. **Non-Encapsulated Receptors**: Merkle's cells.

Connective Tissue Investments of Nervous Tissue:

A. Peripheral nervous system:

1. Epineurium
2. Perineurium
3. Endoneurium



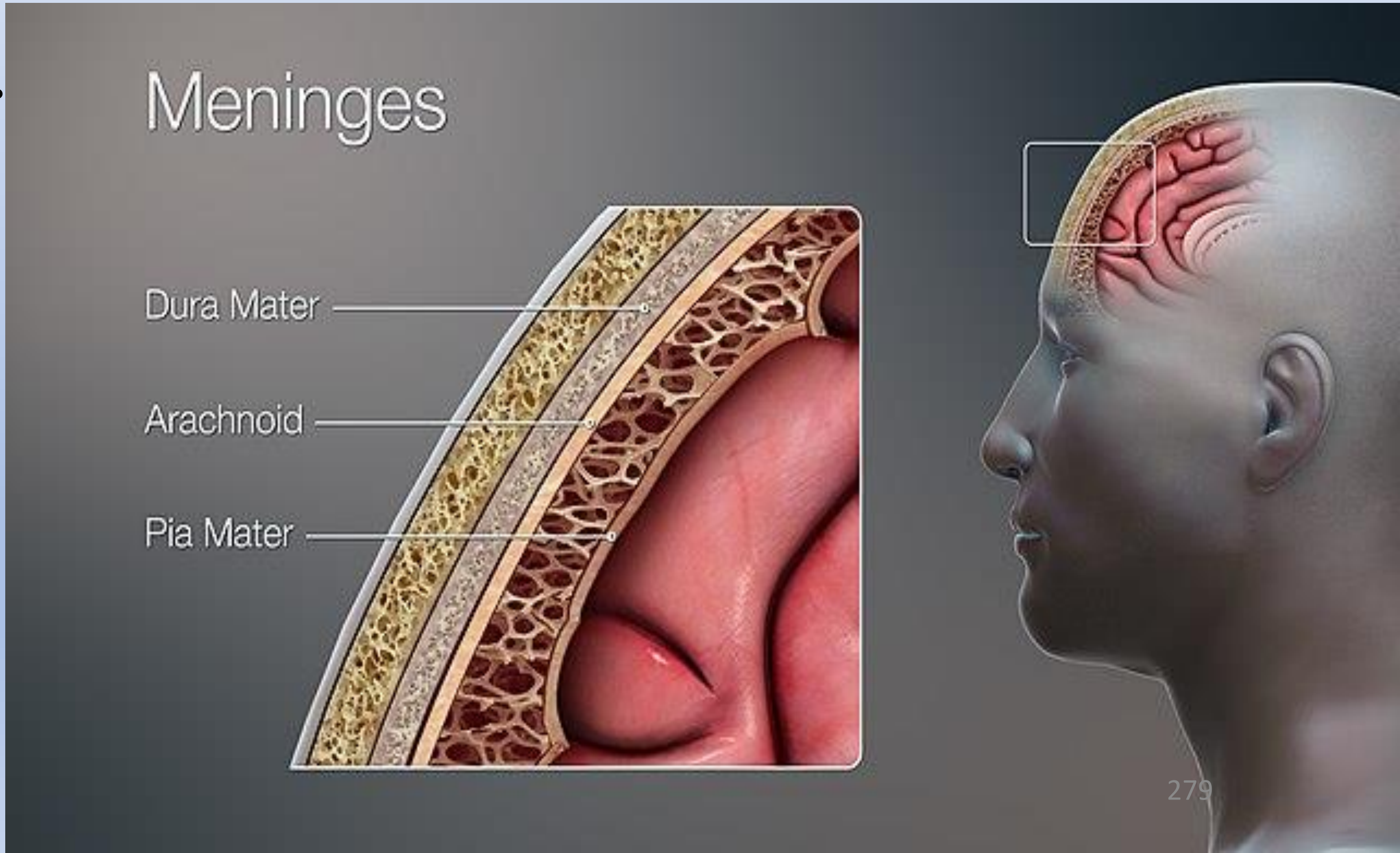
B. Central nervous system:

Meninges: The skull and the vertebral column protect the central nervous system. It is also encased in membranes of connective tissue called the meninges.

a) Pia mater

b) Arachnoid membrane

c) Dura mater



Post-test Quiz

Give the anatomical subdivisions of nervous tissue

ORAL MUCOUS MEMBRANE

LECTURE (12)

Objective: this lecture learn about study the orasl mucous membrane

Pre-test Quiz

Give the function of mucous membrane

Body cavities that communicate that with external surface are lined by mucous membranes which is moist lining due to serous and mucous secretion in which the oral mucosa is wet all the time.

The surface of oral cavity is a mucous membrane, its structure varies in adaptation to function in different regions of the oral cavity.

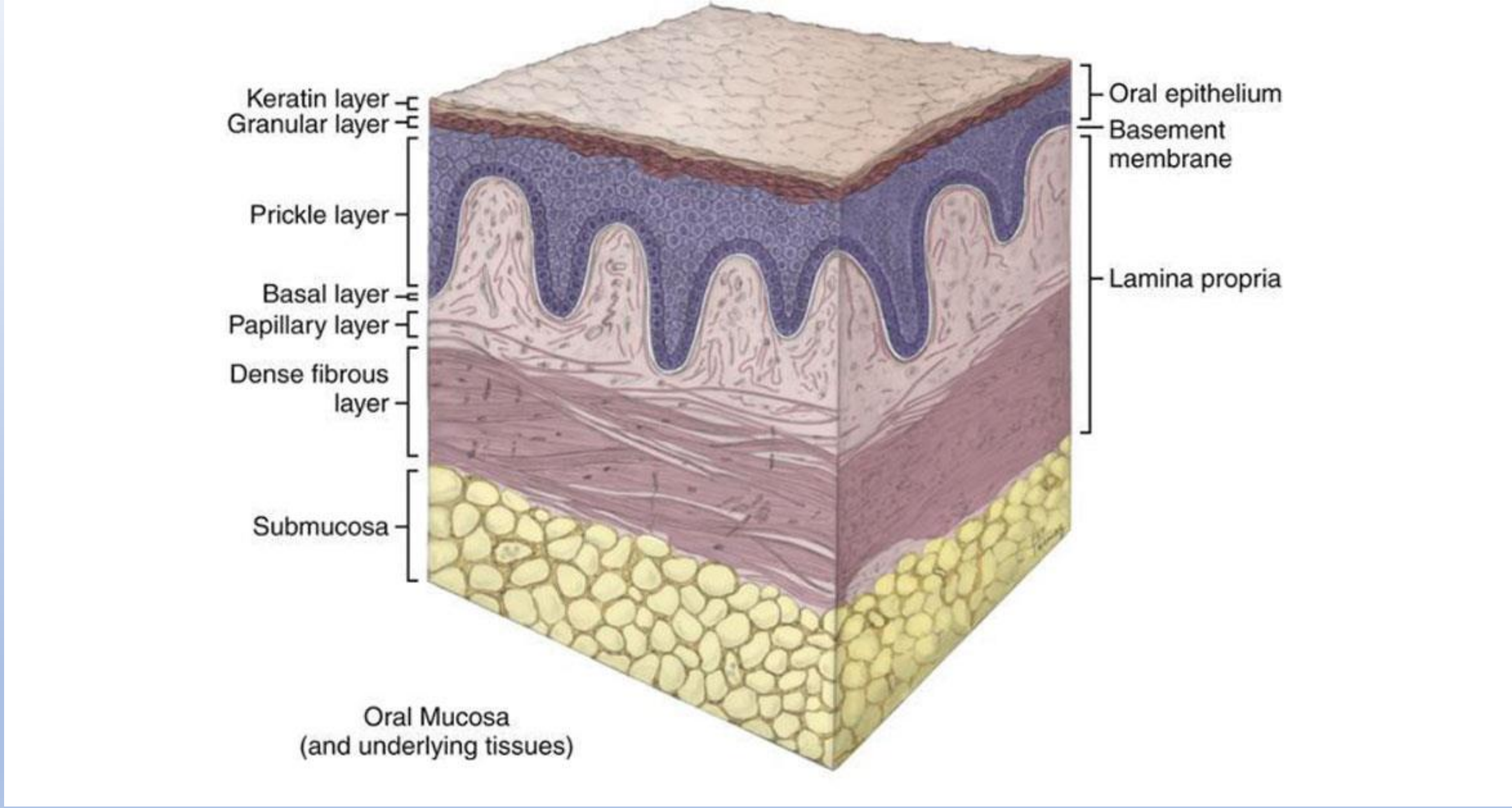
Basic classification of oral mucosa according to their functional criteria may be divided into three major types.

1-Masticabory mucosa (gingival and hard palate).

2-Lining or reflecting mucosa (lip, check, vestibular fornix, alveolar mucosa, floor of mouth).

3-Specilized mucosa (dorsum of the tongue and taste buds).

The skin, oral mucosa and intestinal lining consist of two separate tissue components: covering epithelium, underlying connective tissue (lamina properia). The two layers form an interface that is folded into corrugations, papilla of connective tissue protrude towards the epithelium carrying blood vs. and nerves. The epithelial in turn formed into ridges that protrude towards the lamina properia which called epithelial ridges look like pegs.


Keratin layer
Granular layer
Prickle layer
Basal layer
Papillary layer
Dense fibrous layer
Submucosa
Oral epithelium
Basement membrane
Lamina propria
Oral Mucosa
(and underlying tissues)

The functions of mucous membrane:

1-Protection

2-Sensation

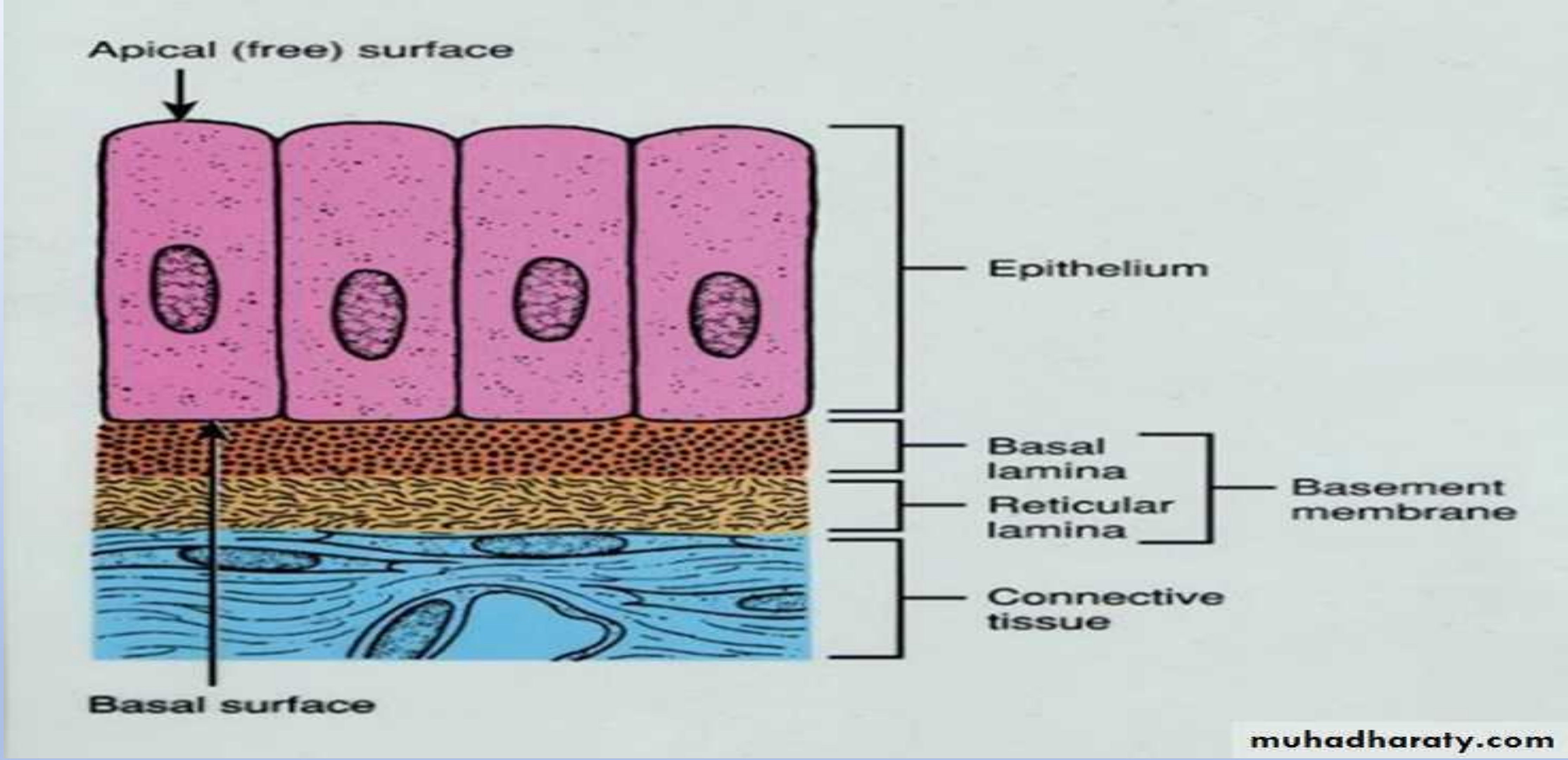
3-Secretion

4-Thermal regulation

The two layers (epithelium and connective tissue) are separated from each other by basement membrane, this membrane is evident at the level of light microscope.

Basal lamina consists of two layers

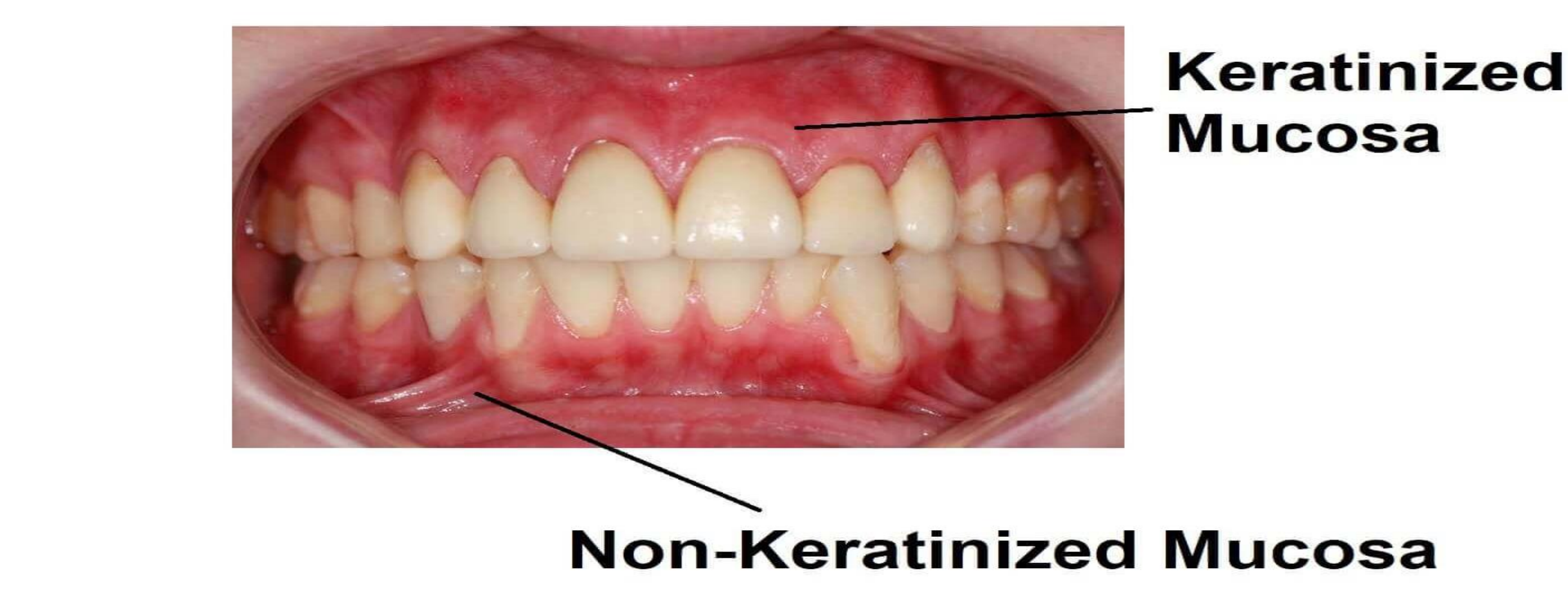
1. Lmina Lucida (a clear zone near the epithelium).
2. Lamina densa (a darker zone towards connective)



Basement Membrane

The oral epithelium

It is a primary barrier between the oral environment and deeper tissues. It is stratified squamous epithelium either keratinized, para-keratinzed or non-keratinized epithelium



Types of epithelium

1. keratinized oral epithelium
2. Non-keratinized oral epithelium

Types of epithelium

1. **keratinized oral epithelium which divided into two types**

Consist of four cell layers

a. Stratum basale (basal cell layer)
b. Stratum spinosum (prickle cell layer)
c. Stratum granulosum (granular layer)
d. Stratum corneum (keratinized or cornified layer)

Types of epithelium

1. keratinized oral epithelium which divided into two types
   a. Para-keratinized epithelium
   b. Ortho-keratinized epithelium

Odland body: Small lamellar granule form at the junction between granular and stratum cornified layer which act as a permeable barrier (concerned with permeability).

1. **Non-keratinized oral epithelium:** have three cell layers:

a. The basal cell layers

b. Stratum intermedium

c. Stratum super facial

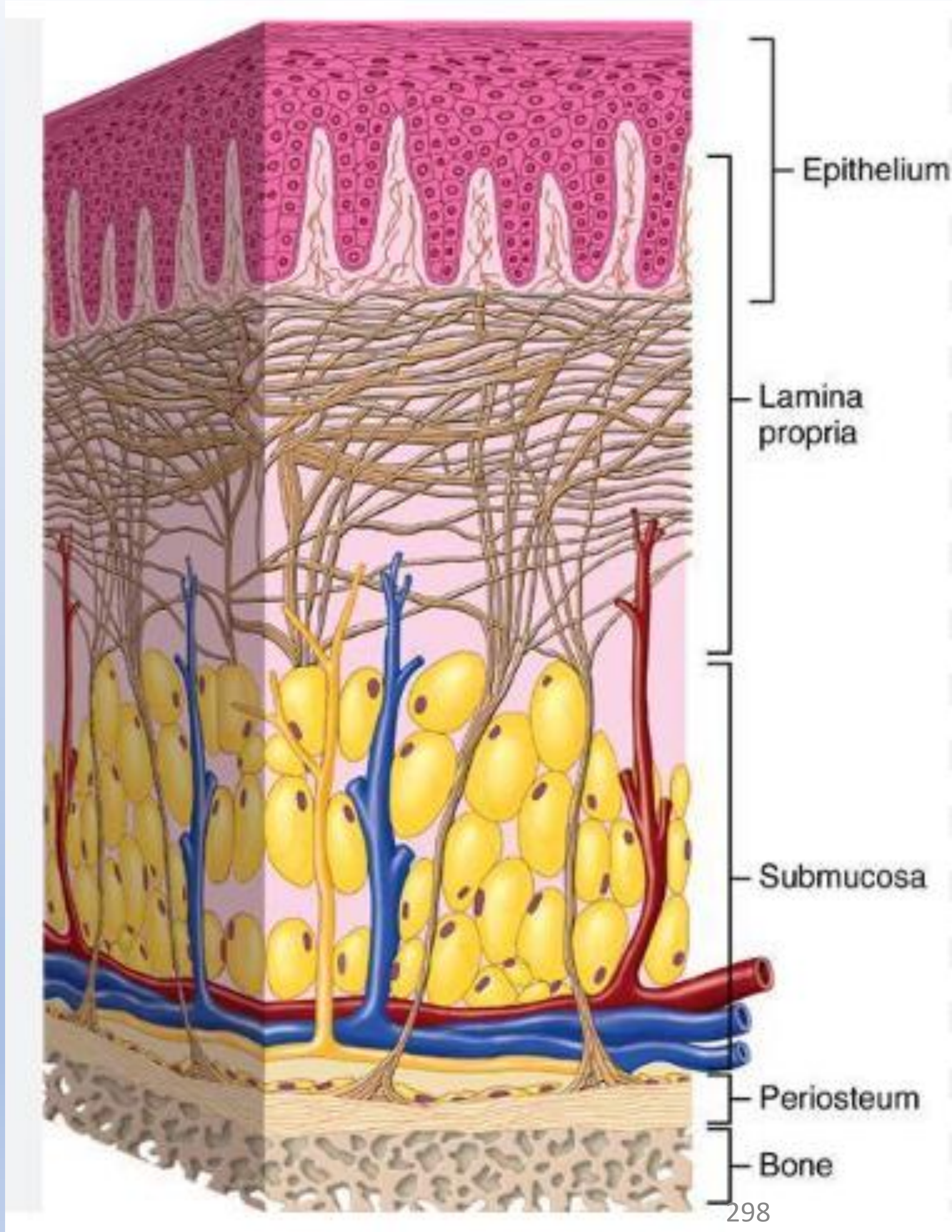
The non-keratinocyte cells: In the oral epithelium there are additional cells called nonkeratinized cells.

1. Melanocyte cells
2. Langerhan's cells
3. Merkel's cells
4. Inflammatory cells e.g. (lymphocyte cells)

Lamina properia: it is a connective tissue of variable thickness that supports the epithelium this divided as descriptive reason into two parts superficial papillary and deeper reticular layer.

Submucosa: The submucosa consists of Connective Tissue of varying thickness & density, glands, blood VS. nerves & also adipose tissue are present in this layer. Submucosa attach oral mucosa to the under lying bone or muscle.

Longitudinal section of oral mucosa



Masticatory mucosa:

It was involving gingiva and hard palate, that are exposed to compressive and forces to abrasion during the mastication of food.

a. **Hard palate:** mucosa is tightly fixed to underlying periosteum & it is immovable. It is pink in color, epithelial is well keratinized.
b. **Gingiva or gum:** extend from dento-gingival junction to alveolar mucosa. In subjected to friction & pressure of mastication.

