[ZOOLOGY zoo103]

King Saud University
College of Science
Zoology Department

[2017]

The Compound Microscope

➢ MICROSCOPY

*The compound light microscope is one of the most important and useful tools of the zoologist.

*It is used to study cells parts. The organization of tissues and the structure of developing embryos, among many other important applications.

*Since many of the exercises in this course will require the use of the compound microscope, it is important to review some aspects of its construction.

*There are numerous models of compound microscopes in use. The microscope assigned for your use may differ from the one illustrated. The operating principles and procedures. However. Will be similar.

*Always carry your microscope with both hands. Grasp the arm of the microscope firmly with one hand and support the base with the other hand.

*Place it gently on your desk with the arm facing you.

*Always remember that this expensive scientific instrument is assigned to you for your use and safe- keeping. Be certain that you use it properly and carefully.

And that you keep it in good condition.

*Promptly notify your laboratory instructor if you observe any malfunction or if you have any difficulty in the use of your microscope.

Parts of the Microscope:

The parts of the microscope can be grouped in three systems:

1 .The magnification system.

2 .The mounting and movement system.

3 .The illumination system.

The Mounting and movement system:

1 .The base: This is the supporting stand: it consists of a broad heavy structure.

2 .The arm: This is a heavy structure that forms the curved back of the microscope. Its function is to support the upper part of the microscope.

3 .The stage: This is a specialized slide holding device provided with an aperture (a hole) in the center through which the light passes to the slide. Some microscopes are provided with clips to hole the slide in place. Most compound microscopes have a graduated stage and two stage-adjustment knobs for controlling the movement of the slide.

4 .The coars focusing knob: This knob is used to raise and to lower the stage from the objective lenses for a relatively large distance.

5 .The fine focusing knob: This knob is used for the purpose of focusing for the sharpest image.

6 .The body tube: This is the housing device for the ocular lens at one end and the objective lenses at the other end. Only one eye lens is present in monocular microscopes and 2 eye lenses are present in binocular microscopes.

7 .The revolving nose-piece: The objective lenses are attached or screwed into a saucer-shaped nosepiece to move the different objective lenses into position over the stage aperture.

The Magnification system:

1 .The objective lenses: most light microscopes are provided with three or four objective lenses screwed onto the revolving nose piece. Each lens gives a different magnification. According to their power of magnification, the objective lenses are known as:

*The scanning objective lens, which has a power of magnification 3.5X, 4X, or 5X.
*The low power objective lens, which has a power of magnification 10X or 20X
*The high power objective lens which has a power of magnification 40X.
*The oil immersion objective lens which magnifies the object 100X.

2 . The condenser: It is a lens system mounted below the stage to collect and concentrate the light that passes through the aperture in the stage towards the slide.

3 .The iris diaphragm: This diaphragm is located ate the bottom of the condenser and has an aperture, the diameter of this opening is controlled by a layer at the side; this diaphragm helps in controlling the amount of light to be passed through the lenses.

How to Use the Microscope:

For the correct use of the microscope to examine the slide clearly follow the steps given below:

1 .Switch on the light of the microscope and see that the revolving nose-piece is in position with the low power lens facing the aperture in the stage.

2 .Put the slide on the stage of the microscope with the cover slip facing upwards, making sure that the part you want to examine is facing the aperture of the stage.

3 .Look through the ocular lens and adjust the distance between the low objective and the slide by using the coarse focusing knob, so that the specimen is brought in focus and until you see the best clear image.

4 .To examine the specimen with the high power objective lens, fix exactly in the

center the part you want to examine, because the exposed field will be smaller than in the case of the low power lens.

5 .Move the revolving nose-piece carefully so as to replace the low power objective lens with the high power objective lens.

6 .Use the fine focusing knob for focusing to see the best clear image. Taking care not to touch the slide. Otherwise you may break it.

7 .When using the highest power objective lens (100X), Place a drop of Seder wood immersion oil over the slide. Take great care when you focus using the fine adjustment knob so as not to break the slide.

8 .After you have finished using the immersion oil, wipe the oil from the objective lens with lens paper. Otherwise oil attracts dust.

9 .Turn off the light of the microscope after you finish using it.

Magnification:

The principle purpose of microscope is to magnify the image of an object. The magnification of an object is determined by multiplying the power of the objective lens by the power of the ocular lens.

Example: 10x ocular X 10x objective=100x total magnification.

Note: A slide will be given to you fix the slide on the stage and focus and observe the specimen at different magnifications.

Measurements :

1 meter = 100 cm

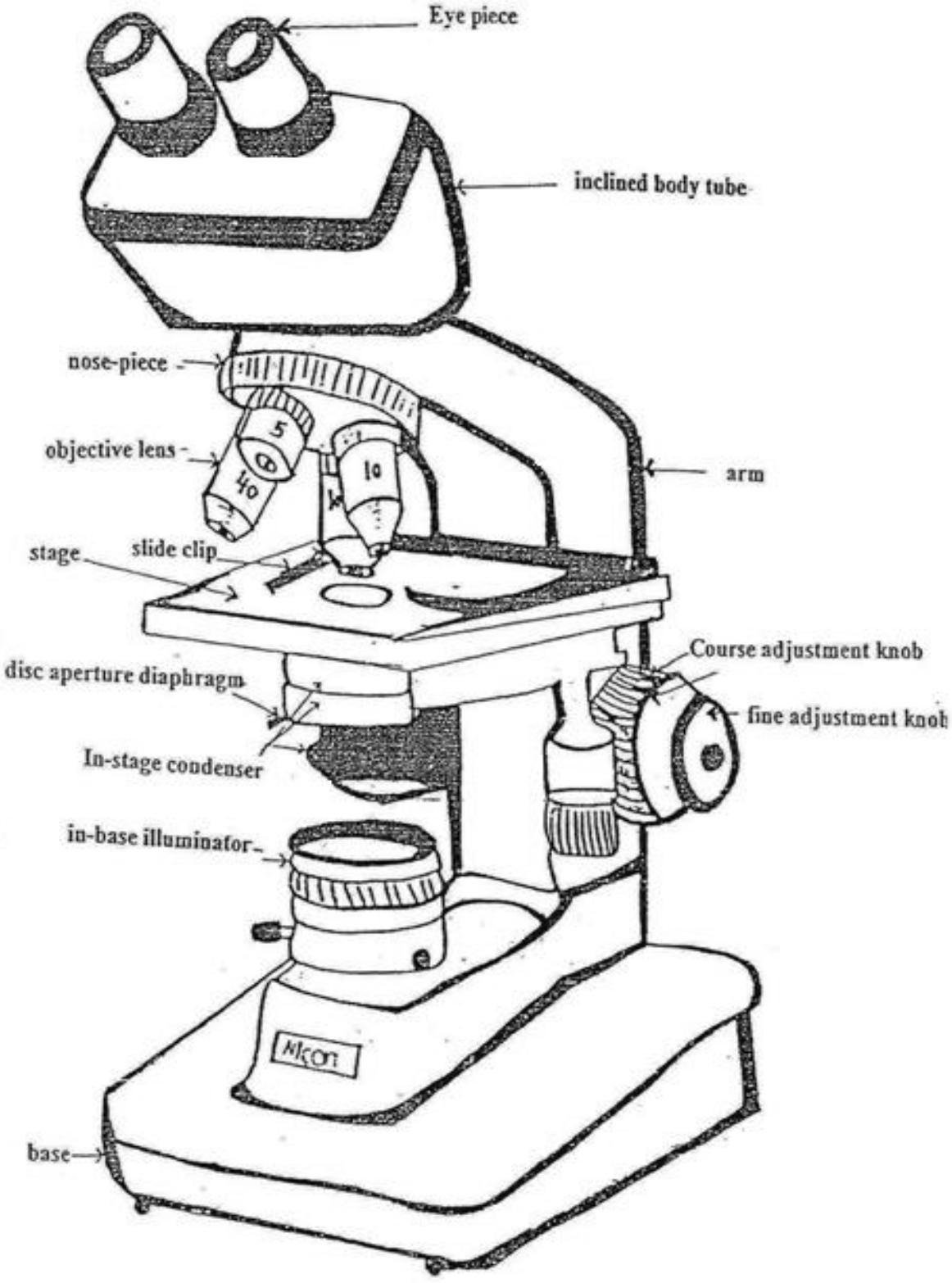
1 cm = 10 mm

1 mm = 1000 µm

1 µm= 1000 nm

1 nm = 10 angstrom (A°)

1 m = 10^{2} cm = 10^{3} mm = 10 µm = 10 nm = 10 A°


Eye piece
inclined body tube
nose-piece
objective lens
5
40
10
arm
stage
slide clip
Course adjustment knob
disc aperture diaphragm
fine adjustment knob
In-stage condenser
in-base illuminator
Micon
base

Histology

THE CELL

- It is the functional and structural unit in organisms.
- Different cell structures depending on their location and function in the body.

3 major cell components:

- Genetic material.
- Cytoplasm.
- Cell membrane.

CELL TYPES

- Two major cell types depending on the arrangement of the genetic material inside the cell:
  - **Eukaryotic cells** (True nucleated cells):

    Nucleus is present. DNA is associated with protein making chromatin.
  - **Prokaryotic cells** (pro = before; Karyone = nucleus):

    Nucleus is absent. The region where the DNA is located in the cytoplasm is called nucleoid.

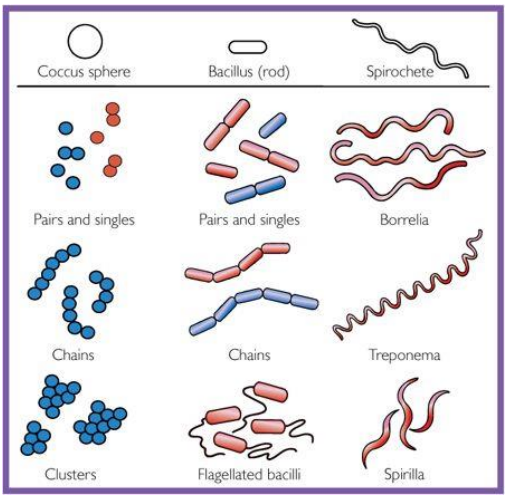
PROKARYOTES: BACTERIA

- Bacillus:

  Rod shape and occur in strands.

- Coccus:

  Rounded and occur in colonies or strands.



EUKARYOTES

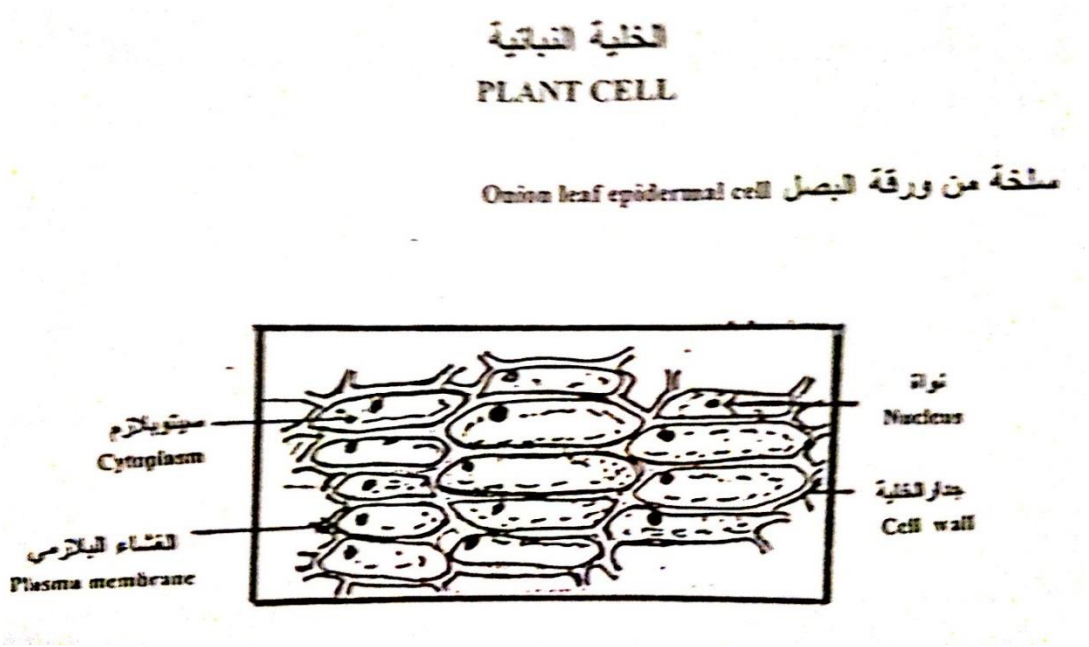
- **Plant cells:**

Have cell wall.

example: onion cells.

Rectangular with eccentric

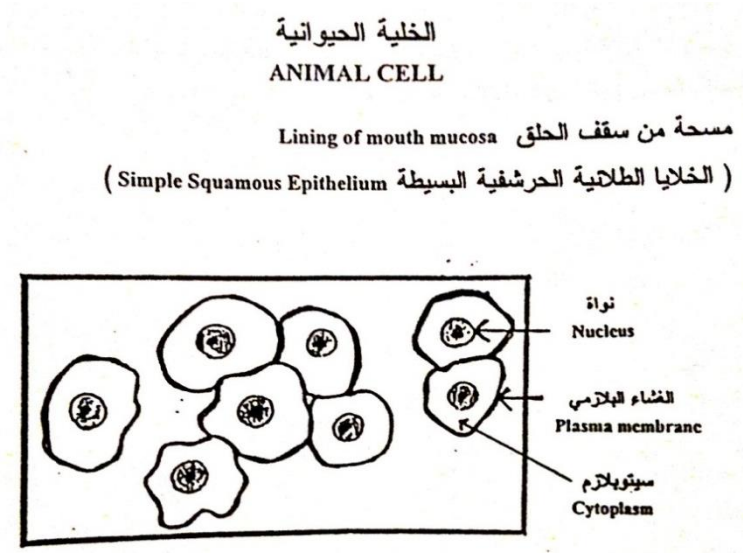
nucleus.