Masticatory mucosa:

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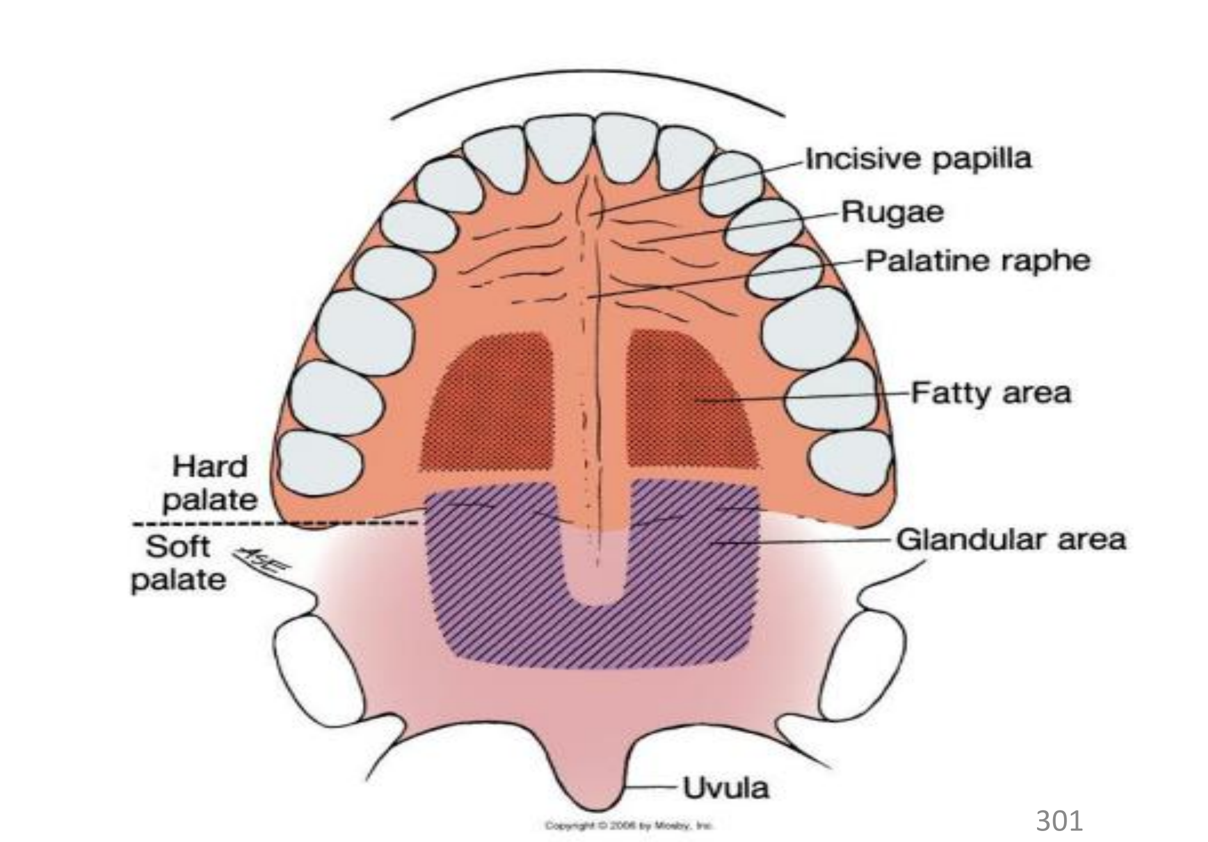
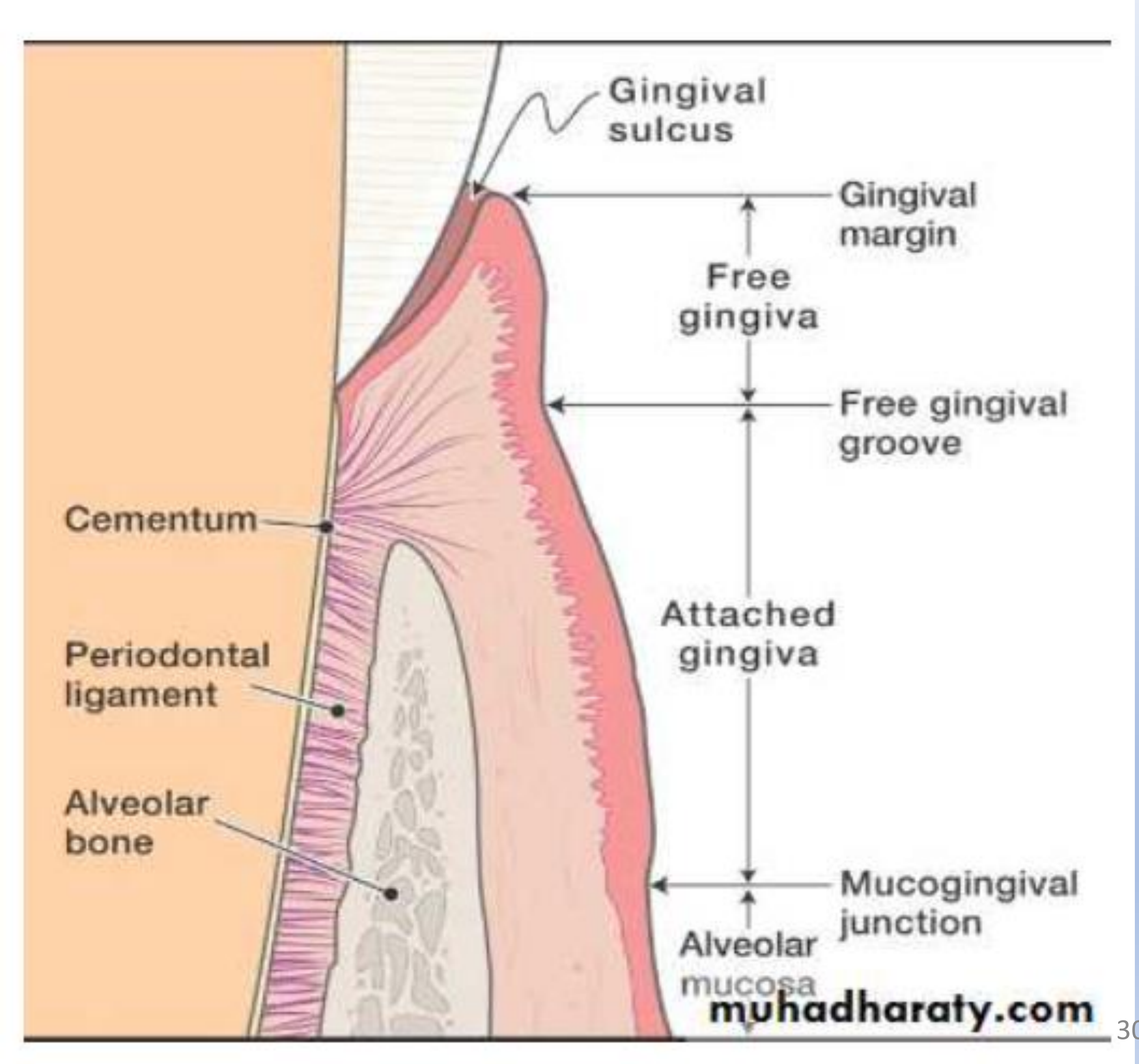


The gingiva can be divided into

1. Free gingiva.
2. Attached gingiva.
3. Interdental papilla.



Lining mucosa:

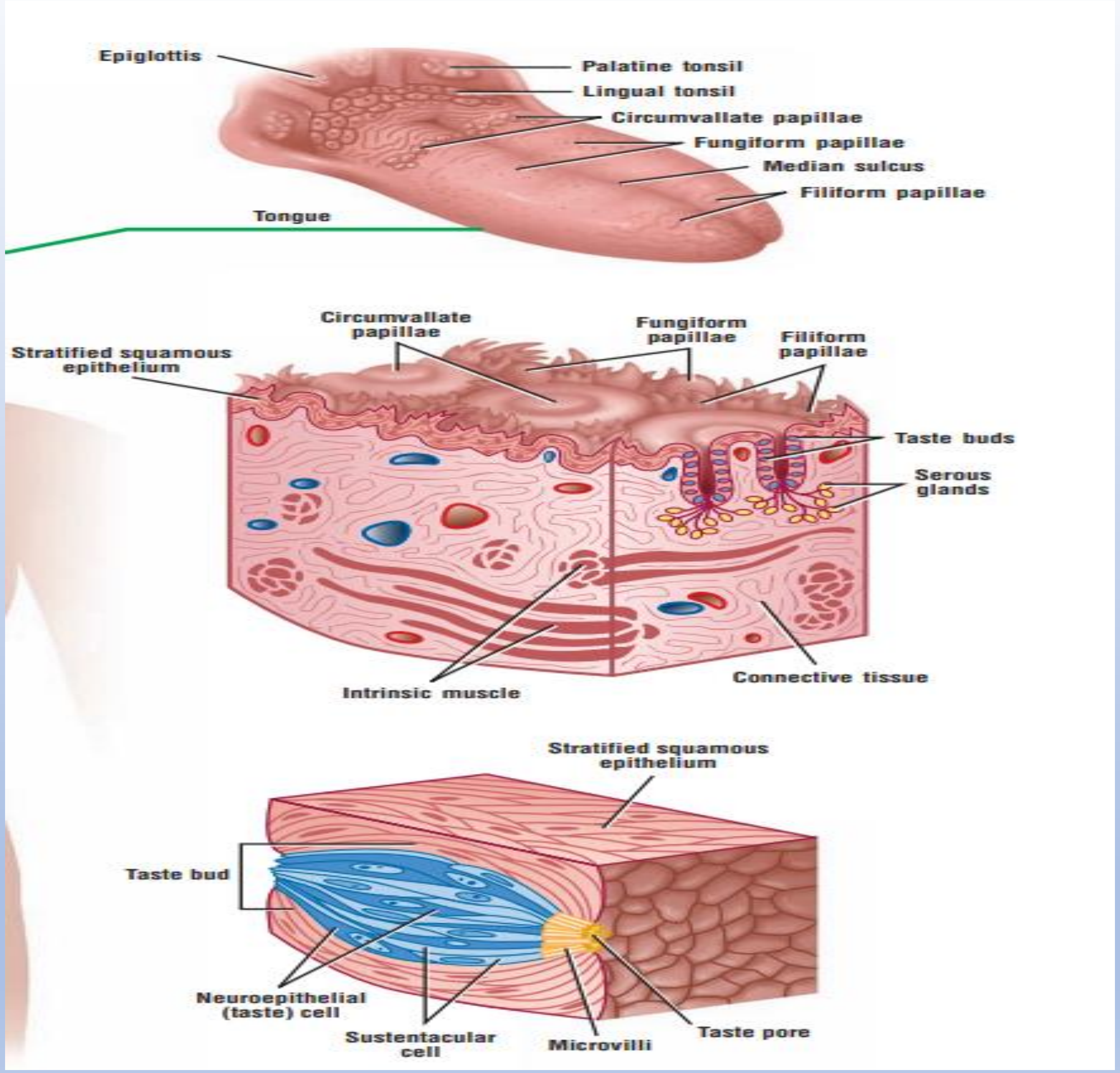
Covering the underside of the tongue, inside the lips, cheeks, floor of the mouth and soft palate. The epithelium was thicker and nonkeratinized, lamina properia contains fewer collagen fibers thus the surface is flexible and able to withstand stretching.

Taste buds:

A taste bud is a collection of cells grouped inside the bumps on your tongue called papillae. A taste bud includes

1. Taste receptor cells
2. Basal cells
3. Supporting cells (sustentacular cells)

Morphology of the tongue in cross section, and added detail of a taste bud



Post-test Quiz

List the layers of oral epithelial

PLASMA MEMBRANE STRUCTURE

PASSAGE OF MATERIALS ACROSS CELL MEMBRANE

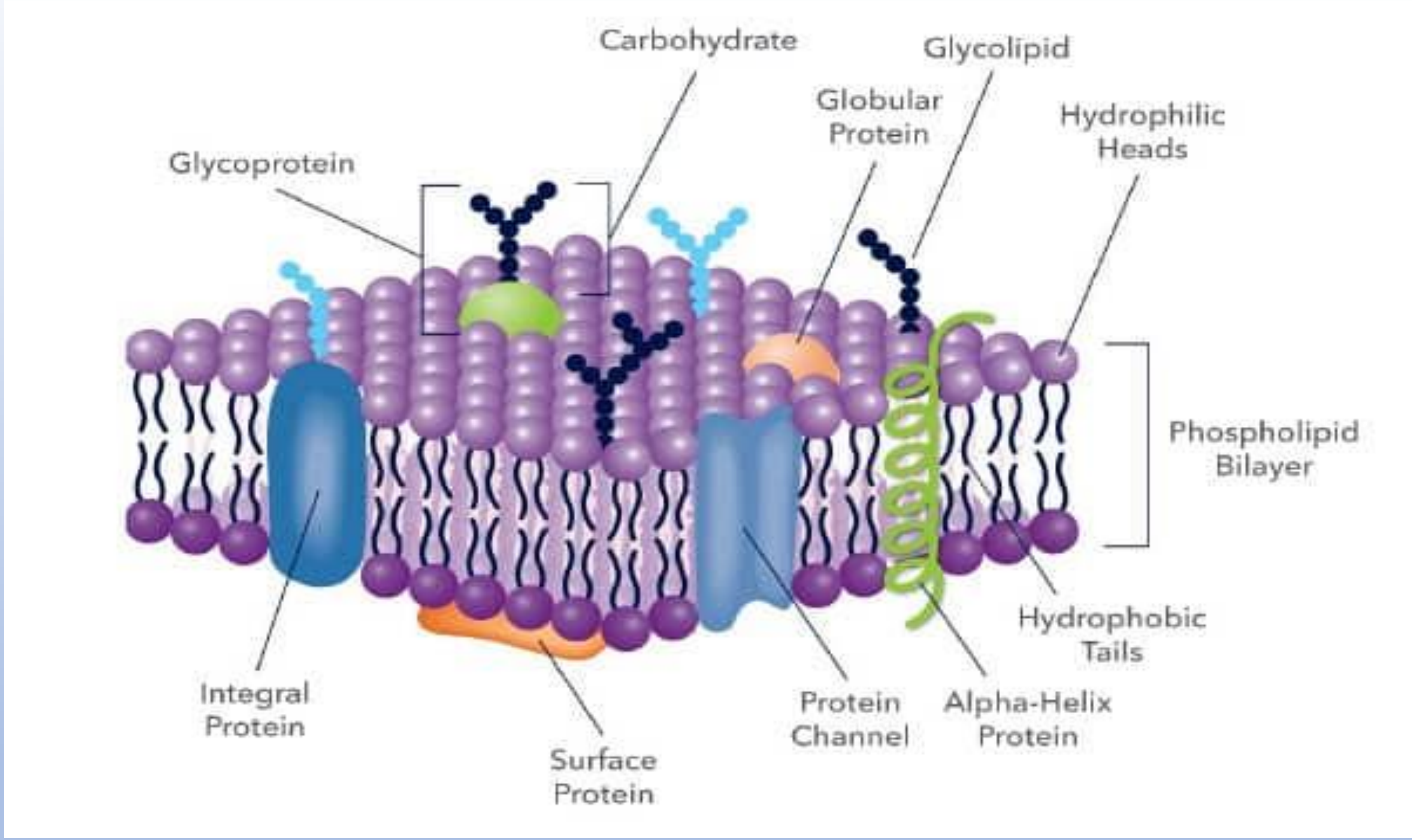
LECTURE (13–14)

Objective: this lecture learn about study the structure of plasma membrane and method of molecule transportation across the plasma membrane

Pre-test Quiz

Give the types of passive diffusion

The plasma membrane is a phospholipid bilayer—sandwich made of two layers of phospholipids. The phospholipid bilayer is selectively permeable, which means it allows certain molecules-but not others-to enter the cell. Proteins scattered throughout the plasma membrane play important roles in allowing substances to enter the cell.



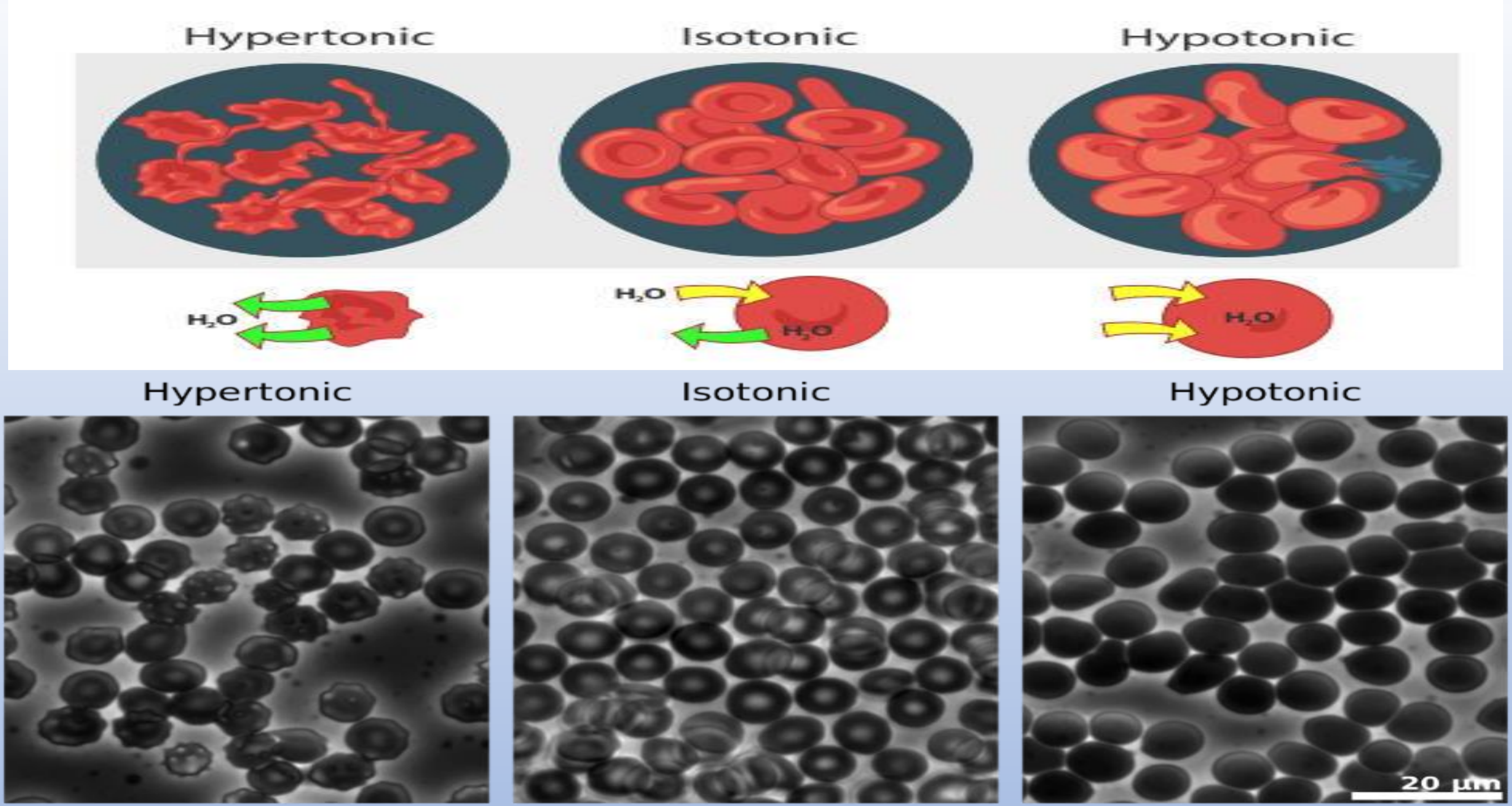
PLASMA MEMBRANE

Osmosis is the diffusion of water molecules across a semipermeable membrane from an area of lower concentration solution (i.e., higher concentration of water) to an area of higher concentration solution (i.e., lower concentration of water).

1. If the RBCs is placed in a hypertonic solution, there will be a net flow of water out of the cell, and the cell will lose volume.

2. If the RBCs is placed in a hypotonic solution, there will be a net flow of water into the cell, and the cell will gain volume.

3. If the RBCs is placed in an isotonic solution, there will be no net flow of water into or out of the cell, and the cell's volume will remain stable.



The diffusion of water molecules across a semipermeable membrane by osmosis

Passage of Materials Across Cell Membrane

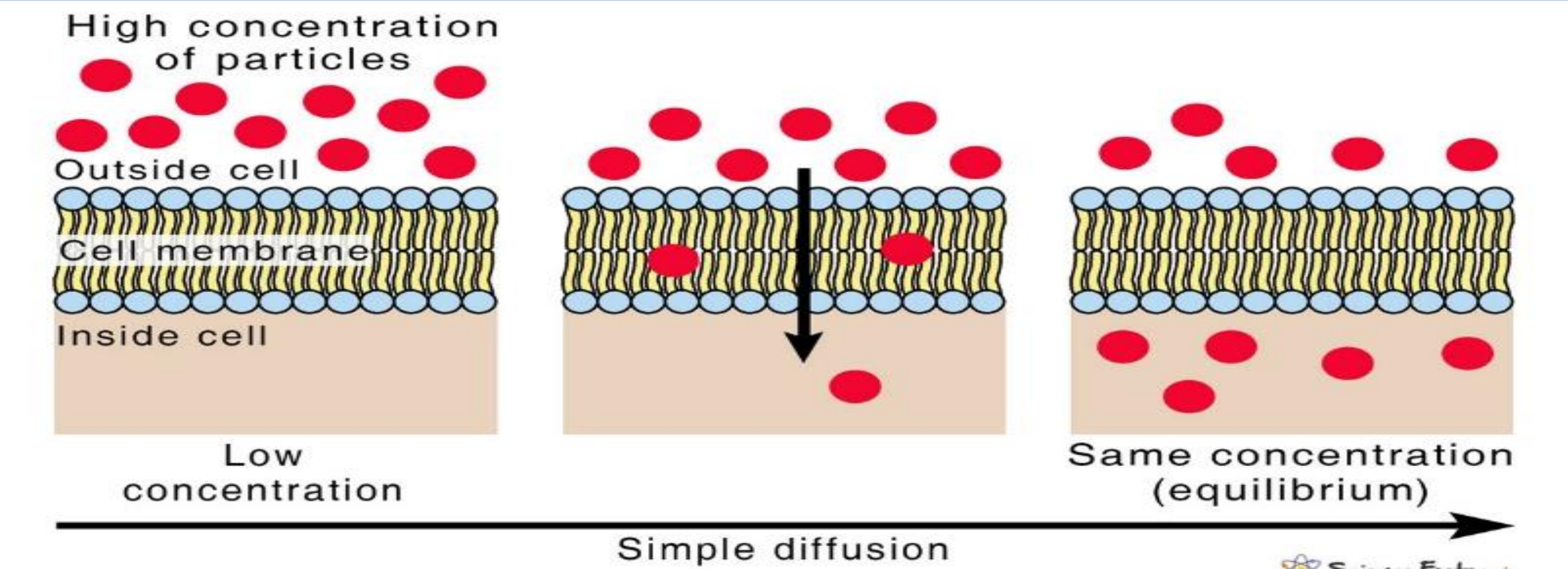
Transport across a cell membrane is a tightly regulated process. When a molecule moves down its concentration gradient is it participating in **passive transport**; moving up the concentration gradient requires energy making it **active transport**.