- **<u>Animal cells:</u>**

Does NOT have cell wall.

Sunday, August



EUKARYOTES

- Plant cells:Onion (……X)

DrawDraw under the microscope:

- **Animal cells:**

Animal cell: Simple squamous epithelium (Top view) (……X)

DrawDraw under the microscope:

THE EPITHELIAL TISSUE

Structure

- closely packed cells
- Specialized to cover external surfaces or line internal cavities.
- Epithelial cells are packed tightly together, with almost no intercellular spaces and only a small amount of intercellular substance.
- Rest on Basement Membrane
    - thin sheet of connective tissue
    - provides structural support for the epithelium
    - binds it to neighboring structures
- Lots of tight junctions and provides tissues with strength and stability

  have the ability of Renewal
    - Stem and germinative cells

Functions:

- Protection
- Permeability
- Sensations
- Secretions

Types of Epithelial Tissue

- Epithelial tissue can be divided into two groups depending on the number of layers of which it is composes.
- Epithelial tissue which is only one cell thick is known as simple epithelium.If it is two or more cells thick such as the skin, it is known as stratified epithelium.

- The shape of the nucleus usually corresponds to the **cell form** and help to identify the **type of** epithelium

Types of Epithelial Tissue

- Covering “surface” epithelium.
- Glandular epithelium.
- Neuro_epithium.

Surface “Covering” Epithelium :

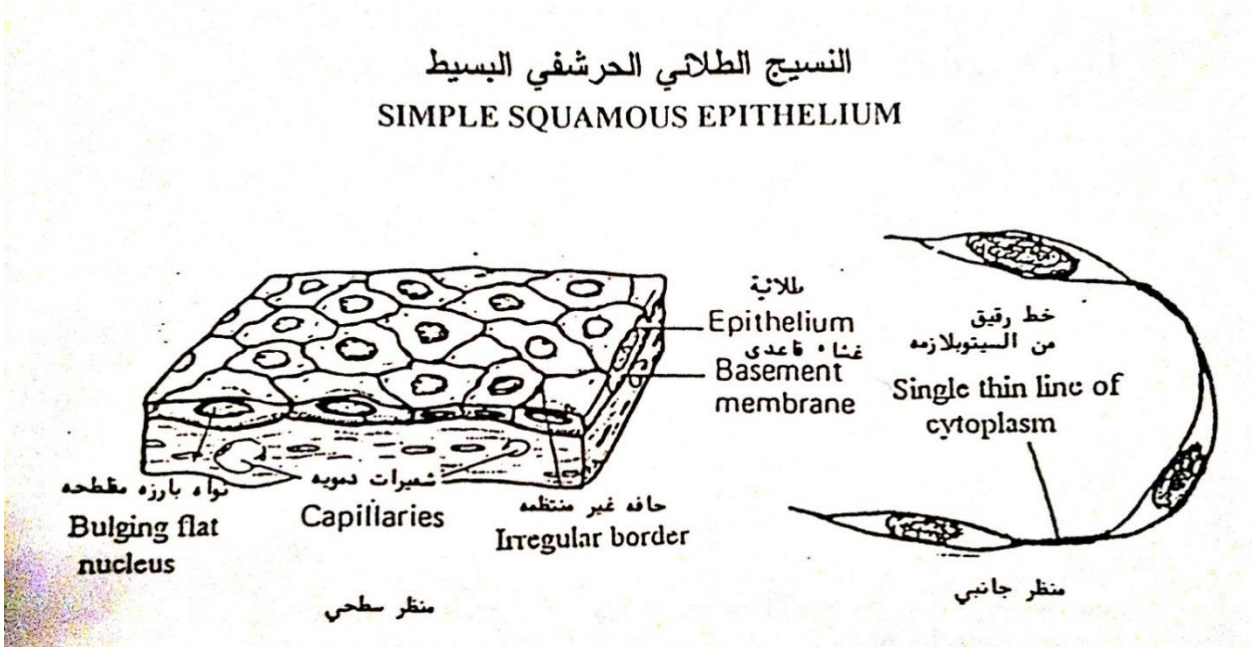
- The Simple.
- Stratified.
- Pseudostratified.

Simple epithelium

Simple epithelium can be subdivided according to the **shape and function** of its cells.

Squamous epithelium

- Squamous cells have the appearance of **thin, flat plates**.
- Squamous cellstend to have **horizontal flattened, elliptical nuclei** because of the thin flattened form of the cell.
- They form the **lining of cavities such as the mouth, blood vessels, heart and lungs and make up the outer layers of the skin**.
- Wall of blood vessels= **Endothelium**
- Wall of peritoneum and pleura= **Mesothelium**



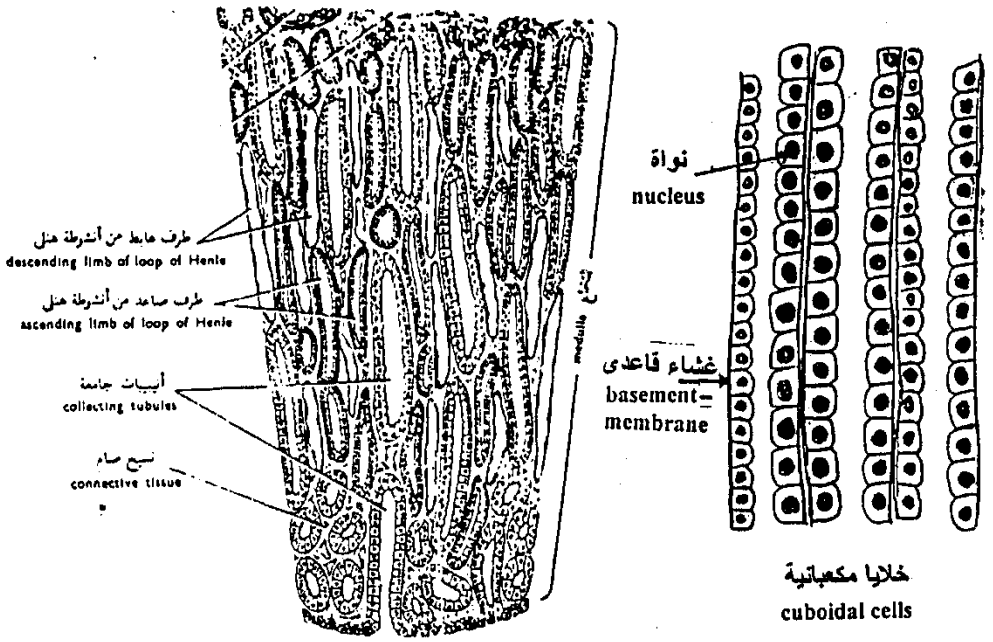
Simple Cuboidal Epithelium

- cuboidal cells are roughly **square** or **cuboidal** in shape.
- Each cell has a **spherical central nucleus**.
- Cuboidal epithelium is found in
    - glands
    - lining of the kidney tubules
    - ducts of the glands
    - constitute the **germinal epithelium** which produces the egg cells in the female ovary and the sperm cells in the male testes.

النسيج الطلائى المكعباني البسيط

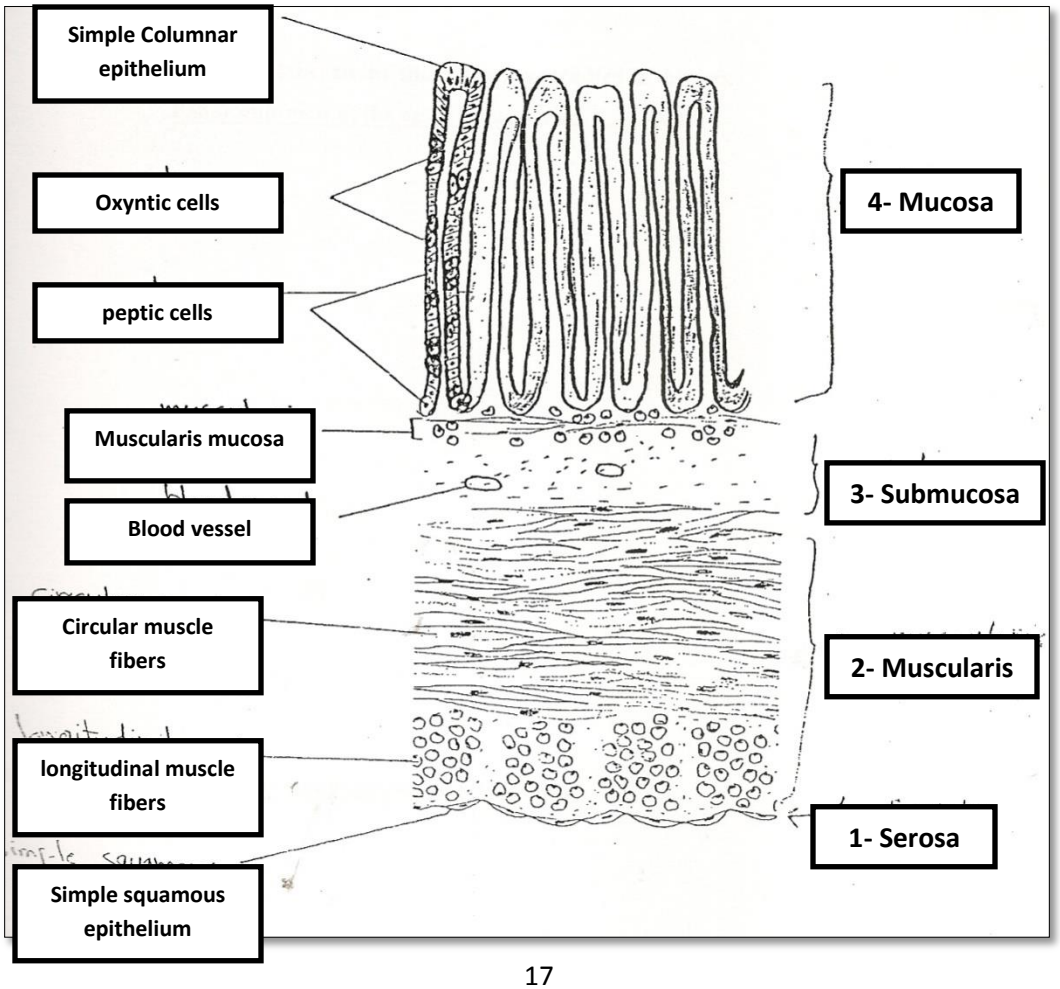
SIMPLE CUBOIDAL EPITHELIUM

قطاع فى نخاع كلية حيوان ثديي يوضح النسيج الطلائى المكعبانى البسيط

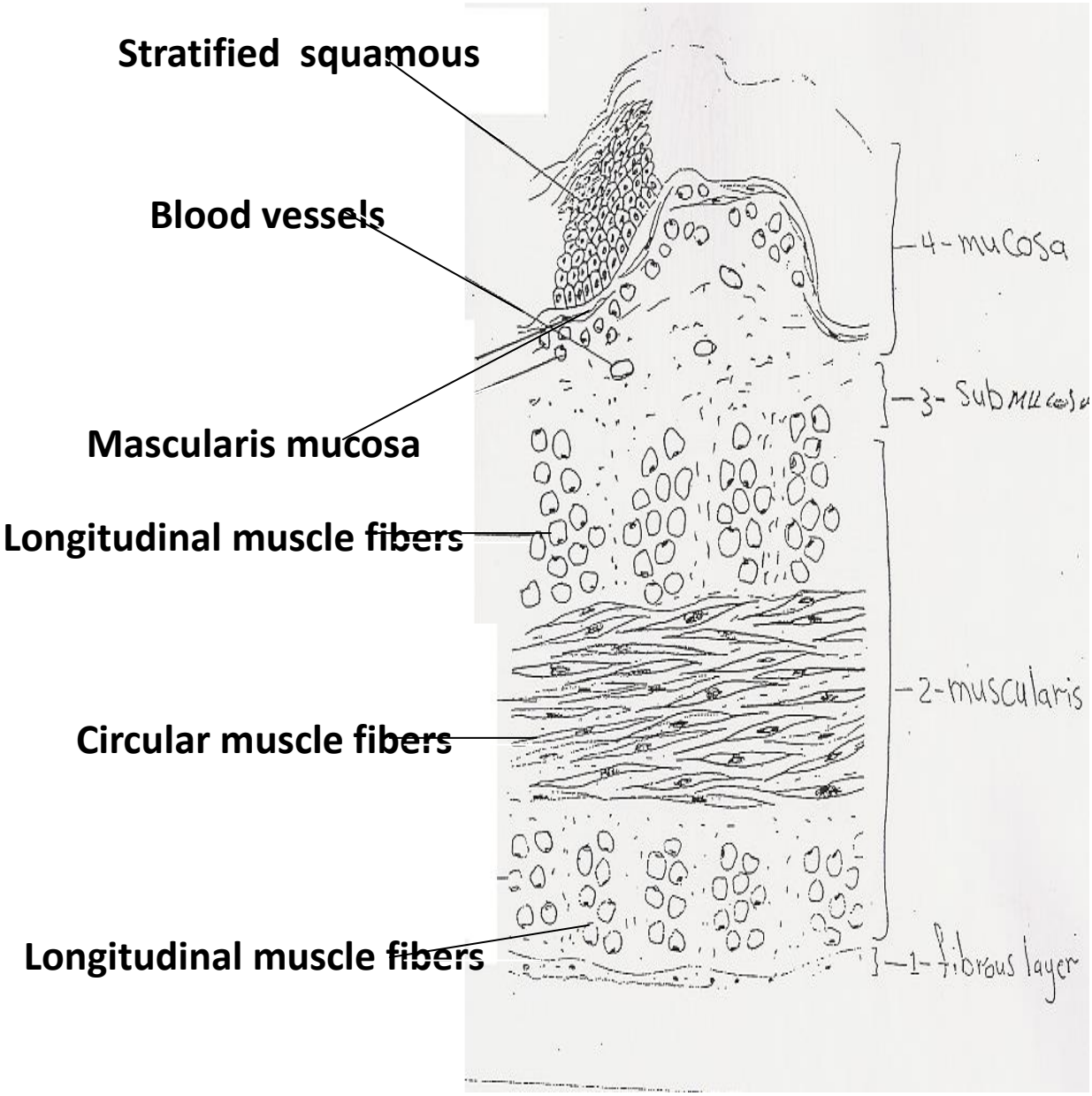


Simple Columnar Epithelium

- The cells are **elongated** and **column-shaped**.
- The nuclei are **elongated** and are usually **oval** and **basal**.
- Columnar epithelium forms the **lining of the stomach and intestines**.
- Some columnar cells are **specialized for sensory reception** such as **"sensory epithelium"**in the **nose, ears and the taste buds** of the tongue.
- Goblet cells (unicellular glands) are found between the columnar epithelial cells of the duodenum. **They secrete mucus or slime, a lubricating substance which keeps the surface smooth**.
- may be **ciliated** or **non-ciliated**



Stratified squamous epithelium



Squamous Epithelium (……X)

Draw

Draw under the microscope:

Simple Cuboidal Epithelium (……X)

Draw

Draw under themicroscope:

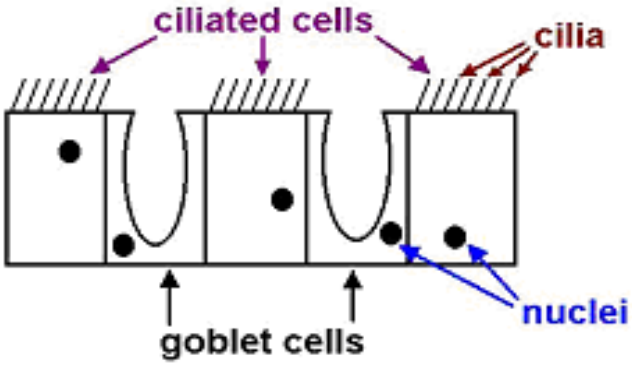
Simple Columnar Epithelium (……X)

Draw

Draw under the microscope:

Glandular Epithelium

- Glandular Epithelium: epithelium of cells **specialized to produce secretion**. All glands are of composed of epithelium.
- Secretion – Exocytotic release of products, not metabolic wastes