1. Passive Transport

- **Simple Diffusion**
- **Facilitated Diffusion**

1. Passive Transport

- **Simple Diffusion:** : the particle or substance moves from higher to lower concentration. However, its movement does not need a membrane protein that will help substances to move downhill.



1. **Passive Transport**

- **Facilitated Diffusion** is the passive movement of molecules across the cell membrane via the aid of a membrane protein.

a) **Channel proteins**

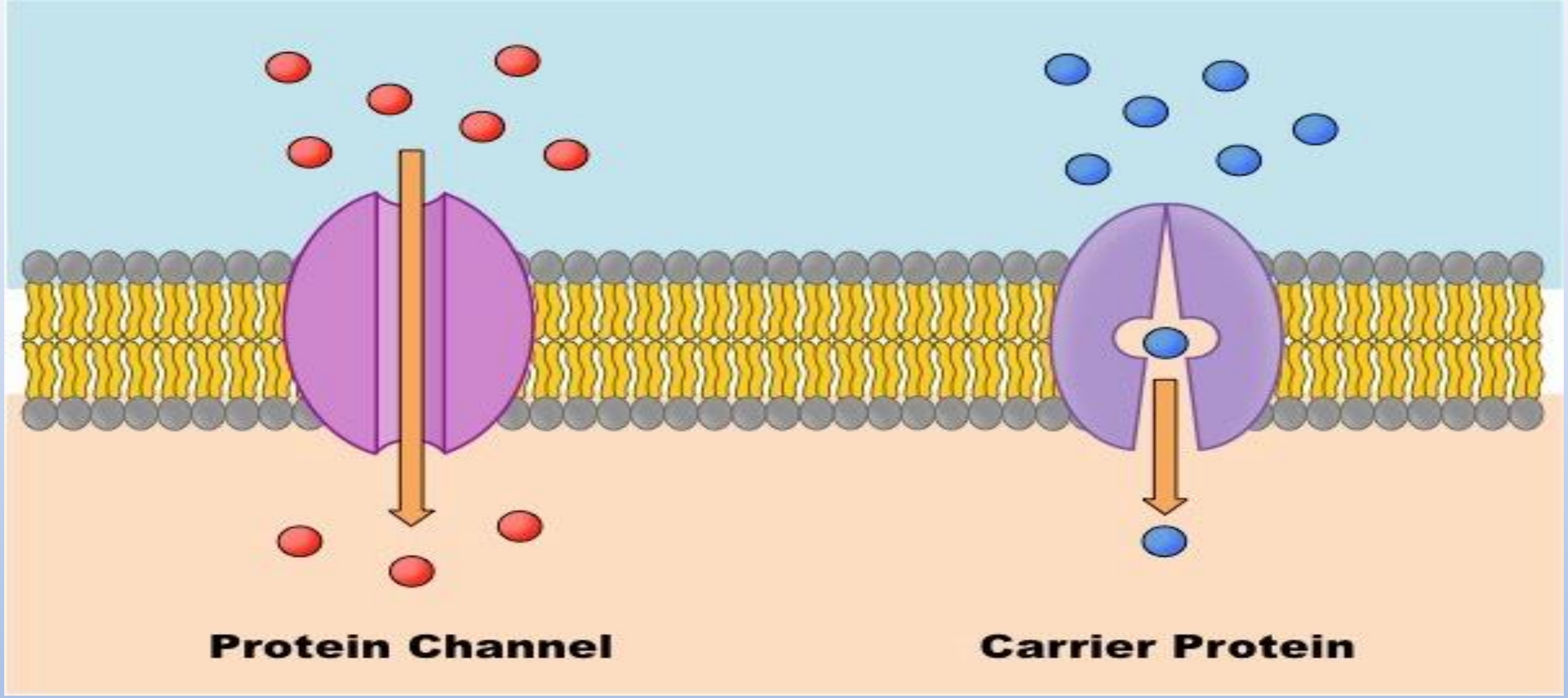
b) **Carrier proteins**

- **Facilitated Diffusion** is the passive movement of molecules across the cell membrane via the aid of a membrane protein.

a) **Channel proteins:** form pores, or tiny holes, in the membrane. This allows water molecules and small ions to pass through the membrane without coming into contact with the hydrophobic tails of the lipid molecules in the interior of the membrane.

- **Facilitated Diffusion** is the passive movement of molecules across the cell membrane via the aid of a membrane protein.

b) Carrier proteins: bind with specific ions or molecules, and in doing so, they change shape. As carrier proteins change shape, they carry the ions or molecules across the membrane.



Facilitated Diffusion

1. **Active Transport**

- **Pumps (Active Transport)**
- **Vesicle Active Transport**

1. **Active Transport**

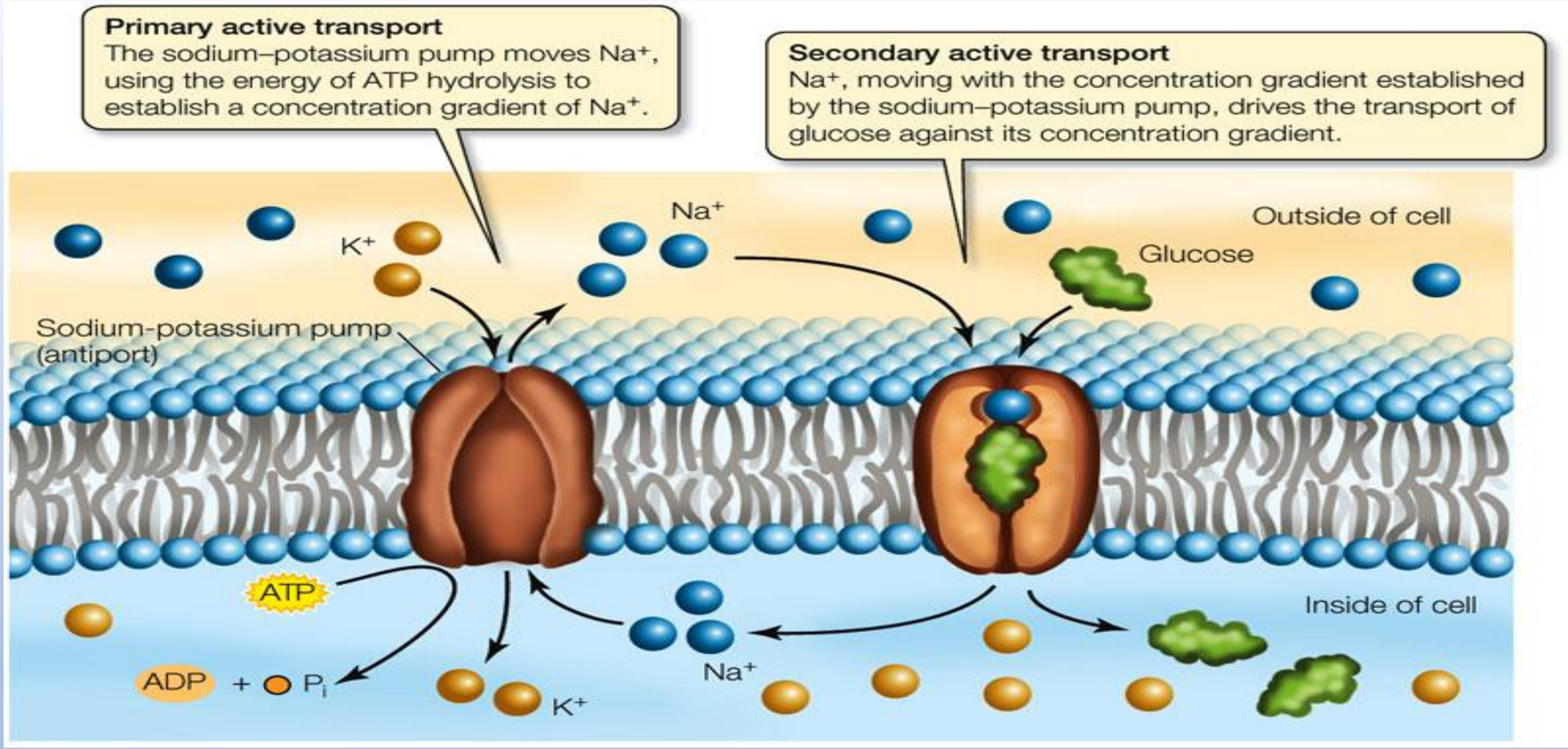
- **Pumps (Active Transport) Pumps (Active Transport):** Pumps are used in active transport. They move substances against their concentration gradient from low concentration to high concentration.
- **Vesicle Active Transport**

1. Active Transport

a) **Primary active transport**, also known as direct active transport, utilizes chemical energy (such as that from the cell membrane's adenosine triphosphate or ATP) to transport all types of solutes against their concentration gradient across a membrane.

1. Active Transport

b) Secondary Active Transport is a type of transport that moves against its concentration gradient. Unlike in primary active transport, in secondary active transport, ATP is not directly coupled to the molecule of interest; and the electrochemical gradient, created by primary active transport, can move other substances against their concentration gradients, a process called co-transport or secondary active transport.



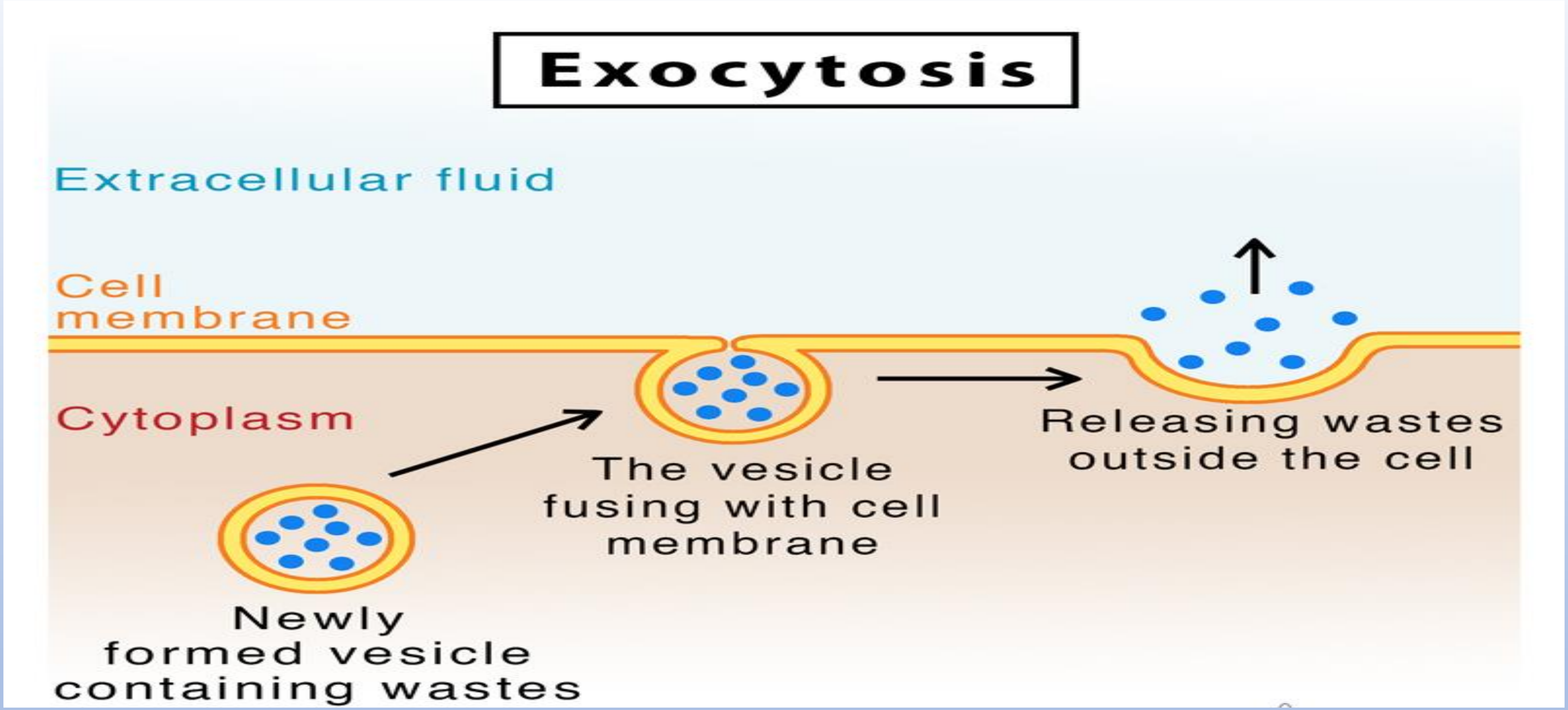
Pumps (Active Transport)

- **Vesicle Active Transport:** Vesicles or other bodies in the cytoplasm move macromolecules or large particles across the plasma membrane.

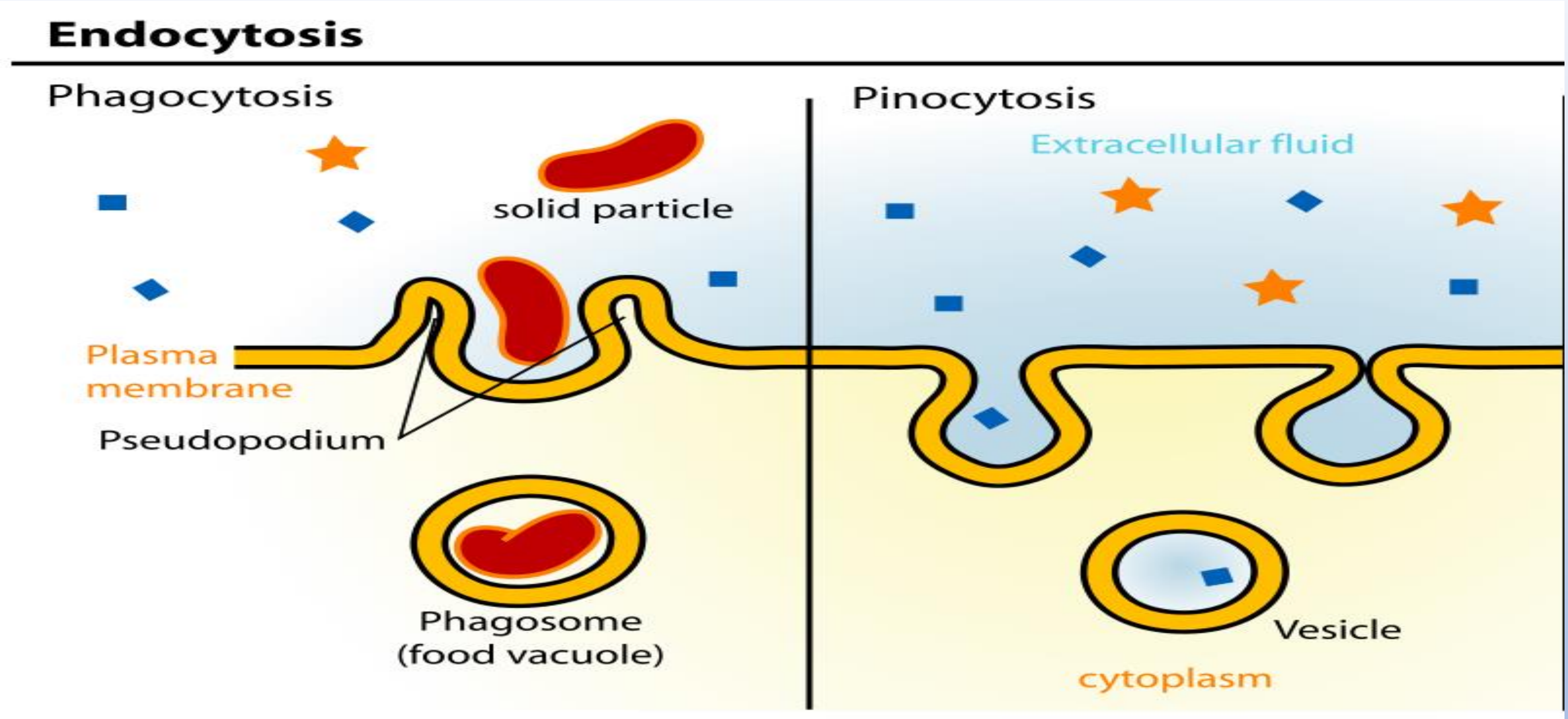
a) **Exocytosis:** is the process by which cells move materials from within the cell into the extracellular fluid.

b) **Phagocytosis**: is a cellular process for ingesting and eliminating particles larger than 0.5μm in diameter, including microorganisms, foreign substances, and apoptotic cells.

c) **Pinocytosis**: is the ingestion of surrounding fluid(s).


Exocytosis
Extracellular fluid
Cell membrane
Cytoplasm
Releasing wastes outside the cell
The vesicle fusing with cell membrane
Newly formed vesicle containing wastes

Exocytosis



Phagocytosis and Pinocytosis

Post-test Quiz

Give the types of the active transport

CELL CYCLE
MITOSIS & MEIOSIS
LECTURES (15 and 16)

Objective: this lecture learn about study the study the cell cycle and method of cell division

Pre-test Quiz

Give the types of cell division

All cells arise from the division of preexisting cells of the multicellular organisms originated from the division of single cell, zygote, which is formed from the union (fertilization) of an egg and sperm. Cell division provides the bases for one form of growth for both sexual and asexual reproduction, and for transmission of hereditary qualities from one cell generation to another. The division of the cells include two types: nuclear division (karyokinesis) and cytoplasmic division (cytokinesis)

Cell Cycle (Cell Division Cycle)

The cell cycle is series of events that take place in a cell leading to duplication of its DNA (DNA replication) and division of cytoplasm and organelles to produce two daughter cells.

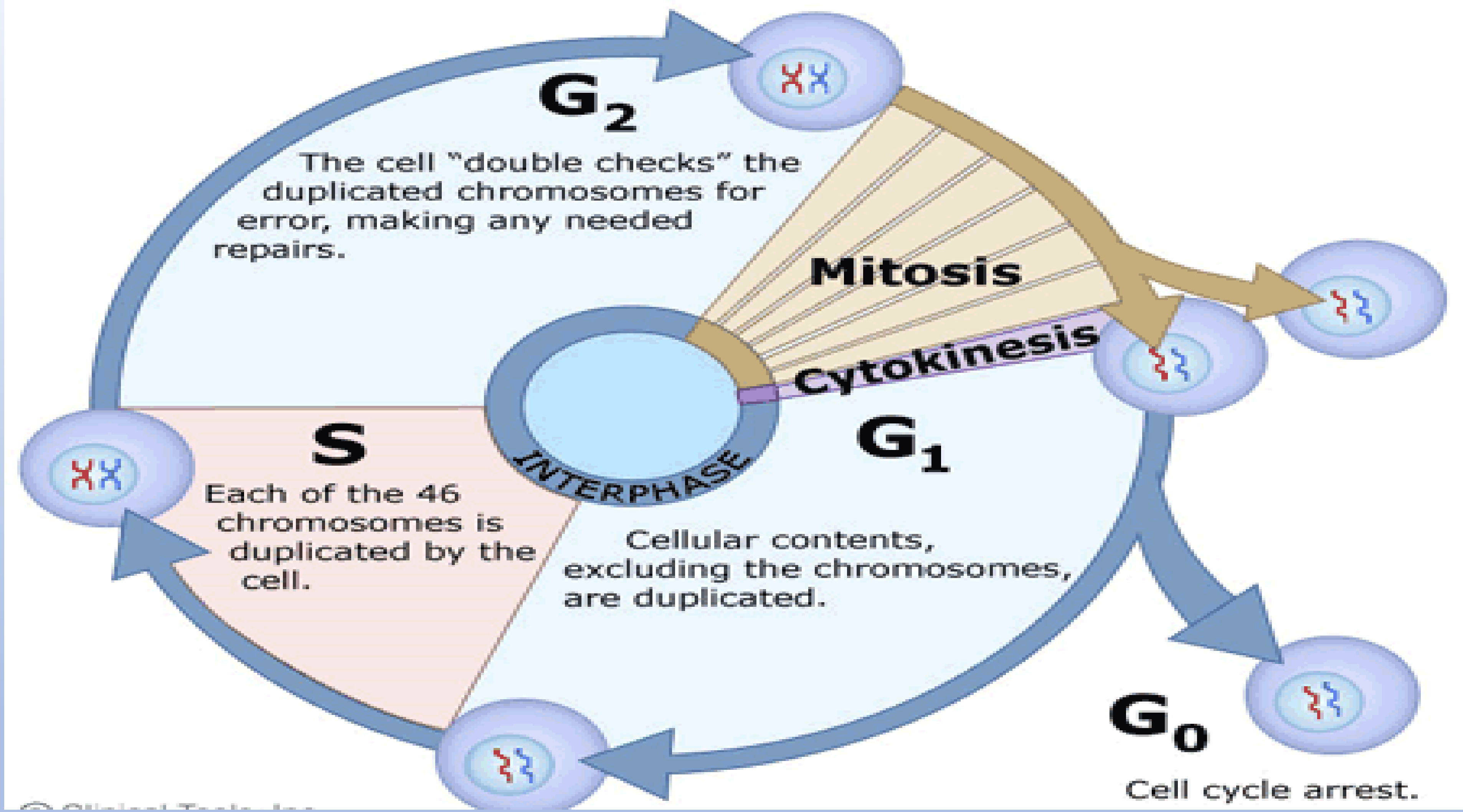
Cell Cycle (Cell Division Cycle)

In animals that reproduce asexually, mitosis is the only mechanism for transverse the genetic information from parent to progeny, while the animals that reproduce sexually, the parent must produce sex cells (gametes) that contain only half number of chromosomes, so that the offspring formed by union of the gametes during fertilization will contain double content of parental genetic material, therefore the gametes require a special type of division called meiosis.