- Columnar and cuboidal epithelial cells often become specialized as gland cells which are capable of synthesizing and secreting certain substances such as **enzymes, hormones, milk, mucus, sweat, wax and saliva.**



Gland Cells (……X)

Draw

Draw under the microscope:

The Connective Tissues

What is the connective tissues?

Connective tissue is the most diverse of the four tissue types with a wide variety of functions.

Functions of connective tissue:

- Protection of organs
- Providing structural framework for the body
- Connection of body tissues
- connects epithelial tissues to the muscle tissues

The Structure of connective tissues:

- Connective tissues have a population of cells scattered through an extracellular matrix
- The matrix generally consists of fibers Collagen or while fibers (occur in bundles) and elastic fibers (occur as a single and branched).
- In most cases, the connective tissue cells secrete the matrix.
- The matrix may be solid (as in bone), soft (as in loose connective tissue), or liquid (as in blood).

Connective tissues classification:

1-Areolar (Loose) Connective Tissue

- Areolar connective tissue is the most widespread connective tissue of the body.
- It is used to attach the skin to the underlying tissue.
- It also fills the spaces between various organs and thus holds them in place as well as cushions and protects them.

  •It also surrounds and supports the blood vessels

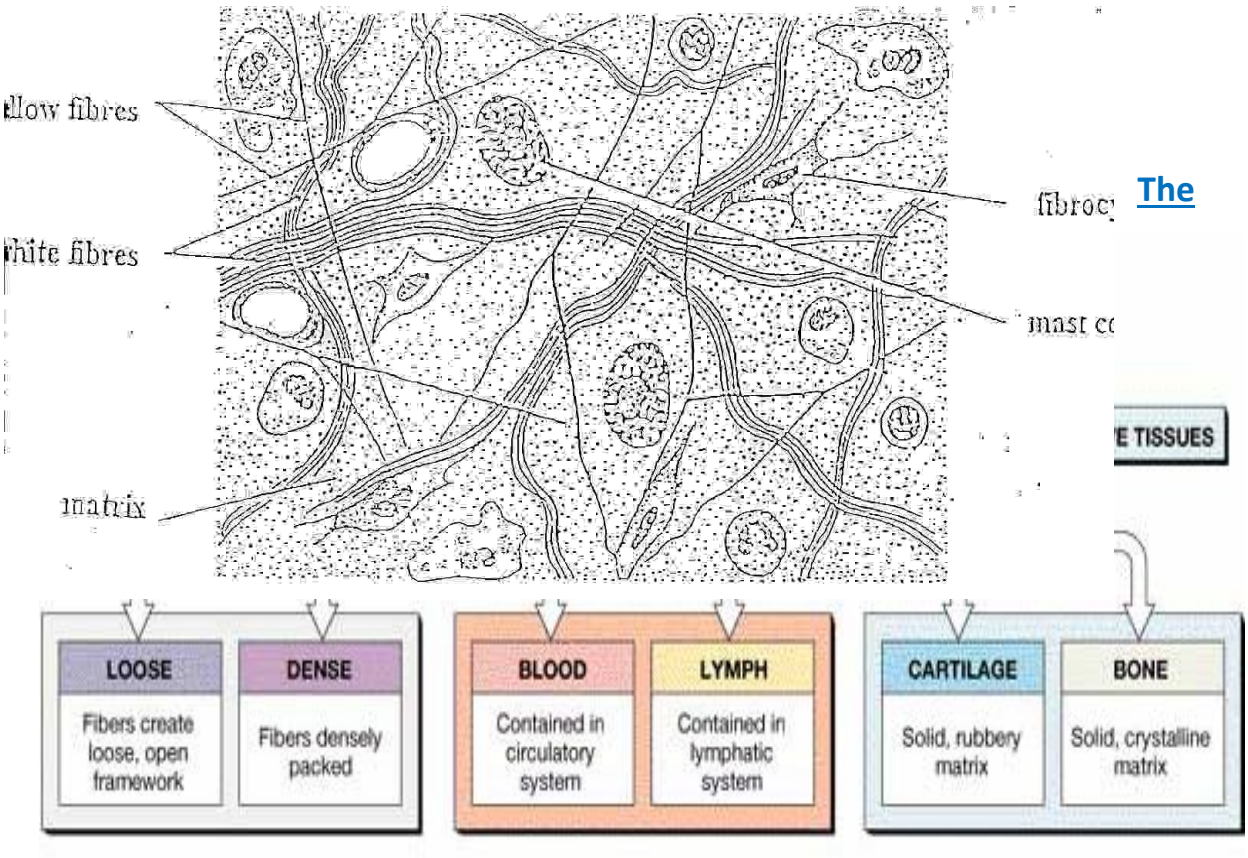
The fibres of areolar connective tissue:

- **Collagen (white) fibres :**

  Occur in bundles and unbranched

- **Elastic (yellow) fibres:**

  Ocuur single and branched



The

cellular elements

- **Fibroblasts:**are difficult to distinguish in the areolar connective tissue.

  Mast cells:are usually visible. They have course, dark-staining granules in their cytoplasm. Since the cell membrane is very delicate it frequently ruptures in slide preparation, resulting in a number of granules free in the tissue surrounding the mast cells. The nucleus in these cells is small, oval and light-staining, and may be obscured by the dark granules

Specialized Connective Tissues

I. Cartilage

Cartilage is studied as an example of skeletal connective tissue

General characteristics of cartilage:

- Cartilage is a flexible connective tissue which provides strength and support in areas of the body that need flexibility.
- Cartilage is a somewhat elastic, pliable, compact type of connective tissue.
- No blood vessels, lymphatic or nerves are present in cartilage.
- It is characterized by three traits: lacunae, chondrocytes, and a rigid matrix.
- The cartilage cells, known as chondrocytes, are rounded, have a rounded nucleus and measure 10-30 µm in diameter. These cells are responsible for production of the fibers and matrix.
- Cartilage cells lie in clear lacunae (lacuna = space). Each lacuna can have anywhere between 1- 4, rarely eight chondrocytes. These groups of cells are called cell nests. In the living tissue, the lacunae are not observed. During histological preparation, the chondrocytes and the matrix shrink causing the appearance of the lacunae.
- The matrix of cartilage is almost solid (semisolid) and is surrounded by a special fibrous membrane called the perichondrium.
- The matrix may contain collagen and elastic fibers.

Cartilage of the body is classified into several types according to:

- the nature of matrix
- The kind of it's fiber :

There are 4 common types:

- **Hyaline cartilage:** with clear matrix.
- **Fibrous cartilage**: with matrix rich in white fibers.
- **Elastic cartilage:** with matrix rich in yellow fibers.
- **Calcified cartilage:** with calcium salts in the matrix (producing bone)

The hyaline cartilage:

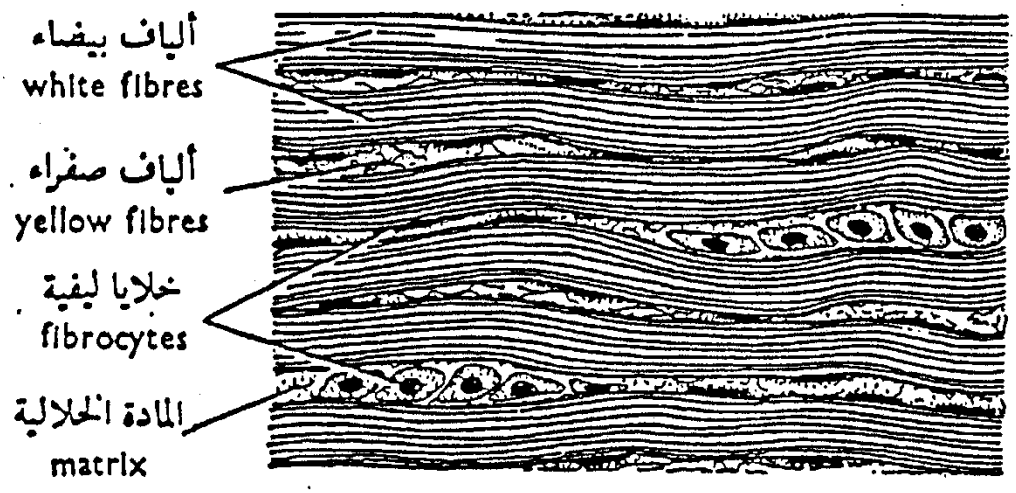
Trachea of the rabbit is studied as an example:

- It is called hyaline (hyalos = gloss) because of its glossy, whitish blue appearance in the fresh state.
- The matrix is semi-solid and contains very delicate collagen fibers. The refractive index of the matrix is equivalent to that of its fibers, so it appears clear.
- It is the most common form of cartilage.
- It has 4 main functions, these are:
- It forms the majority of the temporary skeleton in the mammalian embryos until it is replaced by bone.
- In adults, it supports the structure of the nasal septum, ear pinna, larynx, trachea and bronchi.
- It covers the articular surfaces of movable joints.
- It forms the epiphyseal plate. The growing region in the large bones.

provide slightly flexible support and reduce friction .

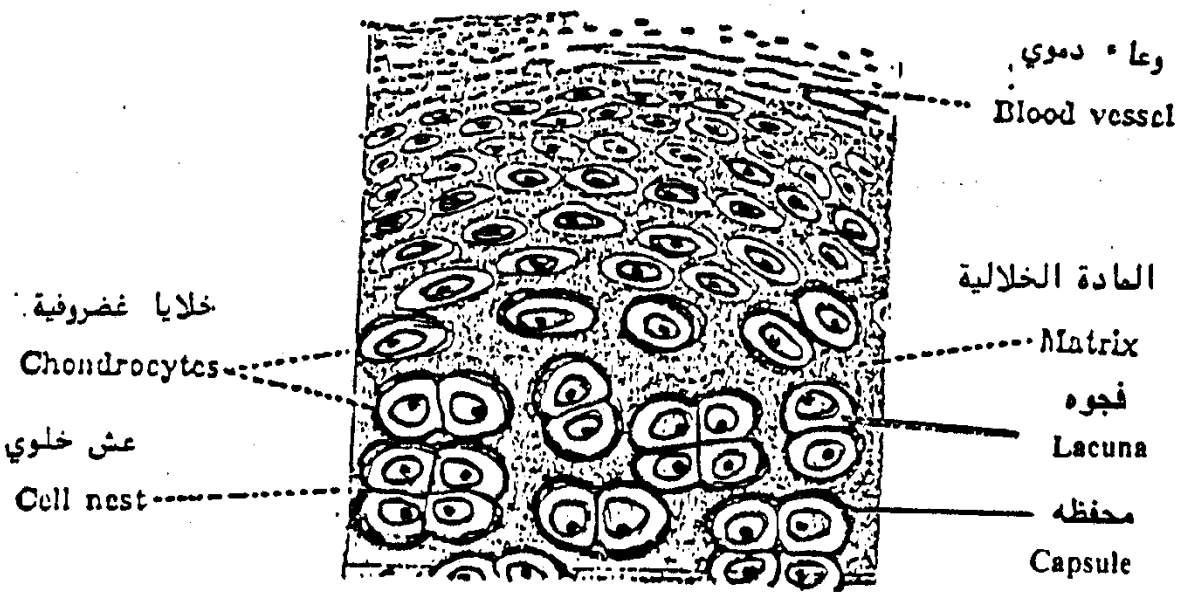
النسيـــــج الضـــــام الليـــــفى
THE FIBROUS CONNECTIVE TISSUE

قطاع طولى من وتر



الغضروف الزجاجى
HYALINE CARTILAGE

قطاع عرضى من القصبة الهوائية للأرنب



Fibrous cartilage (……X)

Draw

Draw under the microscope:

Hyaline Cartilage (……X)

Draw

Draw under the microscope:

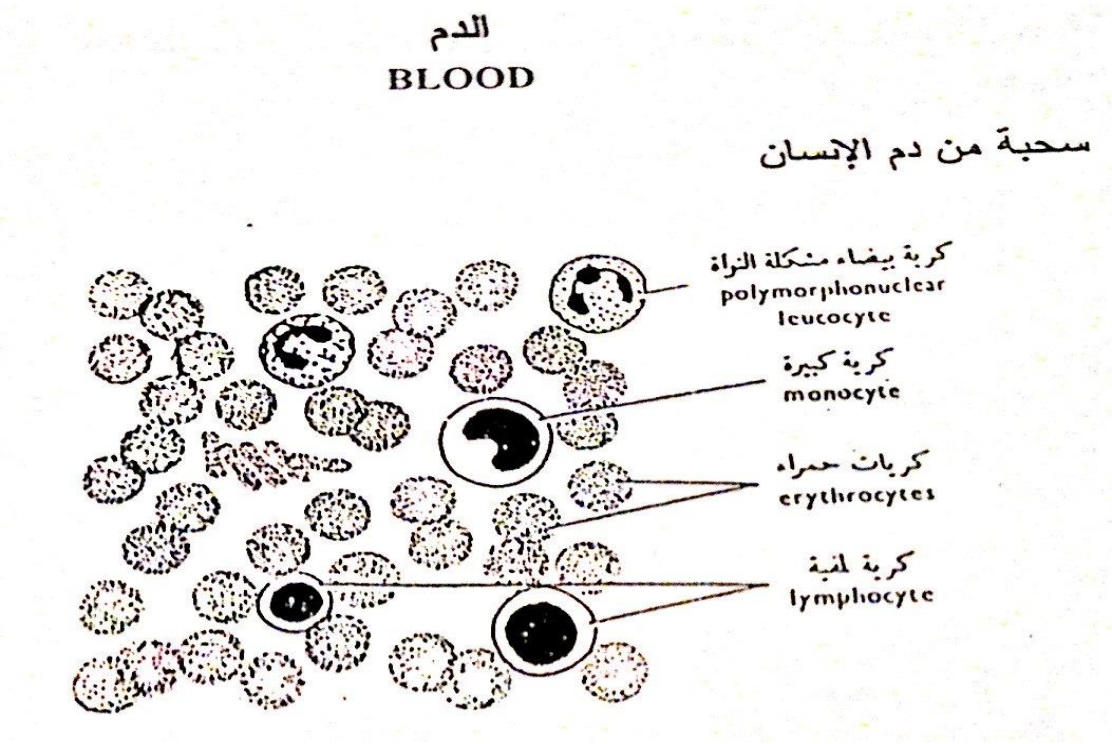
The vascular Tissues

- Vascular tissues include blood and lymph tissue only.
- A liquid and place in containers.
- They are closer to the connective tissues that article be interstitial fibers when exposed to air is that the cells do not produce interstitial material as in other connective tissues.

Featuring pellets into three types depending on the particle tendency toward dyes to:

a- neutrophilis: more leukocytes number cytoplasm contains finely divided imbued well most of the acid dyes and basal nucleus is composed of 3 to 5 parts communicate with each by a thin thread chromatic

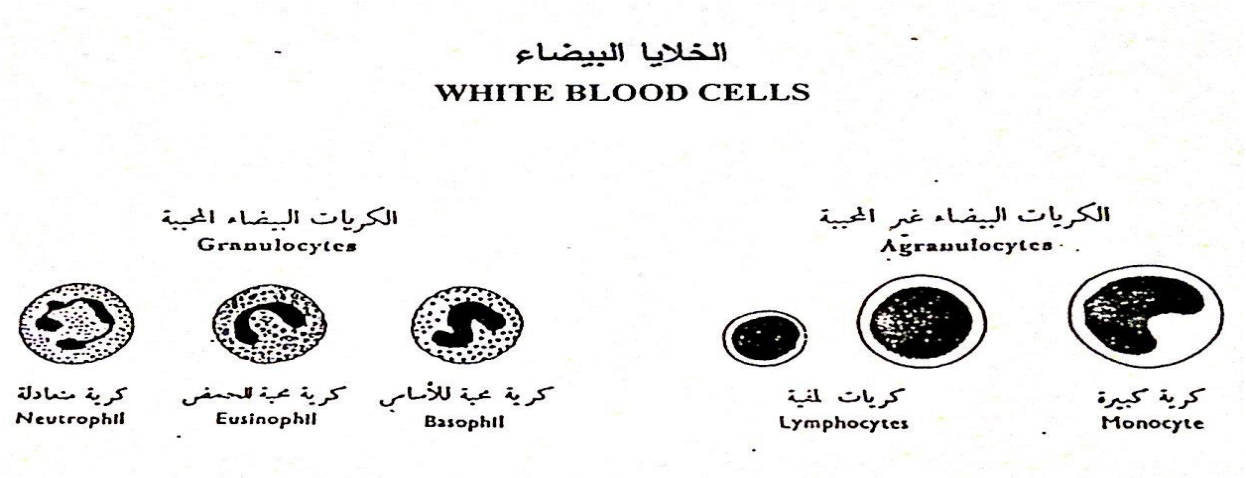
cosinophils or a cidophils: cytoplasm contains large beads and acid-loving imbued Babbag acidic nucleus consists of 2 to 3 cloves