Interphase

Before entering mitosis, a cell spends a period of its growth under interphase. It undergoes the following phases when in interphase:

- **The G_0 phase**, also known as **the resting phase**, is the phase of the cell cycle during which a cell is neither dividing nor preparing to divide. During this period the cell performs regulatory and its basic cellular functions.
- **G_1 Phase:** This is the period before the synthesis of DNA.
- **S Phase:** This is the phase during which DNA synthesis takes place.
- **G_2 Phase:** This is the phase between the end of DNA synthesis and the beginning of the prophase.


G2
The cell "double checks" the duplicated chromosomes for error, making any needed repairs.
Mitosis
Cytokinesis
S
Each of the 46 chromosomes is duplicated by the cell.
INTERPHASE
G1
Cellular contents, excluding the chromosomes, are duplicated.
G0
Cell cycle arrest.

CELL CYCLE

Types of the Cell Division

1. Mitosis

2. Meiosis

Types of the Cell Division

Mitosis: Mitosis is the process by which a cell replicates its chromosomes and then segregates them, producing two identical nuclei in preparation for cell division. Mitosis is generally followed by equal division of the cell's content into two daughter cells that have identical genomes.

1- Prophase

Prophase immediately follows the S and G2 phases of the cycle and is marked by condensation of the genetic material to form compact mitotic chromosomes composed of two chromatids attached at the centromere. The completion of the prophase is characterized by the initiation of the assembly of the mitotic spindle, the microtubules and the proteinaceous components of the cytoplasm that help in the process. The nuclear envelope starts disintegrating.

2- Metaphase

At this stage, the microtubules start pulling the chromosomes with equal force and the chromosome ends up in the middle of the cell. This region is known as the metaphase plate. Thus, each cell gets an entire functioning genome.

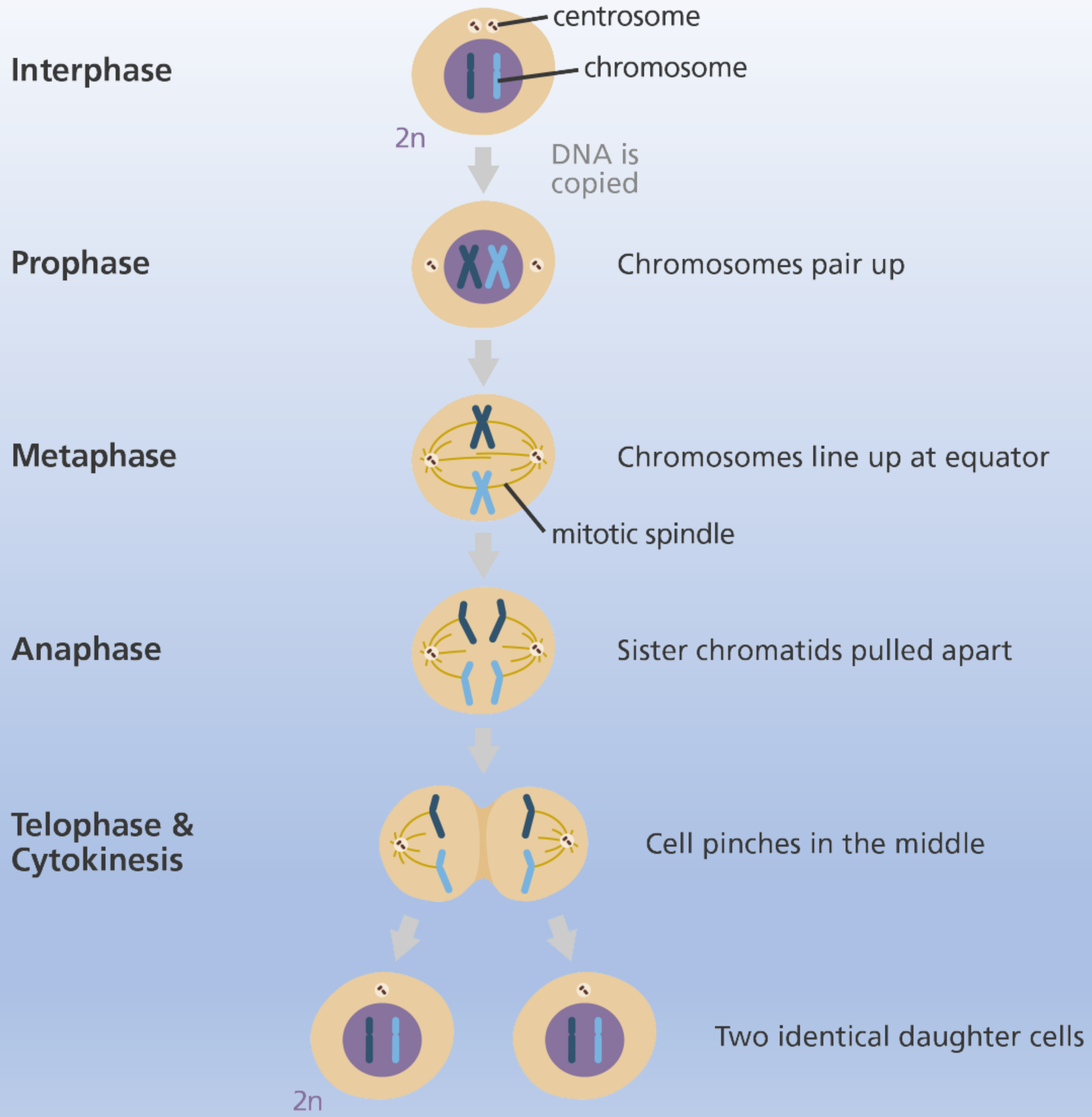
3- Anaphase

The splitting of the sister chromatids marks the onset of anaphase. These sister chromatids become the chromosome of the daughter nuclei. The chromosomes are then pulled towards the pole by the fibers attached to the kinetochores of each chromosome. The centromere of each chromosome leads at the edge while the arms trail behind it.

4- Telophase

The chromosomes that cluster at the two poles start coalescing into an undifferentiated mass, as the nuclear envelope starts forming around it. The nucleolus, Golgi bodies and ER complex, which had disappeared after prophase start to reappear.

Mitosis


Interphase
centrosome
chromosome
2n
DNA is copied
Prophase
Chromosomes pair up
Metaphase
Chromosomes line up at equator
mitotic spindle
Anaphase
Sister chromatids pulled apart
Telophase & Cytokinesis
Cell pinches in the middle
Two identical daughter cells
2n

2. Meiosis

It is a type of cell division in sexually reproducing organisms that reduces the number of chromosomes in gametes (the sex cells, or egg and sperm).

- **Meiosis I:** **t**he first meiotic division is a reduction division (diploid → haploid) in which homologous chromosomes are separated.
- **Meiosis II:** The second division separates sister chromatids (these chromatids may not be identical due to crossing over in prophase I).

Meiosis I

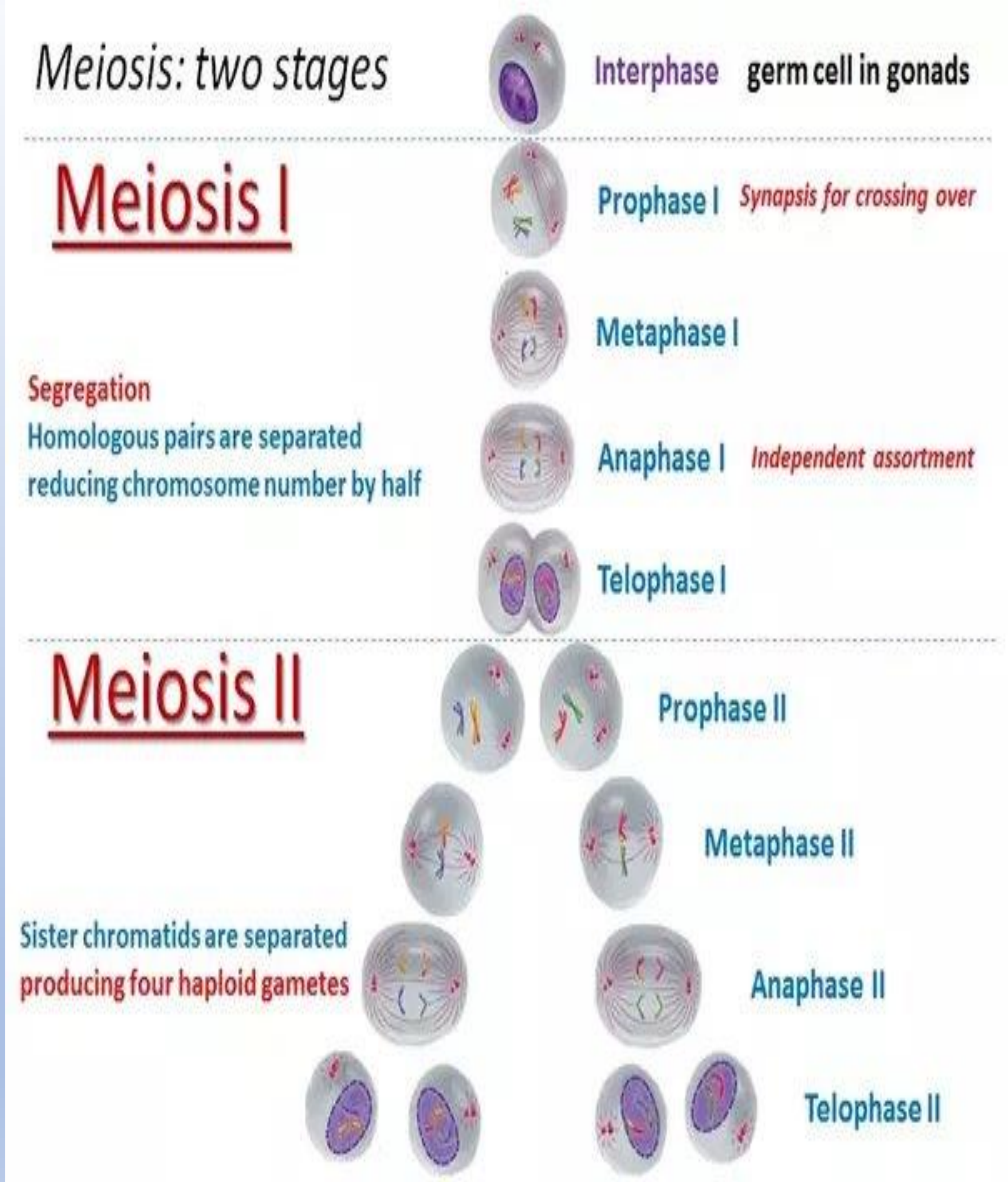
- **Prophase-I:** Chromosomes condense, nuclear membrane dissolves, homologous chromosomes form bivalents, crossing over occurs.
- **Metaphase-I:** Spindle fibres from opposing centrosomes connect to bivalents (at centromeres) and align them along the middle of the cell.
- **Anaphase-I:** Spindle fibers contract and split the bivalent, homologous chromosomes move to opposite poles of the cell.
- **Telophase-I:** Chromosomes decondense, nuclear membrane may reform, cell divides (cytokinesis) to form two haploid daughter cells.

Meiosis II

- **Prophase-II:** Chromosomes condense, nuclear membrane dissolves, centrosomes move to opposite poles (perpendicular to before)
- **Metaphase-II:** Spindle fibers from opposing centrosomes attach to chromosomes (at centromere) and align them along the cell equator
- **Anaphase-II:** Spindle fibers contract and separate the sister chromatids, chromatids (now called chromosomes) move to opposite poles
- **Telophase-II:** Chromosomes decondense, nuclear membrane reforms, cells divide (cytokinesis) to form four haploid daughter cells

The final outcome of meiosis is the production of four haploid daughter cells. These cells may all be genetically distinct if crossing over occurs in prophase I (causes recombination of sister chromatids)

Meiosis


Meiosis: two stages
Interphase
germ cell in gonads
Meiosis I
Prophase I
Synapsis for crossing over
Metaphase I
Segregation
Homologous pairs are separated
reducing chromosome number by half
Anaphase I
Independent assortment
Telophase I
Meiosis II
Prophase II
Metaphase II
Sister chromatids are separated
producing four haploid gametes
Anaphase II
Telophase II

At the end of the two types of the cell division (Mitosis and Meiosis) **the Cytokinesis** that defined as the physical process of cell division, which divides the cytoplasm of a parental cell into two daughter cells was taken place.

Post-test Quiz

Give one differences between meiosis I and meiosis II

CELL ENERGY

LECTURE (17)

Objective: this lecture learn about the energetic pathways of the human cells

Pre-test Quiz

List the types of the metabolic processes

Cell energy: the process by which biochemicals are used to generate energy (in the form of ATP).

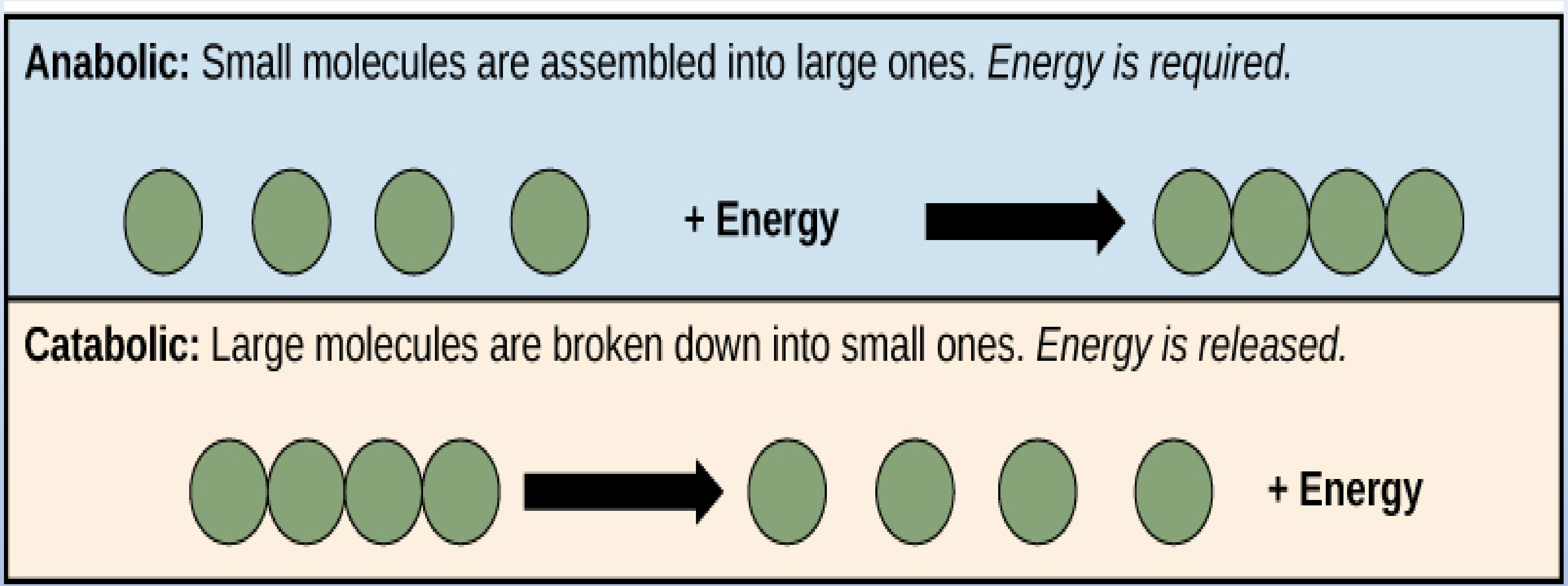
Bioenergetics: are metabolic processes that relate to the flow of energy in living organisms. Those processes convert energy into adenosine triphosphate (ATP), which is the form suitable for muscular Metabolic Process.

Metabolism: the total amount of biochemical reactions in a biological organism that maintain the healthy operation of cells. Furthermore, it provides the energy necessary for biological processes such as growth, reproduction, and maintaining the structure of organisms.

Metabolic Processes

There are two types of metabolic process

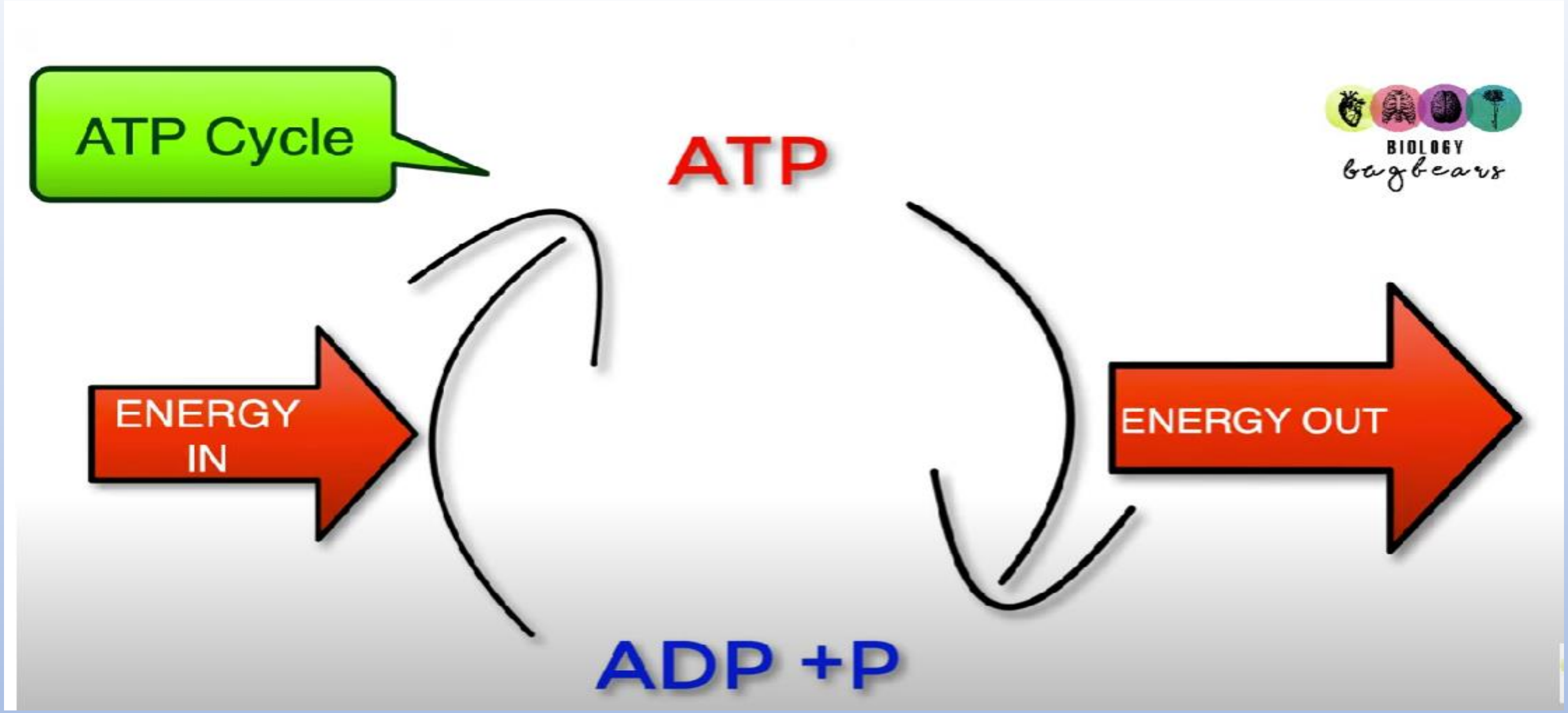
1. **Catabolism:** involved in breaking down larger organic molecules into smaller molecules. This metabolic process releases energy.
2. **Anabolism**: involved in building up or synthesizing compounds from simpler substances required by the cells. This metabolic process requires and stores energy.


Anabolic: Small molecules are assembled into large ones. *Energy is required.*
+ Energy
Catabolic: Large molecules are broken down into small ones. *Energy is released.*
+ Energy

Metabolic Pathways: is a series of connected chemical reactions that feed one another. The pathway takes in one or more starting molecules and, through a series of intermediates, converts them into products.

Adenosine Triphosphate (ATP): energy-carrying molecule found in the cells of all living things. ATP captures chemical energy obtained from the breakdown of food molecules and releases it to fuel other cellular processes.

Usually only the outer phosphate is removed from ATP to yield energy; when this occurs ATP is converted to adenosine diphosphate (ADP), the form of the nucleotide having only two phosphates this process called (**ATP Cycle**)as showed in figure below.


ATP Cycle
ATP
ENERGY IN
ENERGY OUT
ADP +P
BIOLOGY bugbears

Respiration is one of the important chemical processes, which is carried out by all living organisms including plants animals and humans in order to release energy required for life processes. The process of respiration occurs both during the presence or in the absence of Oxygen

1. **Aerobic cellular respiration**: It is the process of cellular respiration that takes place in the presence of oxygen gas to produce energy from food. This type of respiration is common in humans. In this process, water and carbon dioxide are produced as end products.

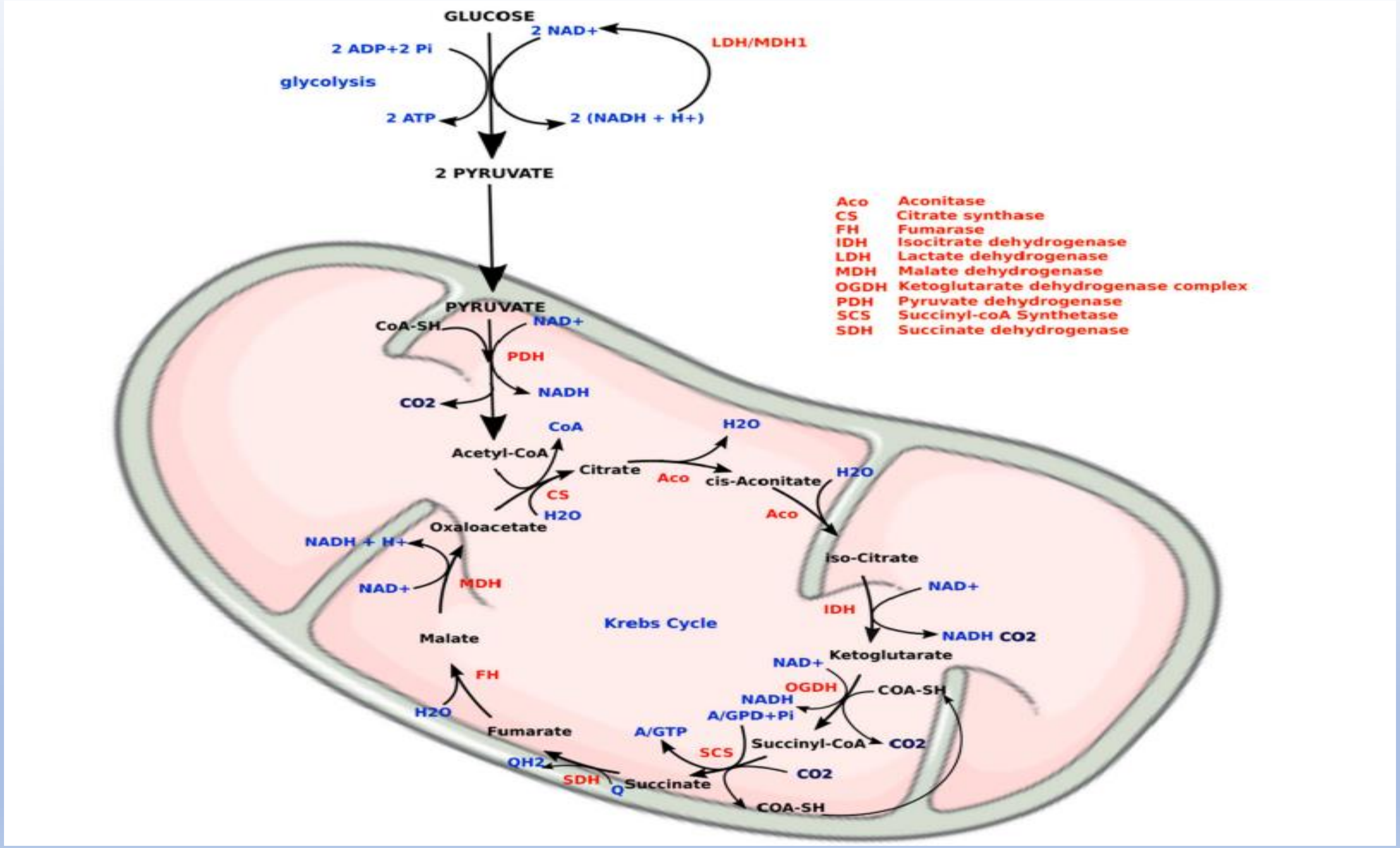
Aerobic cellular respiration is made up of three parts:

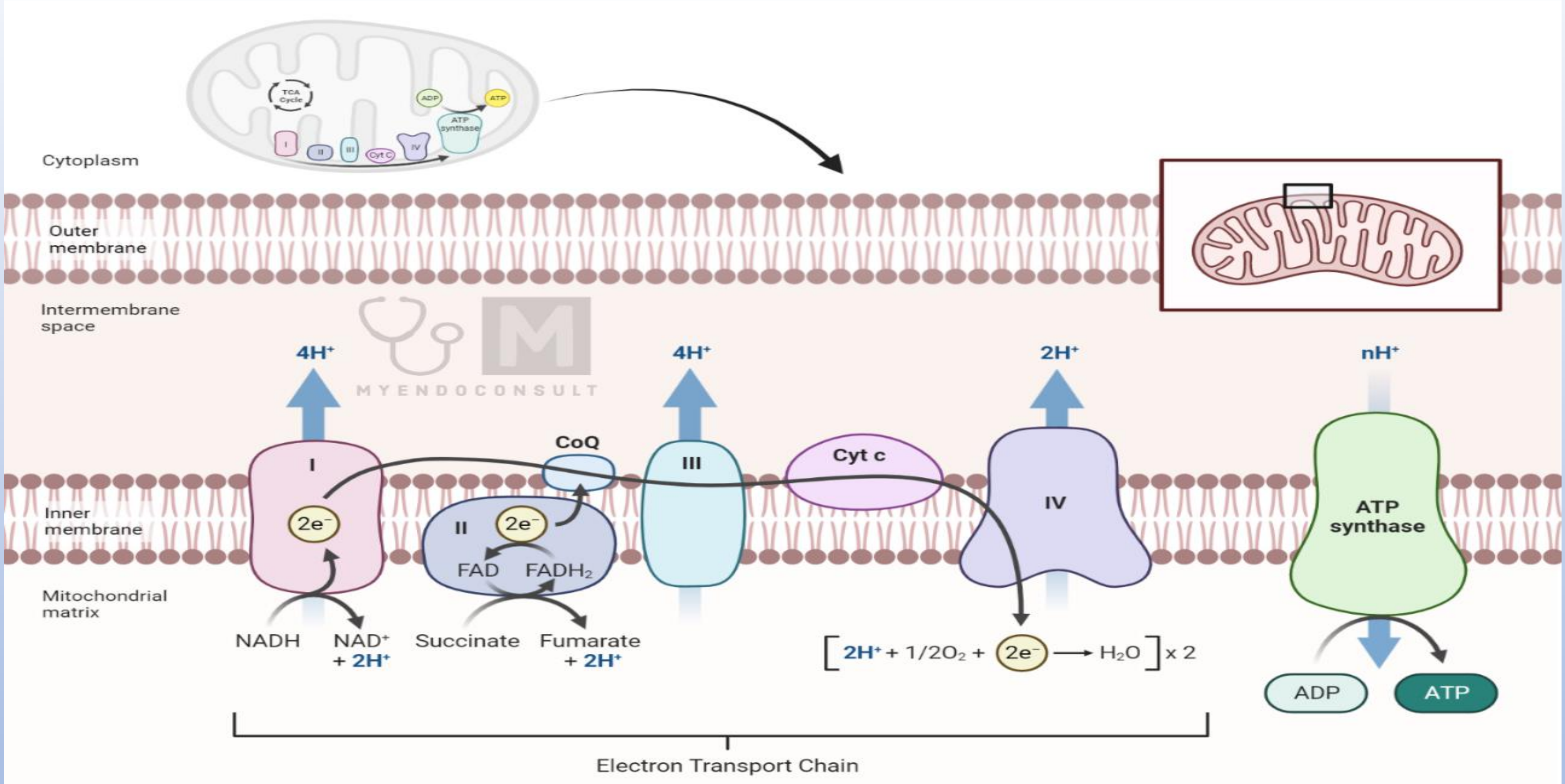
a. Glycolysis.

b. The citric acid (Krebs) cycle.

c. Oxidative phosphorylation.

- The electron transport chain (ETC).
- Chemiosmosis.


GLUCOSE
2 NAD+
LDH/MDH1
2 ADP+2 Pi
glycolysis
2 ATP
2 (NADH + H+)
2 PYRUVATE
Aco Aconitase
CS Citrate synthase
FH Fumarase
IDH Isocitrate dehydrogenase
LDH Lactate dehydrogenase
MDH Malate dehydrogenase
OGDH Ketoglutarate dehydrogenase complex
PDH Pyruvate dehydrogenase
SCS Succinyl-coA Synthetase
SDH Succinate dehydrogenase
PYRUVATE
CoA-SH
NAD+
PDH
CO2
NADH
CoA
H2O
Acetyl-CoA
Citrate
Aco
cis-Aconitate
H2O
CS
H2O
Aco
Oxaloacetate
NADH + H+
NAD+
MDH
Iso-Citrate
NAD+
IDH
NADH CO2
Krebs Cycle
Malate
Ketoglutarate
NAD+
OGDH
COA-SH
FH
NADH
A/GPD+Pi
H2O
Fumarate
A/GTP
Succinyl-CoA
CO2
SCS
QH2
SDH
Q
Succinate
CO2
COA-SH

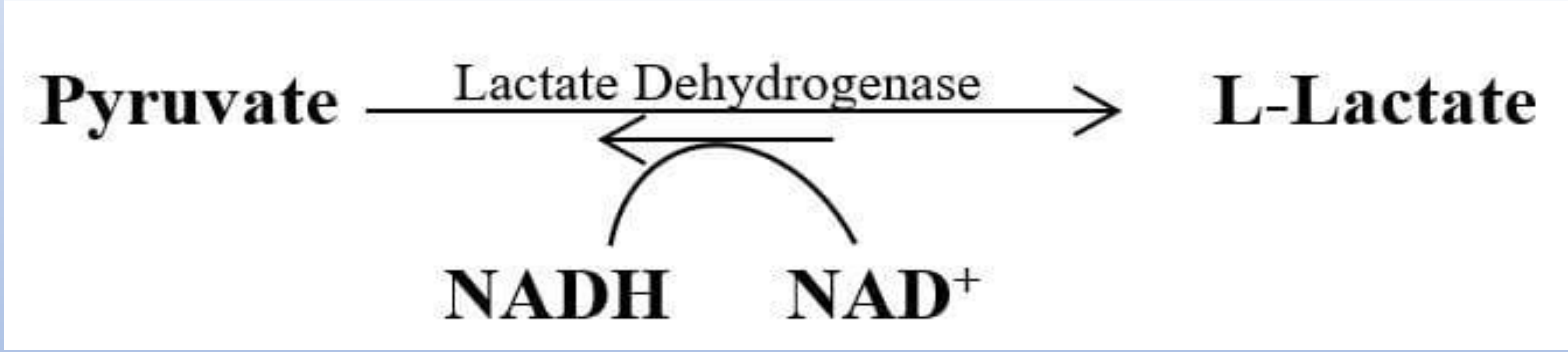


TCA Cycle
ADP
ATP
ATP synthase
I
II
III
Cyt C
IV
Cytoplasm
Outer membrane
Intermembrane space
MYENDOCONSULT
4H+
4H+
2H+
nH+
CoQ
I
III
Cyt c
IV
ATP synthase
Inner membrane
2e-
II
2e-
FAD
FADH2
Mitochondrial matrix
NADH
NAD+ + 2H+
Succinate
Fumarate + 2H+
[2H+ + 1/2O2 + 2e- → H2O] x 2
ADP
ATP
Electron Transport Chain

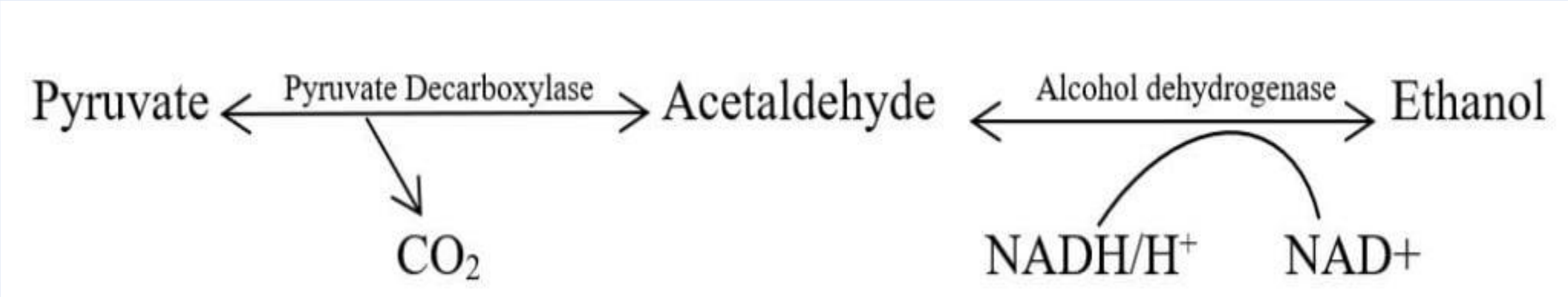
2. Anaerobic Respiration: It is a process which takes place in the absence of oxygen gas. In this process, the energy is obtained by the breakdown of glucose in the absence of oxygen. One of the best examples of anaerobic respiration is the process of fermentation in yeast.

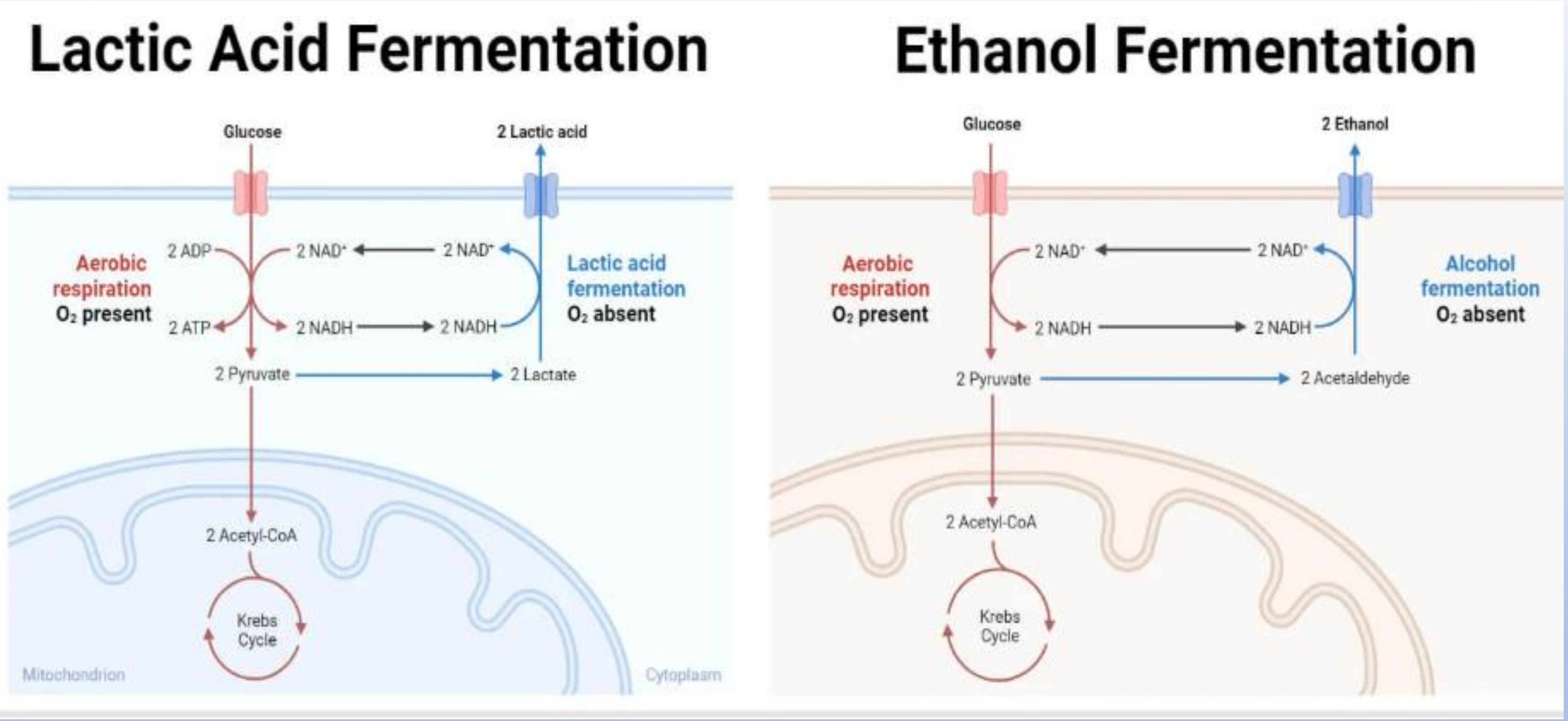
1. Glycolysis
2. Fermentation

a. Lactic Acid Fermentation.



a. Ethanol Fermentation.




Lactic Acid Fermentation
Glucose
2 Lactic acid
2 ADP
2 NAD+
2 NAD+
Aerobic respiration
O2 present
Lactic acid fermentation
O2 absent
2 ATP
2 NADH
2 NADH
2 Pyruvate
2 Lactate
2 Acetyl-CoA
Krebs Cycle
Mitochondrion
Cytoplasm
Ethanol Fermentation
Glucose
2 Ethanol
2 NAD+
2 NAD+
Aerobic respiration
O2 present
Alcohol fermentation
O2 absent
2 NADH
2 NADH
2 Pyruvate
2 Acetaldehyde
2 Acetyl-CoA
Krebs Cycle

Post-test Quiz

Define anaerobic respiration

NUCLEIC ACID, DNA AND RNA
LECTURE (18)

Objective: this lecture learn about molecular structure of the genetic material

Pre-test Quiz

List the nitrogenous bases of DNA

Molecular biology is the branch of biology that deals with the nature of biological phenomena at the molecular level through the study of the life molecules (DNA, RNA, and proteins). Nucleic acids are polymers, or small biomolecules, essential to all known forms of life.

The term nucleic acid is the overall name for DNA and RNA. Nucleic acids composed of nucleotides, which are the monomers made of three components:

1. 5- Carbon Sugar.
2. Phosphate Group.
3. Nitrogenous Base.

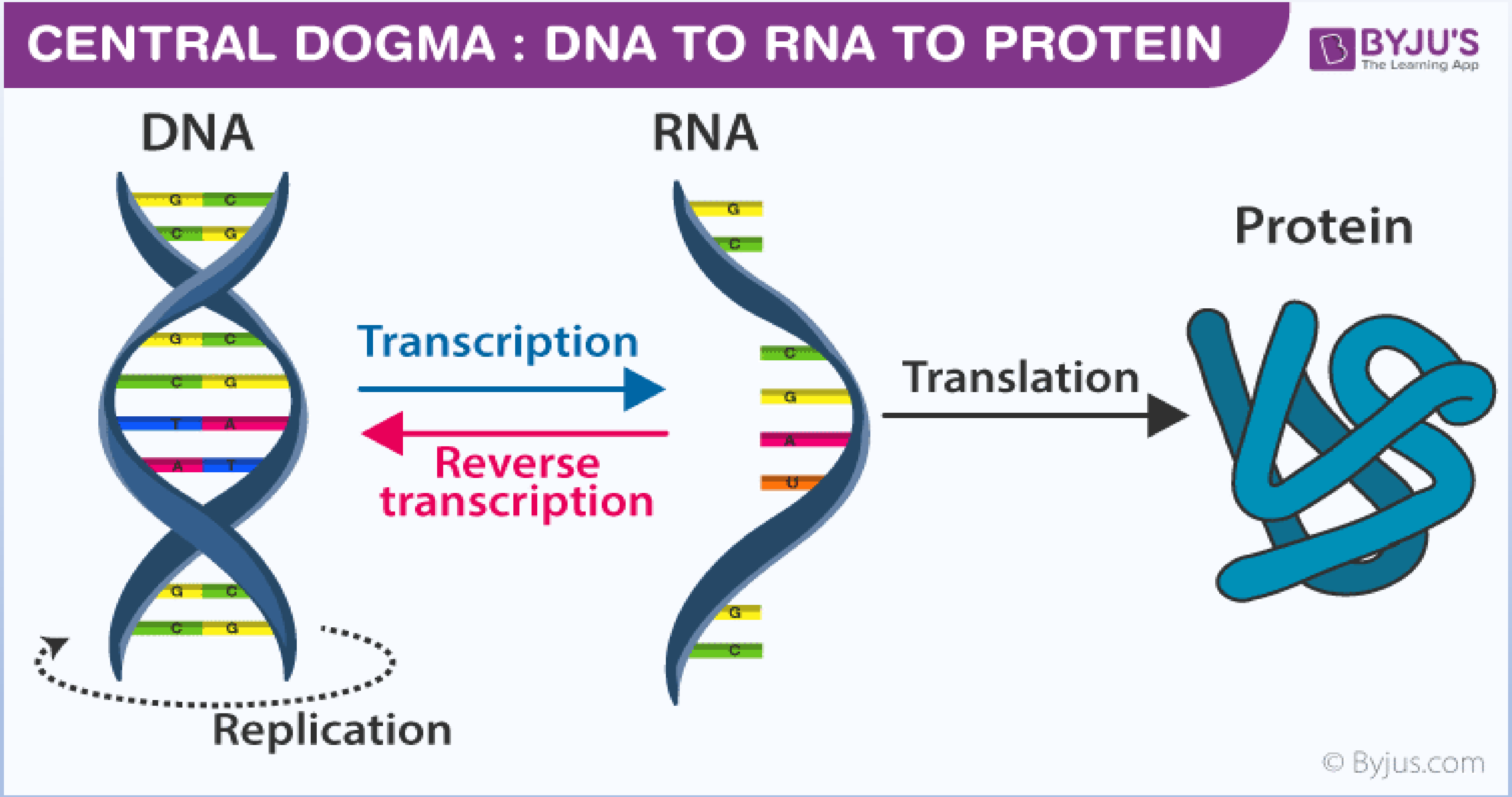
If the sugar is ribose, the polymer is RNA (ribonucleic acid); if the sugar is derived from ribose as deoxyribose the polymer is DNA (deoxyribonucleic acid). A nucleic acid is a chain of nucleotides which stores genetic information needed by cells to create proteins. This information is stored in multiple sets of three nucleotides, known as codons.

1st position of codon (5')	2nd position of codon U	C	A	G	3rd position of codon (3')
U	UUU Phe F Phenylalanine	UCU Ser S Serine	UAU Tyr Y Tyrosine	UGU Cys C Cysteine	U
	UUC Phe F Phenylalanine	UCC Ser S Serine	UAC Tyr Y Tyrosine	UGC Cys C Cysteine	C
	UUA Leu L Leucine	UCA Ser S Serine	UAA * **stop**	UGA * **stop**	A
	UUG Leu L Leucine	UCG Ser S Serine	UAG * **stop**	UGG Trp W Tryptophan	G
C	CUU Leu L Leucine	CCU Pro P Proline	CAU His H Histidine	CGU Arg R Arginine	U
	CUC **Leu** L Leucine	CCC Pro P Proline	CAC His H Histidine	CGC Arg R Arginine	C
	CUA Leu L Leucine	CCA Pro P Proline	CAA Gln Q Glutamine	CGA Arg R Arginine	A
	CUG Leu L Leucine	CCG Pro P Proline	CAG Gln Q Glutamine	CGG Arg R Arginine	G
A	AUU Ile I Isoleucine	ACU Thr T Threonine	AAU Asn N Asparagine	AGU Ser S Serine	U
	AUC Ile I Isoleucine	ACC Thr T Threonine	AAC Asn N Asparagine	AGC Ser S Serine	C
	AUA Ile I Isoleucine	ACA Thr T Threonine	AAA Lys K Lysine	AGA Arg R Arginine	A
	AUG Met M Methionine	ACG Thr T Threonine	AAG Lys K Lysine	AGG Arg R Arginine	G
G	GUU Val V Valine	GCU Ala A Alanine	GAU Asp D Aspartate	GGU Gly G Glycine	U
	GUC Val V Valine	GCC Ala A Alanine	GAC Asp D Aspartate	GGC Gly G Glycine	C
	GUA Val V Valine	GCA Ala A Alanine	GAA Glu E Glutamate	GGA Gly G Glycine	A
	GUG Val V Valine	GCG Ala A Alanine	GAG Glu E Glutamate	GGG Gly G Glycine	G

cDNA Codon Table

Function of the nucleic acid

1. DNA is the chemical basis of heredity.
2. Reserve bank of genetic information.
3. Responsible of maintaining the identity of different species of organisms over millions of years
4. The basic information pathway
5. DNA direct the synthesis of RNA, which in turn directs protein synthesis (Central Dogma).



Central Dogma

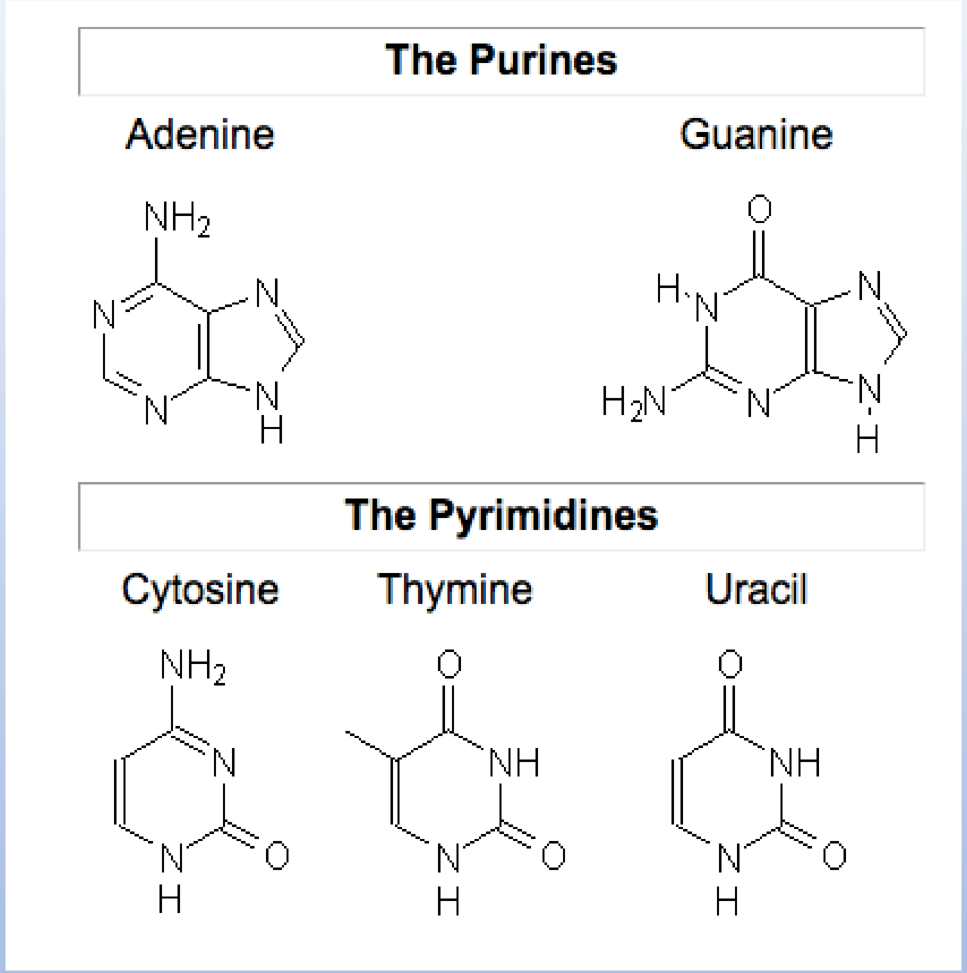
The nitrogenous bases in DNA are

1. Adenine (A)
2. Guanine (G)
3. Thymine (T)
4. Cytosine (C).

The nitrogenous bases in RNA are

1. Adenine (A)
2. Guanine (G)
3. Uracil (U)
4. Cytosine (C).

The **purines** in DNA are adenine and guanine, the same as in RNA. the **pyrimidines** in DNA are cytosine and thymine; in RNA, they are cytosine and uracil. Purines are larger than pyrimidines because they have a two-ring structure while pyrimidines only have a single ring.



General characteristics of DNA (deoxyribonucleic acid)

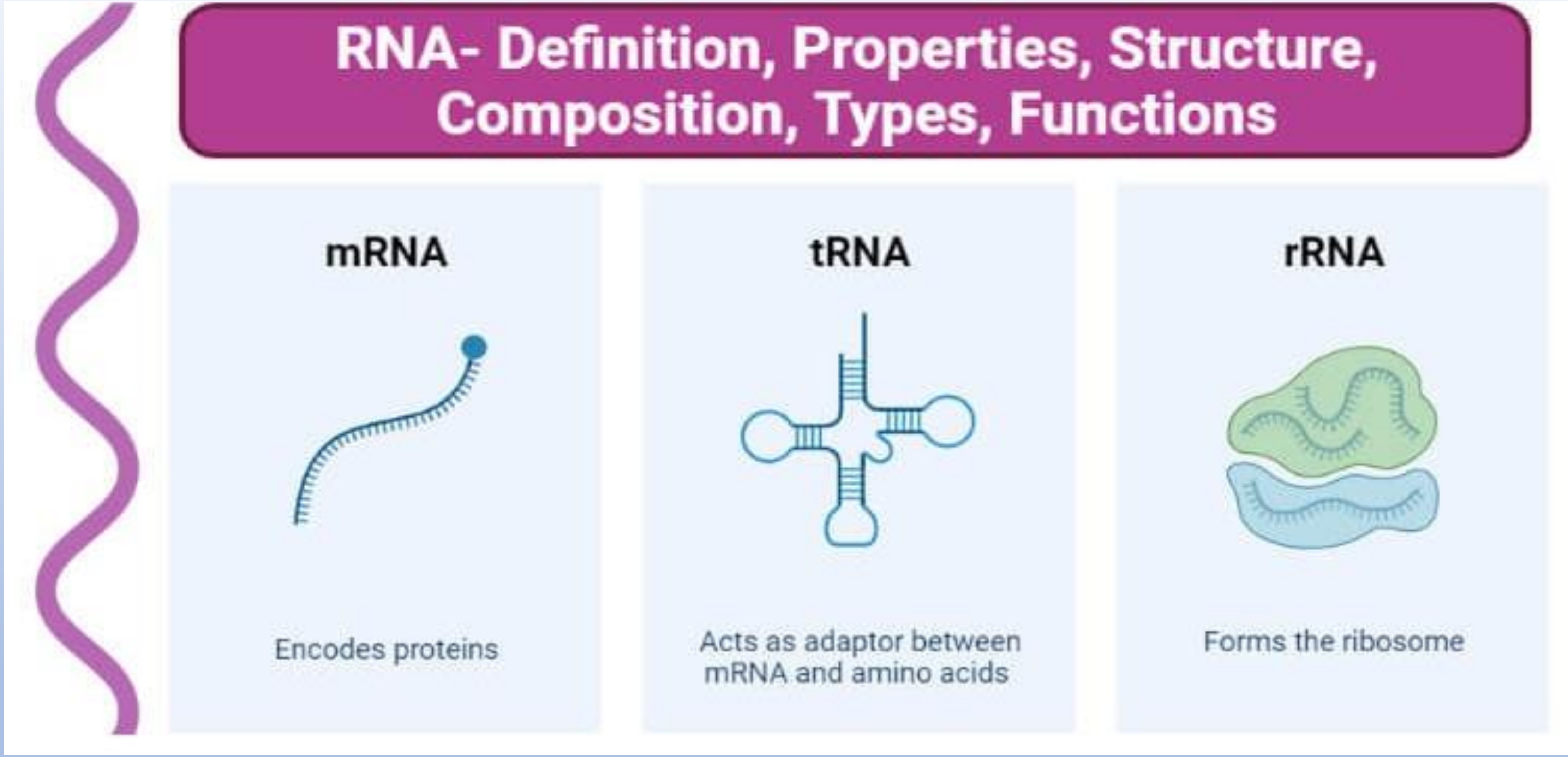
- Double helix, made up of a pair of DNA strands.
- The term **nucleotide** refers to the building blocks of both DNA (deoxyribonucleoside triphosphates, dNTPs) and RNA (ribonucleoside triphosphates, NTPs).
- Nucleotides contain three primary structural components. these are a nitrogenous base, a pentose sugar, and at least one phosphate group Nitrogen bases joined by hydrogen bonds to form base pairs – adenine always paired with thymine, and guanine paired with cytosine. Two hydrogen bonds are formed between adenine and thymine, but three hydrogen bonds hold together guanine and cytosine.
- Molecules that contain only a sugar and a nitrogenous base (no phosphate) are called **nucleosides**.

General characteristics of RNA (ribose nucleotides)

- The structure of RNA is very similar to that of a single strand of DNA.
- RNA consists of ribose nucleotides (nitrogenous bases appended to a ribose sugar) attached by phosphodiester bonds, forming strands of varying lengths.
- The nitrogenous bases in RNA are adenine, guanine, cytosine, and uracil, which replaces thymine in DNA.

Types of RNA

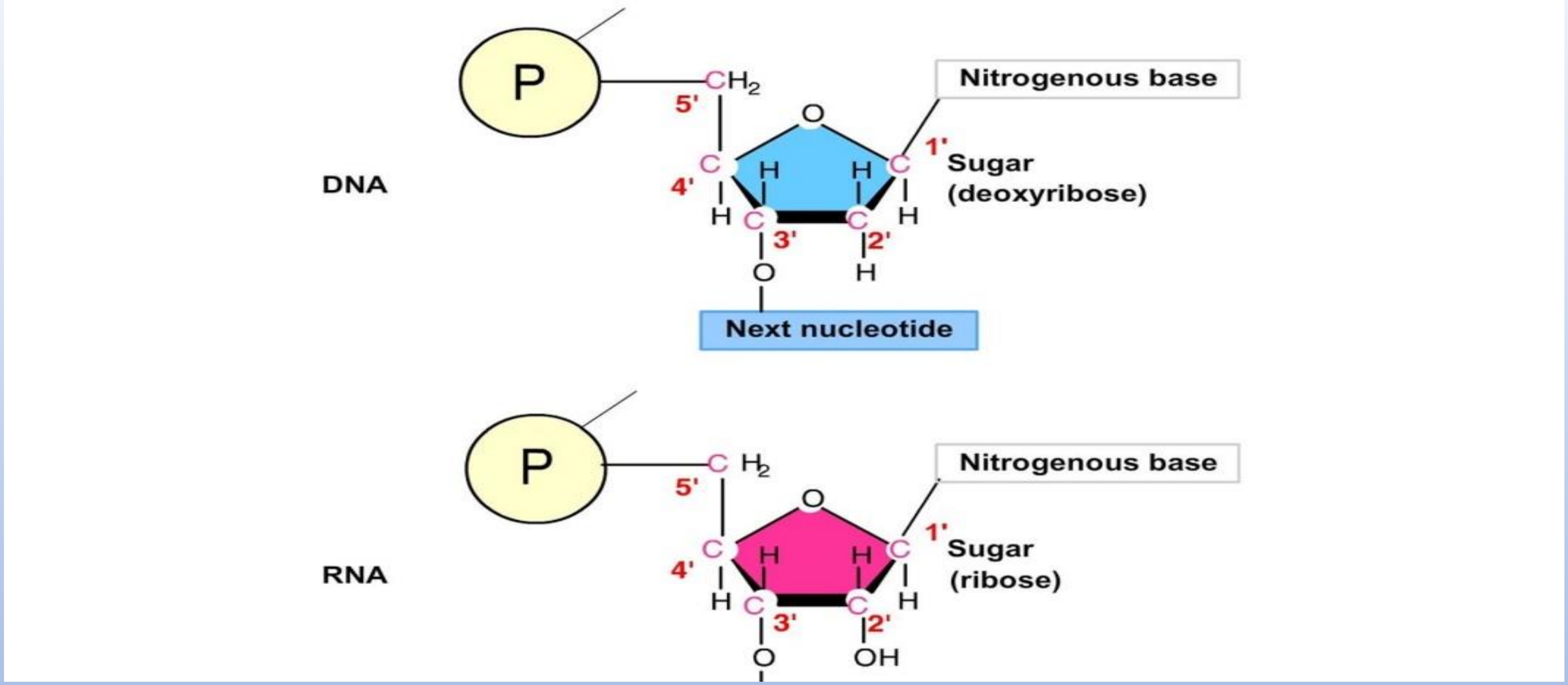
1. **mRNA,** or messenger RNA, that serve as temporary copies of the information found in DNA
2. **rRNA,** or ribosomal RNA, that serve as structural components of protein-making structures known as ribosomes.
3. **tRNA,** or transfer RNA, that ferry amino acids to the ribosome to be assembled.


RNA- Definition, Properties, Structure, Composition, Types, Functions
mRNA
tRNA
rRNA
Encodes proteins
Acts as adaptor between mRNA and amino acids
Forms the ribosome

Types of RNA

Comparison between DNA and RNA

DNA	RNA
It is double stranded nucleic acid.	It is single stranded nucleic acid.
It contains deoxyribose sugar.	It contains ribose sugar.
It contains Thymine (T) as a nitrogenous base.	It contains Uracil (U) instead of thymine
It is the genetic and hereditary material of the cells.	It is involved in synthesis of proteins.



Nucleotides of DNA and RNA

Post-test Quiz
List the types of RNA

INTRODUCTION TO PARASITOLOGY

LECTURE (19)

Objective: this lecture learn parasite life cycle and its role in human infection

Pre-test Quiz

Define the parasite

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

A **parasite** is an organism that lives on or in a host organism and gets its food from or at the expense of its host.

A host is a larger organism that harbors a smaller organism (parasite).

Types of parasites and hosts

There are three main classes of parasites that can cause disease in humans: protozoa, helminths, and ectoparasites. The two types of hosts are – primary and secondary hosts. The primary host is a definitive host or organism in which the parasite reaches the adult stage and reproduces sexually. The secondary or intermediate host harbors a sexually immature parasite for a short transition period.

Oral protozoa: is parasites that established at oral cavity, the protozoan species such as *Trichomonas tenax* and *Entamoeba gingivalis* are components of our normal oral microbiome. They are more common in people having poor oral hygiene and gingival diseases.

1-**Sarcodina (Amoebae)**

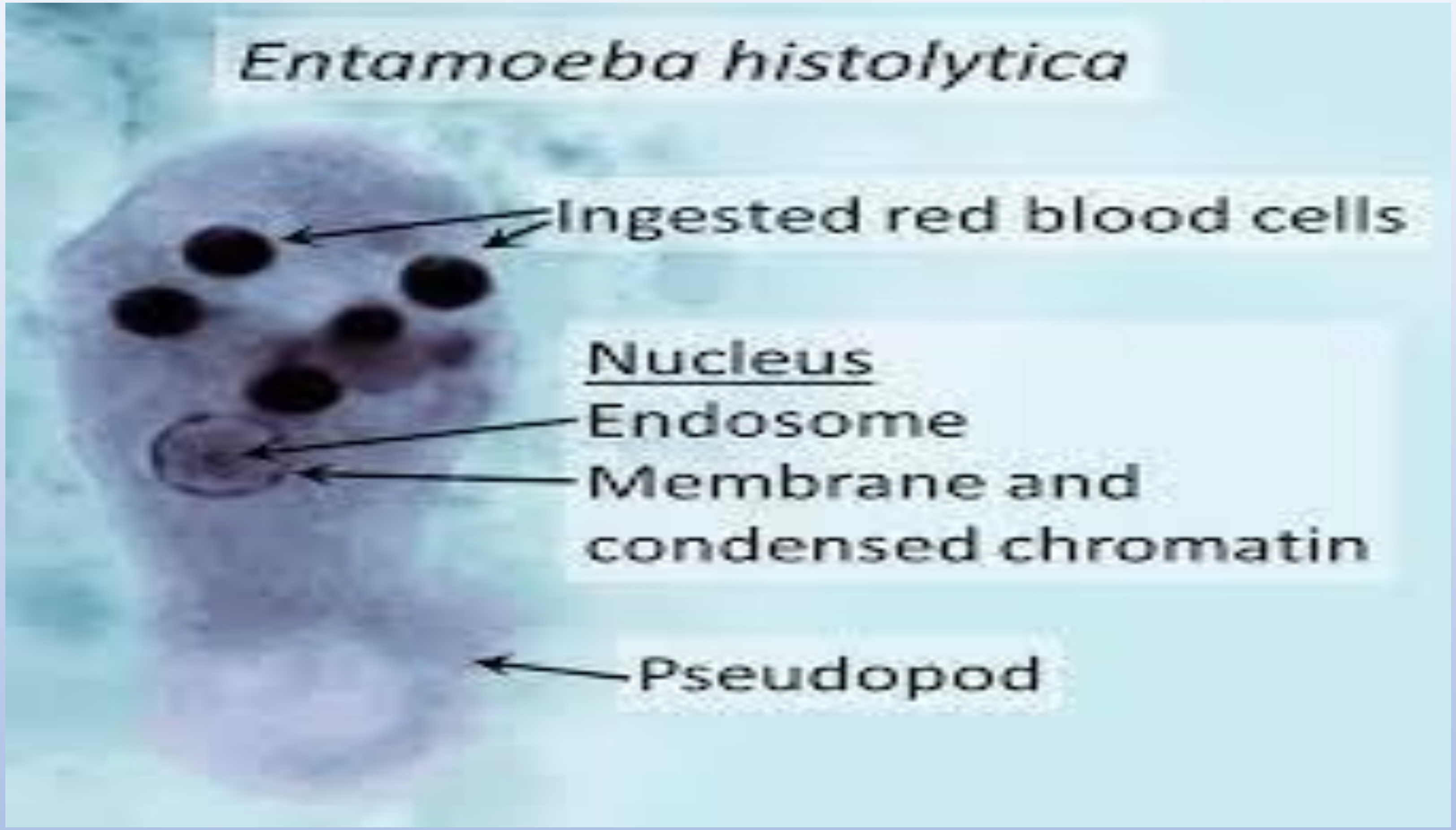
General Characteristics

a. They have a naked body; thus, their shape is not rigid.

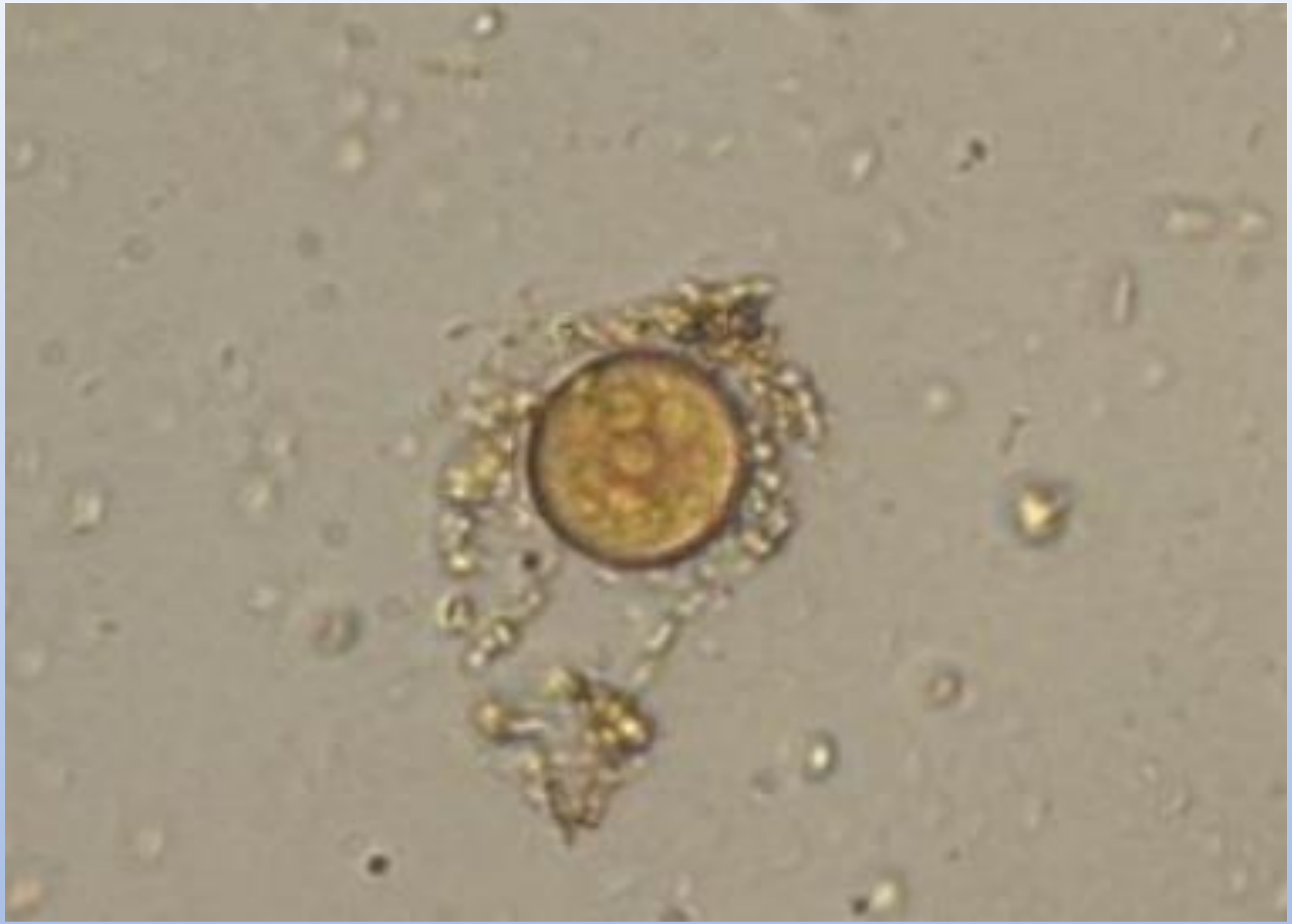
b. They use pseudopodia as locomotory appendage.

c. The cytoplasm is classified into an endo and ecto cytoplasm.

1. Entamoeba histolytica: is an anaerobic parasitic amoebozoan, part of the genus *Entamoeba*. Predominantly infecting humans and other primates causing amoebiasis, Amebiasis is a disease caused by the parasite Entamoeba histolytica. It can affect anyone, although it is more common in people who live in tropical areas with poor sanitary conditions.

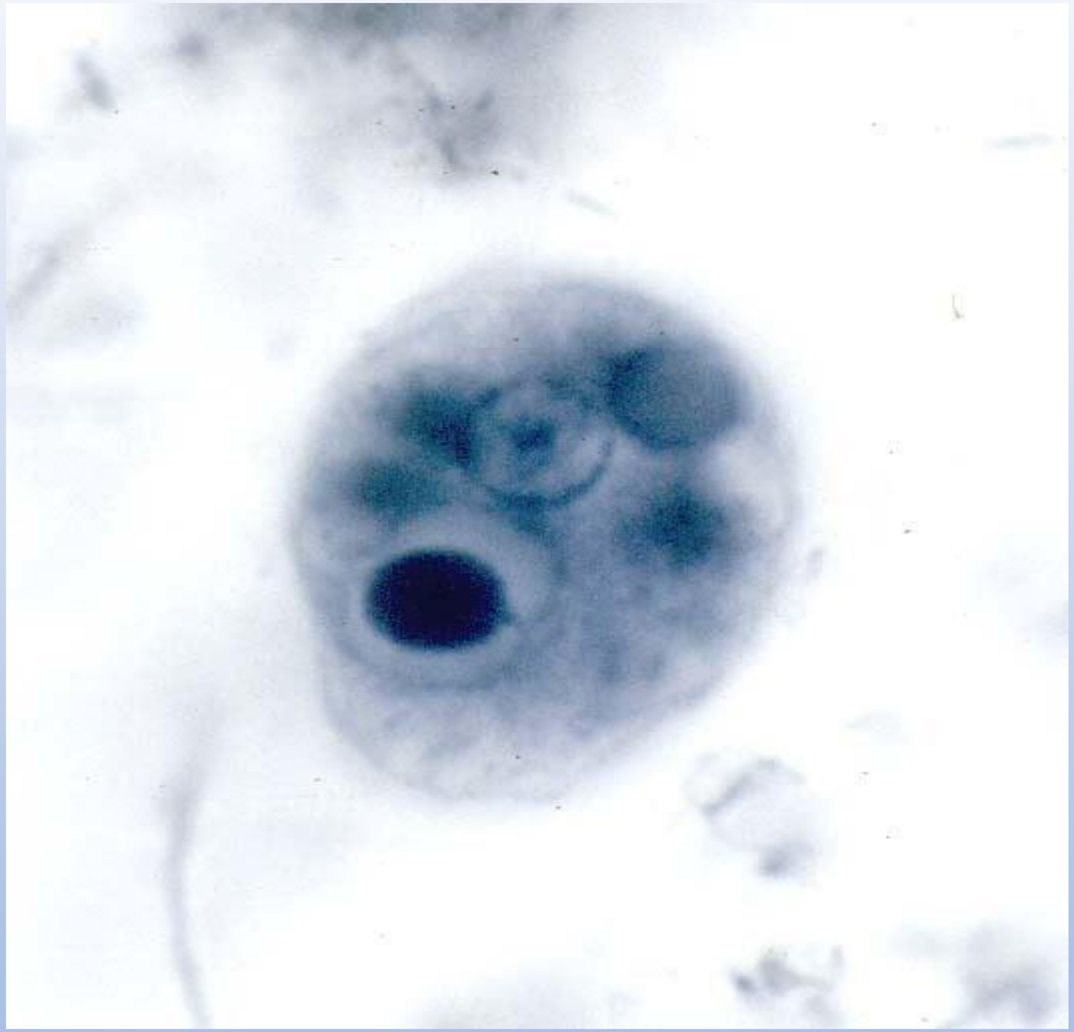

Entamoeba histolytica
Ingested red blood cells
Nucleus
Endosome
Membrane and
condensed chromatin
Pseudopod

2. Entamoeba coli is a non-pathogenic amoeba with worldwide distribution. Its life cycle is similar to that of *E. histolytica* but it does not have an invasive stage and do not ingest red blood cells.



Entamoeba coli

3. Entamoeba gingivalis is an Entamoeba histolytica-like amoebae that lives in/on the teeth, gums, and sometimes tonsils. It measures 10-35 micrometers in length. Endocytotic vacuoles are often numerous and the parasite will ingest bacteria, leukocytes, and erythrocytes (dark circles in trophozoites, above) although it is not itself invasive. No cysts are formed and transmission is entirely by oral-oral contact. Multiple samplings reveal the parasite to colonize the oral cavity of nearly all adult humans.



Entamoeba gingivalis

Mastigophora (Flagellates):

General Characteristics

a) Members of this class are parasitic animals.

b) Are seen in water hence they are aquatic animals.

c) Thread like structure is present on their body which is used as locomotive organelles.

d) Flagella may be one or even more than two.

1. Giardia lamblia (also known as Giardia intestinalis or Giardia duodenalis) is an intestinal protozoan parasite. It has a worldwide distribution, with many developing countries considered endemic areas due to poor sanitary conditions and limited water-treatment facilities. Approximately 280 million people are affected annually. Giardia may cause epidemic or sporadic disease. Infants, children, immunocompromised patients and travellers are considered high-risk groups.

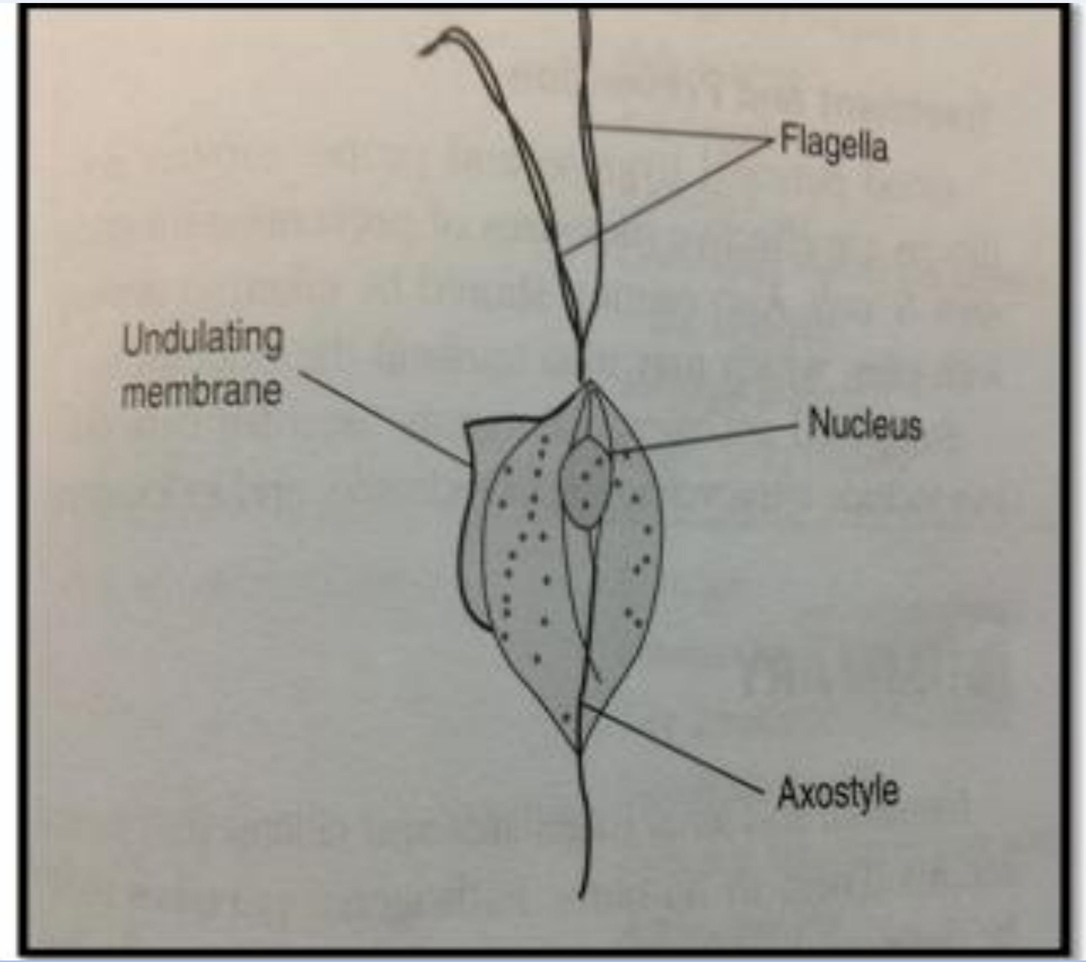
Giardia lamblia

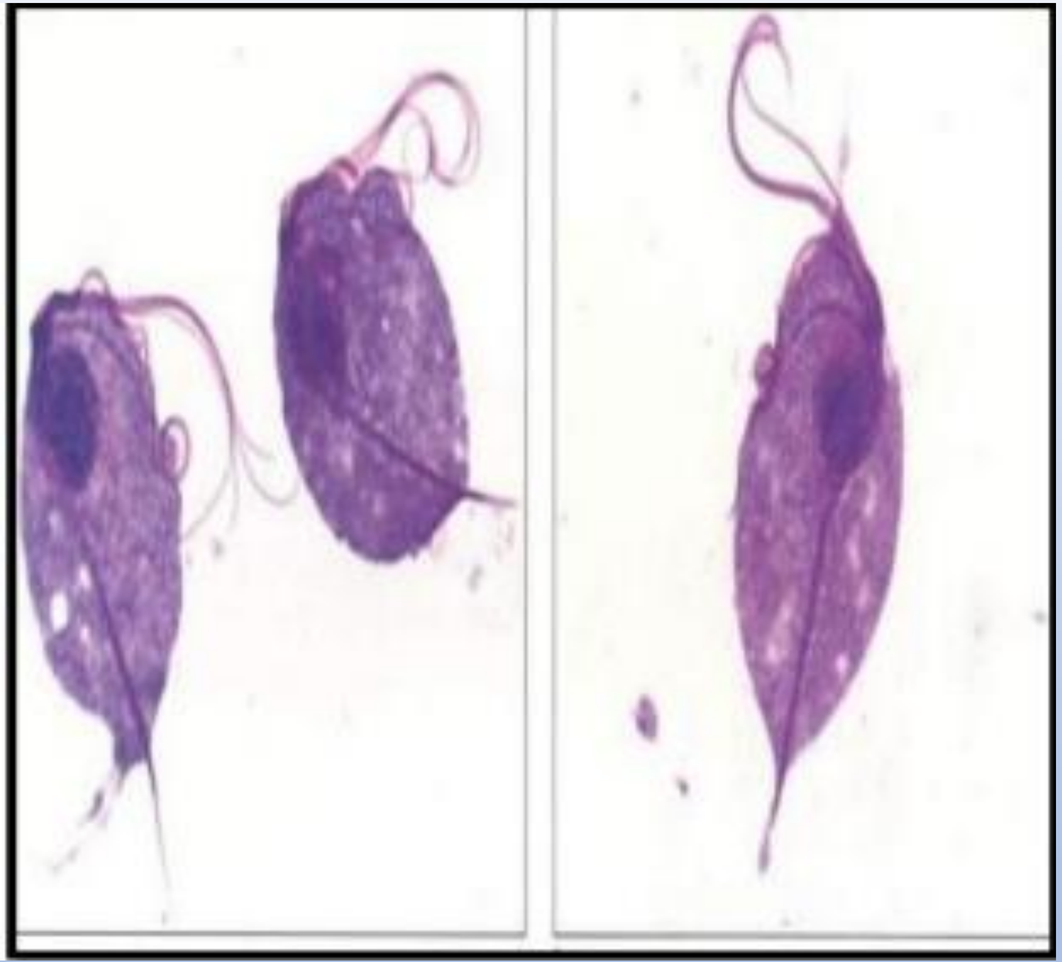
2. Trichomonas

The trichomonas are flagellate protozoa with three to five anterior flagella, other organelles, and an undulating membrane. Trichomonas vaginalis causes the most common form of trichomoniasis in humans. Trichomoniasis (or “trich”) is a very common sexually transmitted disease. It is caused by infection with a protozoan parasite called Trichomonas vaginalis.

a. *Trichomonas tenax*, or oral trichomonas:

is a species of Trichomonas commonly found in the oral cavity of humans. Routine hygiene is generally not sufficient to eliminate the parasite, hence its Latin name, meaning "tenacious". The parasite is frequently encountered in periodontal infections, affecting more than 50% of the population in some areas, but it is usually considered insignificant. T. tenax is generally not found on the gums of healthy patients. It is known to play a pathogenic role in necrotizing ulcerative gingivitis and necrotizing ulcerative periodontitis, worsening preexisting periodontal disease

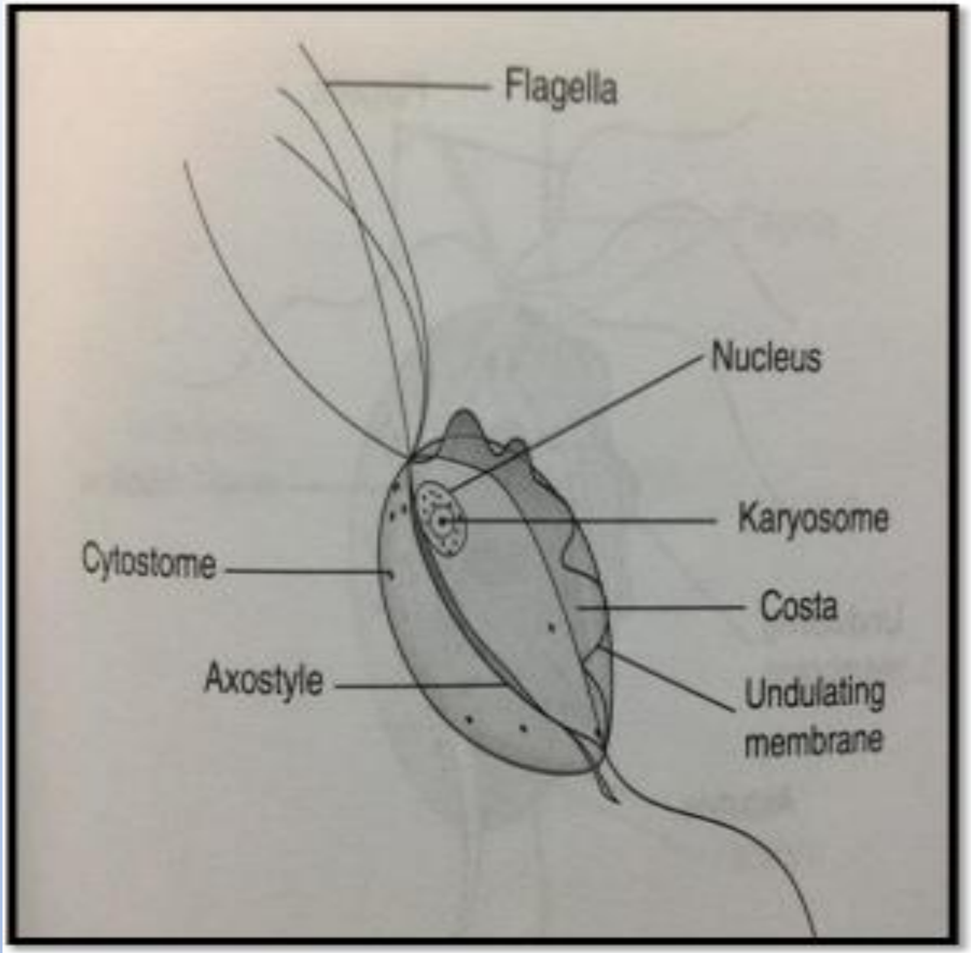


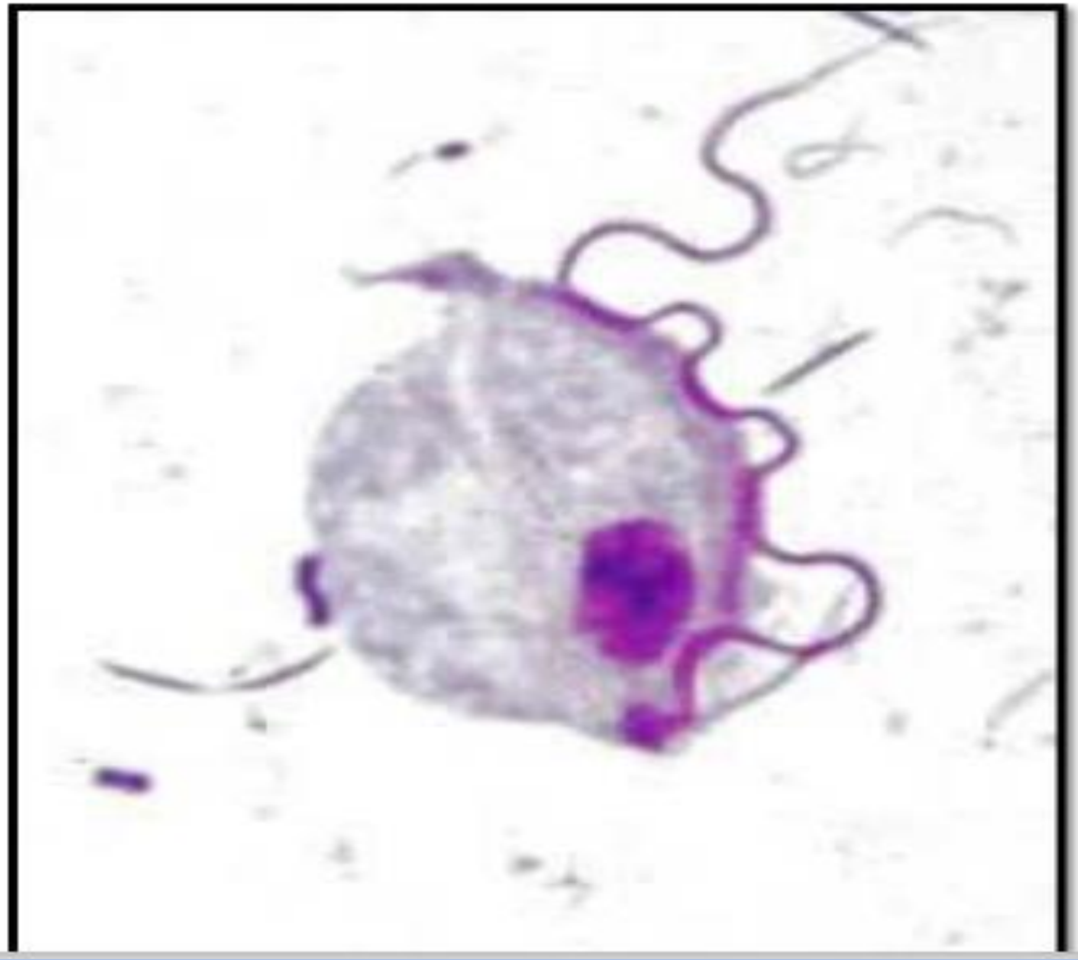


Trichomonas tenax

***b. Trichomonas hominas*:**

is considered a nonpathogenic inhabitant of the large intestine. Trophozoites of this may be observed in fresh smears of both normal and diarrheic fecal samples. Since this organism is nonpathogenic, efforts to eliminate or prevent infection are not usually undertaken.

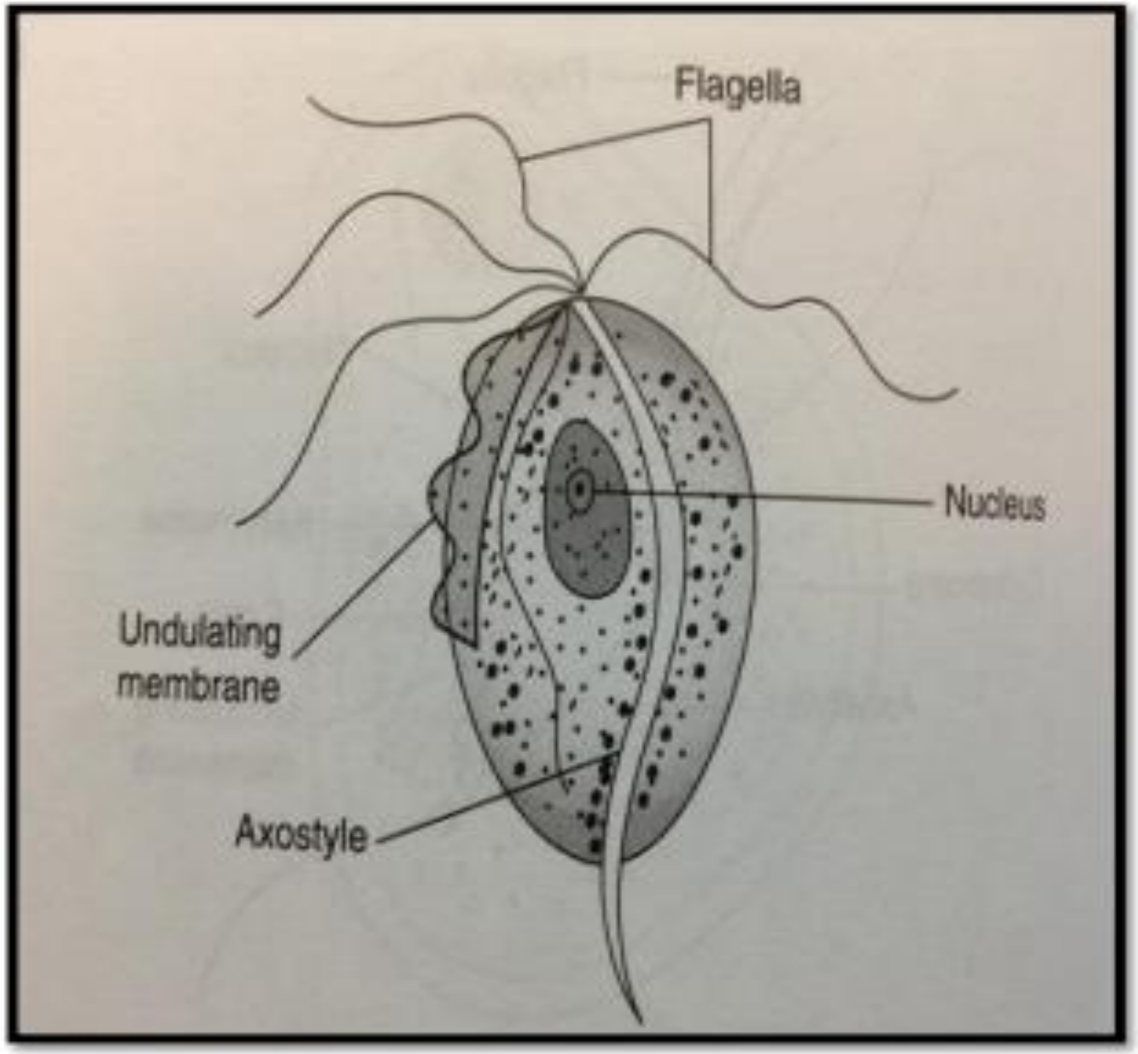




Trichomonas hominas

c. *Trichomonas vaginalis*:

is an anaerobic, flagellated protozoan parasite and the causative agent of a sexually transmitted disease called trichomoniasis. It is the most common pathogenic protozoan that infects humans in industrialized countries. Infection rates in men and women are similar but women are usually symptomatic, while infections in men are usually asymptomatic.



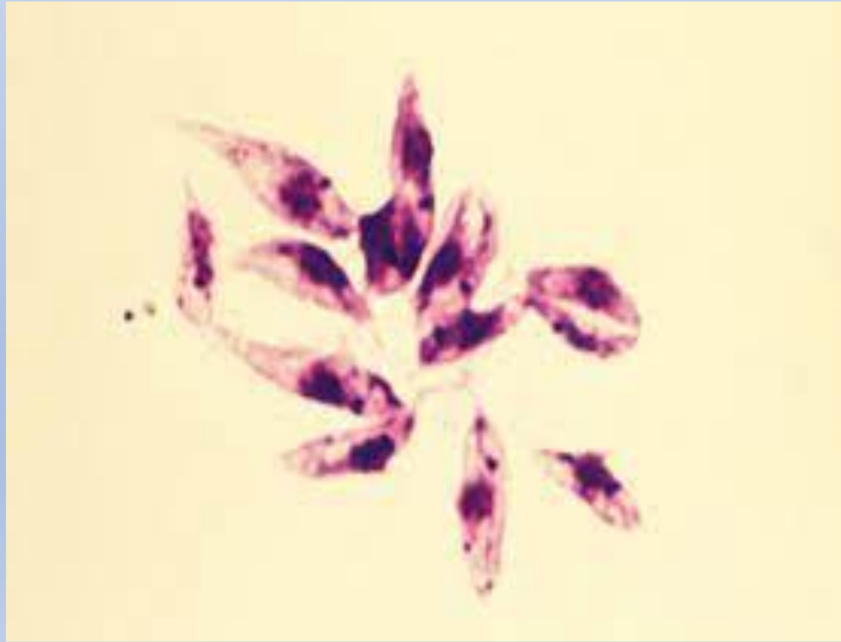
Trichomonas vaginalis

Leishmania is a parasitic protozoan, a single-celled organism of the genus Leishmania that are responsible for the disease leishmaniasis.

Leishmaniasis is a parasitic disease that is found in parts of the tropics, subtropics, and southern Europe. It is classified as a neglected tropical disease (NTD). Leishmaniasis is caused by infection with Leishmania parasites, which are spread by the bite of phlebotomine sand flies. There are several different forms of leishmaniasis in people. The most common forms are cutaneous leishmaniasis, which causes skin sores, and visceral leishmaniasis, which affects several internal organs (usually spleen, liver, and bone marrow).

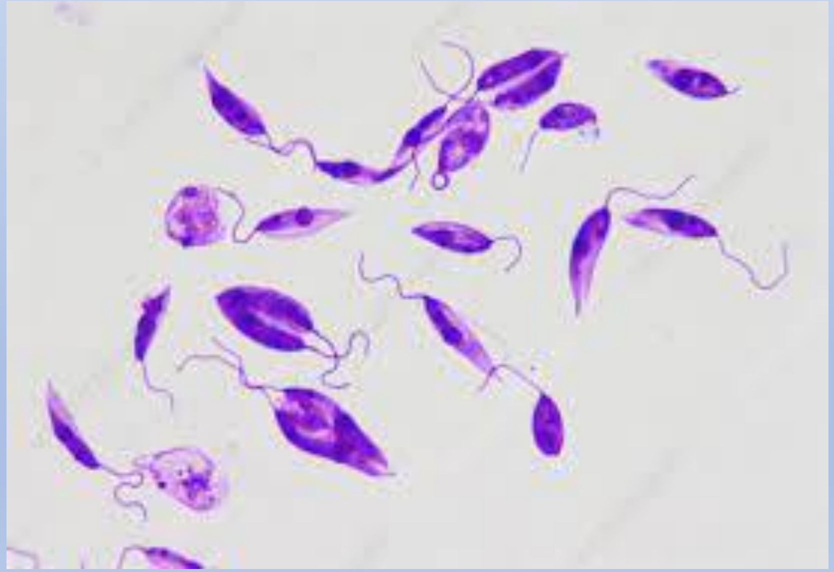
a- Leishmania tropica (cutaneous leishmaniasis): is a flagellate parasite and the cause of anthroponotic(dubious – discuss) cutaneous leishmaniasis in humans. This parasite is restricted to Afro-Eurasia and is a common cause of infection in Afghanistan, Iran, Syria, Yemen, Algeria, Morocco, and northern India.

- Location:- Cutaneous
- Pathogenic:- Baghdad boil or oriental sore
- Form:- Amastigote + Promastigote
- Vector:- Phlebotomus (Sand fly)



b. Leishmania donovani (visceral Leishmania) is a species of intracellular parasites belonging to the genus Leishmania, a group of haemoflagellate kinetoplastids that cause the disease leishmaniasis. It is a human blood parasite responsible for visceral leishmaniasis or kala-azar, the most severe form of leishmaniasis.

- Location:- visceral
- Pathogenic:- Dum – Dum fever or kalazar
- Form:- Amastigote + Promastigote
- Vector:- Phlebotomus



c. Sporozoa:

General Characteristics

a) Produce spores, oocyst.

b) No clear organs for movement or locomotion

c) Reproduction:

1. Binary fission, Multiple fission, Endodyogeny
2. Sexual: Anisogametes, Isogametes

1. ***Plasmodium*** is an intracellular endoparasitic protozoan which passes on to human beings by female Anopheles mosquito, is responsible for causing Malaria. It is commonly known as the malaria parasite.

Four species of *Plasmodium* can infect humans:

- *Plasmodium falciparum*
- *Plasmodium vivax*
- *Plasmodium ovale*
- Plasmodium *malariae*

Comparative between the human species of *Plasmidium* spp.

Species	***P. falciparum***	***P. vivax***	***P. malariae***	***P. ovale***
General features	Small, compact dark, staining parasite. Multiple infections of single RBC	Large light staining amoeboid parasite. Many trophozoites	Regular shape Strong tendency to form a band across the infected RBC	Regular shape. Size in between P. vivax and P. malariae

Comparative between the human species of *Plasmidium* spp.

Species	***P. falciparum***	***P. vivax***	***P. malariae***	***P. ovale***
Ring stage	Delicate, small, 1.5 µm Double chromatin and multiple rings common.	Large 2.5 µm, usually single. Prominent thicker chromatin	Similar to P. vivax but thicker	Similar to P. vivax, but compact

Comparative between the human species of *Plasmidium* spp.

Species	*P. falciparum*	*P. vivax*	*P. malariae*	*P. ovale*
Trophozoite	Compact, small, vacuole inconspicuous, seldom seen in smear	Large, irregular vacuole prominent Chromatin as dots or threads	Characteristic band form, vacuole inconspicuous	Compact rough pigment, large irregular clumps of chromatin

Comparative between the human species of *Plasmidium* spp.

Species	***P. falciparum***	***P. vivax***	***P. malariae***	***P. ovale***
Schizont	Small, compact rarely seen in blood smear	Large, filling the RBC, segmented, yellow brown pigment	Nearly fills RBC, segmented, pigment is dark brown	Fills three fourth of RBC, segmented, pigment dark yellow brown

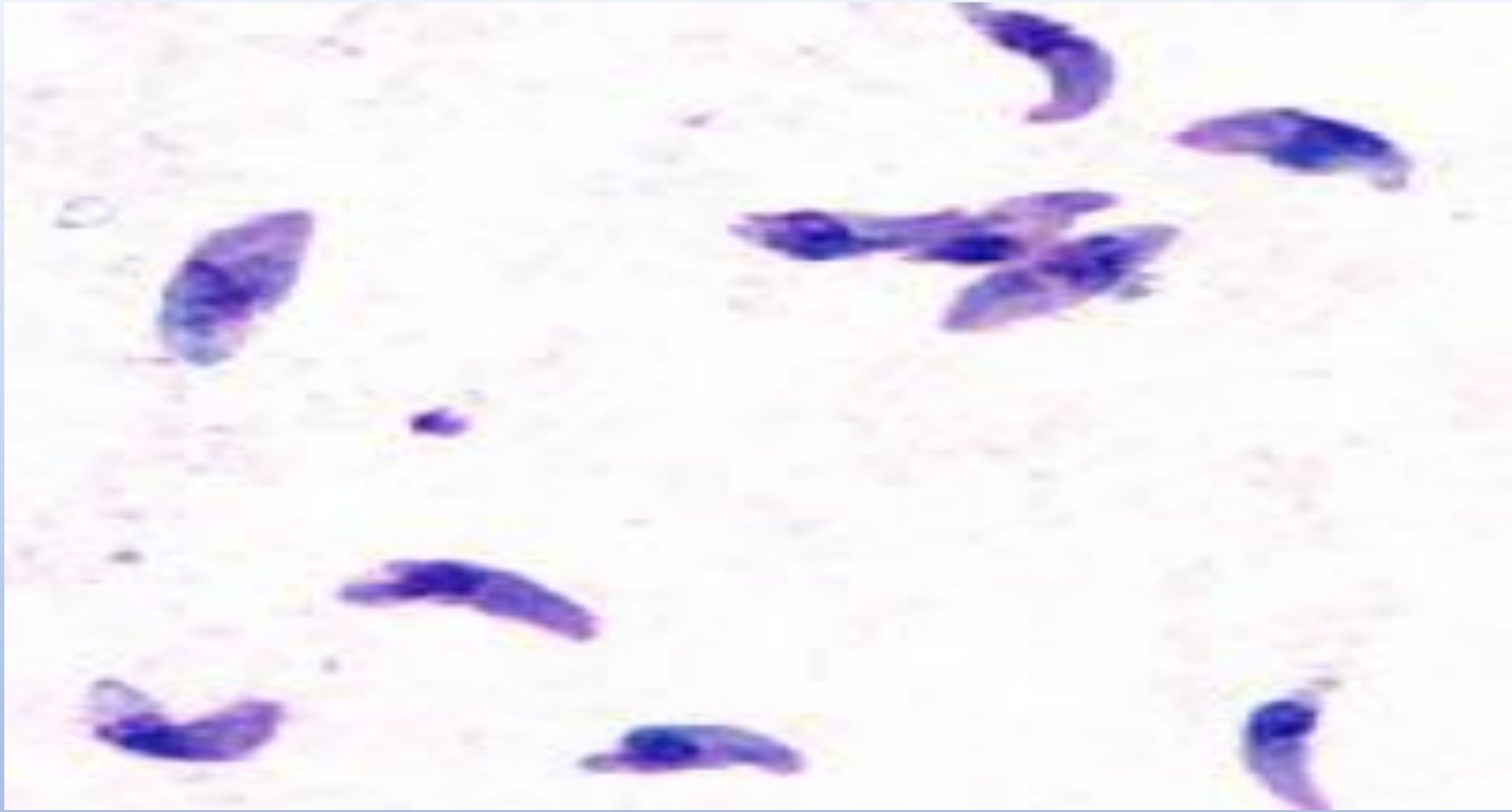
Comparative between the human species of *Plasmidium* spp.

Species	***P. falciparum***	***P. vivax***	***P. malariae***	***P. ovale***
Microgametocyte	Larger than RBC, kidney shaped with blunt round ends, cytoplasm reddish blue, many fine granules in smear	Fills enlarged RBC, round or oval, compact cytoplasm, pale blue, profuse brown granules	Smaller than RBC, very few in peripheral blood film, round compact. Pale blue cytoplasm. Pigment and chromatin as in P. vivax	Same of RBC, round, compact very few in peripheral blood film, cytoplasm pale blue, chromatin and pigment as in P. vivax

Comparative between the human species of *Plasmidium* spp.

Species	***P. falciparum***	***P. vivax***	***P. malariae***	***P. ovale***
Macrogametocyte	Slender, nucleus small, compact, pigment granules closely aggregated	Large, loose and ill-defined mass of chromatin and smaller mass	Same as P.vivax, low numbers appear after 12–14 days.	Same as P.vivax, low numbers appear after 12–14 days.

2. ***Toxoplasma gondii*** is a parasitic protozoan (specifically an apicomplexan) that causes toxoplasmosis. Found worldwide, T. gondii is capable of infecting virtually all warm-blooded animals, but felids are the only known definitive hosts in which the parasite may undergo sexual reproduction. T. gondii primarily exists in three forms: oocysts, tachyzoites, and bradyzoites. Final host was members of family Felidae (domestic cats and their relatives). Intermediate host was many warm-blooded animals, including



Toxoplasma gondii

Nemathelminthes or Aschelminthes

They are a group of parasites that commonly known as roundworms, and characterized as the following

- They are commonly called thread worm or round worm.
- It is a phylum of unsegmented, triploblastic, pseudocoelomic, cylindrical or thread-like worms which are covered by a body wall having cuticle and epidermis.

1. *Ascaris lumbricoides* is an obligate internal parasite and adults usually reside in the small intestine of humans, specifically the jejunum. The worm produces a pepsin inhibitor to prevent host enzymes from digesting it and uses muscular activity to avoid being excreted. The roundworm Ascaris lumbricoides is the largest intestinal nematode infecting humans, with females averaging 30 cm in length (ranging from 20-49 cm) and measuring 3-6 mm in diameter. Males are smaller, ranging from 15-30 cm in length and 2-4 mm in diameter. Both sexes have an elongated, cylindrical body which tapers at both ends.

Ascaris lumbricoides

2. *Ancylostoma duodenale* is the most dangerous parasitic roundworm, causing serious infection in humans. it is commonly known as old world hook worm infection or Ancylostomiasis commonly known as Old World hookworm. it is dioecious: Males are 8 mm to 11 mm long with a copulatory bursa at the posterior end. Females are 10 mm to 13 mm long, with the vulva located at the posterior end; females can lay 10,000 to 30,000 eggs per day. it is common in the tropical, subtropical, and temperate region of Asia, Africa, Europe, the pacific islands, and the southern states of America.

Ancylostoma duodenale

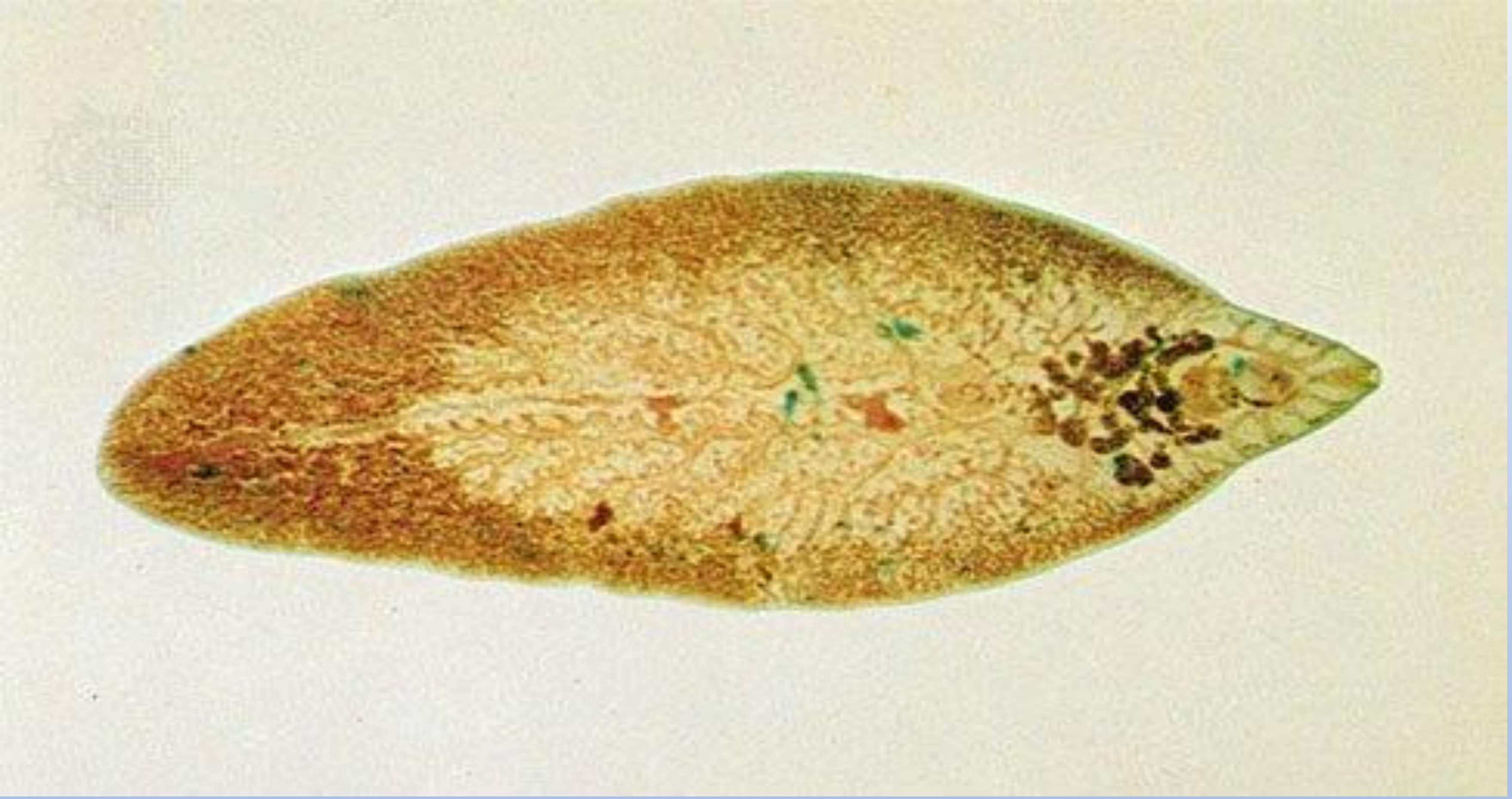
a.Enterobius vermicularis is commonly called the **thread worm, pin** or **seat worm**. It causes an intestinal parasitic infection called enterobiasis (anal itching) that occurs commonly in children. The adult worm is small, white in color, more or less spindle shaped andresembles a short piece of thread. They are visible to the naked eye.

a.Enterobius vermicularis True buccal capsule is absent. A pair of cervical alae (wing like expansions) is present as the anterior extremity. The posterior end of the oesophagus is dilated into a conspicuous globular bulb/ a double- bulb oesophagus which is a characteristic feature of this nematode. The oral end has three lips with a dorso-ventral bladder like expansion of the cuticle.

Enterobius vermicularis

Phylum Platyhelminthes are commonly known as flatworms or tapeworms. They are a group of soft-bodied invertebrate animals. A few of these live as parasites on humans and other animals. A few species belonging to this phylum can be a major cause of certain diseases. For example, Schistosomiasis, or bilharzia or bilharziasis. Characterized by Their body is dorsoventrally flattened. They exhibit bilateral symmetry. They exhibit an organ system grade of organization. The life cycle of these organisms can be complex, especially if they are parasitic, as this may involve one or more host animals.

1. *Fasciola hepatica*, also known as the common liver fluke or sheep liver fluke, is a parasitic trematode (fluke or flatworm, a type of helminth) of the class Trematoda, phylum Platyhelminthes. It infects the livers of various mammals, including humans, and is transmitted by sheep and cattle to humans the world over. The disease caused by the fluke is called fasciolosis or fascioliasis, which is a type of helminthiasis and has been classified as a neglected tropical disease. Fasciolosis is currently classified as a plant/food-borne trematode infection.



Fasciola hepatica

2. ***Schistosoma*** is a genus of trematodes, commonly known as blood flukes. They are parasitic flatworms responsible for a highly significant group of infections in humans termed schistosomiasis, which is considered by the World Health Organization as the second-most socioeconomically devastating parasitic disease (after malaria), with hundreds of millions infected worldwide.

Schistosoma

There are three main types belong to the *Schistosoma* spp.

a. *Schistosoma japonicum* their eggs were large and more rounded than other species, measuring 70-100 µm long by 55-64 µm wide. The spine on S. japonicum eggs is smaller and less conspicuous than other species.

Schistosoma japonicum *egg*

b. *Schistosoma haematobium* their eggs of Schistosoma haematobium are large (110-170 µm long by 40-70 µm wide) and bear a conspicuous terminal spine. Eggs contain a mature miracidium when shed in urine. Figure A: Egg of S. haematobium in a wet mount of urine concentrates, showing the characteristic terminal spine.

***Schistosoma haematobium* egg**

c. *Schistosoma mansoni* their eggs are large (114 to 180 µm long by 45-70 µm wide) and have a characteristic shape, with a prominent lateral spine near the posterior end. The anterior end is tapered and slightly curved.

Schistosoma mansoni **egg**

Post-test Quiz

List the species of *Plasmodium*