- **Basophilis**: cytoplasm contains large granules loving the basis of any pigmented basal dyes and the nucleus in the form of s letter

- **2 – Tagranulocytes or non granular leucocytes :**
  That contain cytoplasm blisters is grainy and characterized into two types:
  1 - lymphocytes: small and large spherical nucleus occupies most of the internal space of the globule the cytoplasm little some of these large-sized pellets known large lymphatic valves

  2 – **monocytes or marcocytes:**is the largest white blood cells have a nucleus big horseshoe-like horse



1.Red Cell (erythrocytes)

2. Agranulocytes

3. Granulocytes

The White Blood Cells(……X)

Draw

Draw under the microscope:

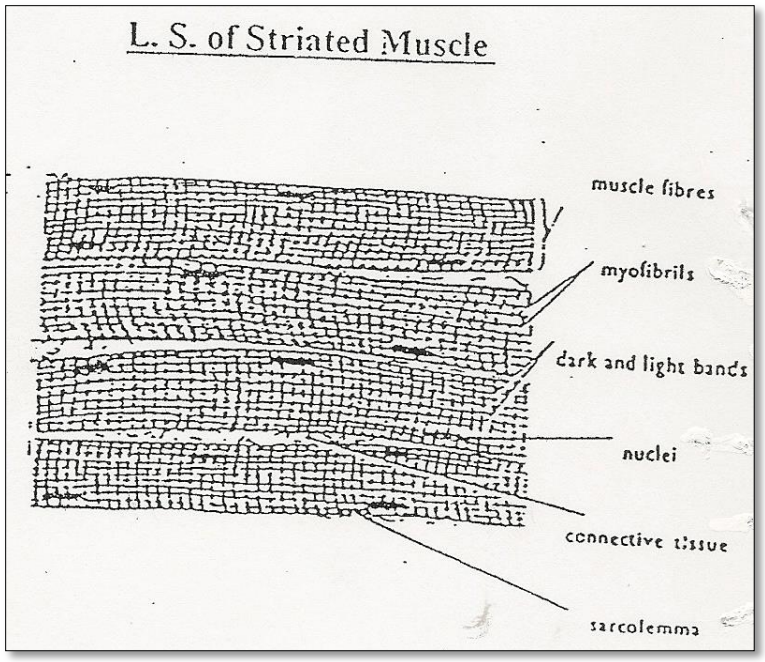
The Muscular Tissues

General characteristics of the muscular tissues:

- The **cells** of the muscular tissues are elongated elements, named**muscle fibers.**
- The **cytoplasm** of the muscle fiber, the **sarcoplasm**, contains myofibrils. These fibrils are made up of the proteins actin and myosin.
- The **plasma membrane** of the muscle fiber is called the **sarcolemma**.
- There are three types of muscle fiber:
    - **Skeletal muscles**, which are **voluntary** and **striated**.
    - **Smooth muscle,** which are **involuntary** and **non- striated**.
    - **Cardiac muscles**, which are **involuntary** and **striated**.

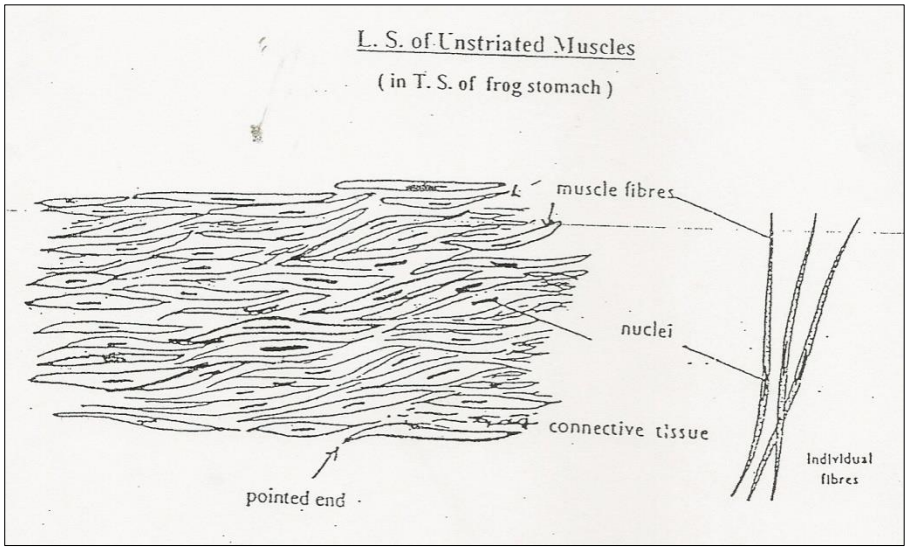
A) The skeletal or striated muscles

- These are the muscle **attached to the skeleton**.
- The skeletal muscle fibers are transversely **striated** and are **voluntary**.
- Each muscle fiber is **elongated**, **unbranched**, **cylindrical cell**, with **numerous peripheral flatten nuclei**.
- Each individual muscle fiber is surrounded by a delicate connective tissue, the **endomysium**
- Bundles or groups of fibers are wrapped by a dense connective tissue called the **perimysium**.
- The whole muscle (formed of several bundles) is covered by a dense connective tissue sheath, the **epimysium**.



B) The Smooth Unstriated Muscle

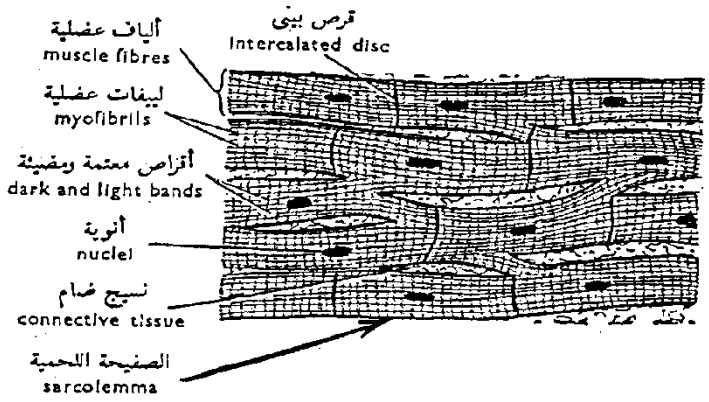
- The smooth muscle fibers are **Unstriated** and contract under the control ofthe autonomic nervous system, i.e. **involuntary**.
- The smooth muscle fibers are **elongated**, **spindle- shaped** cells with pointed ends.
- The nucleus is elongated or **rod-shaped** and **centrally** located in the cytoplasm at the widest part of the cell.
- These muscles are present in the wall of **blood vessels**, and **digestive, respiratory, urinary** and **reproduction systems**.

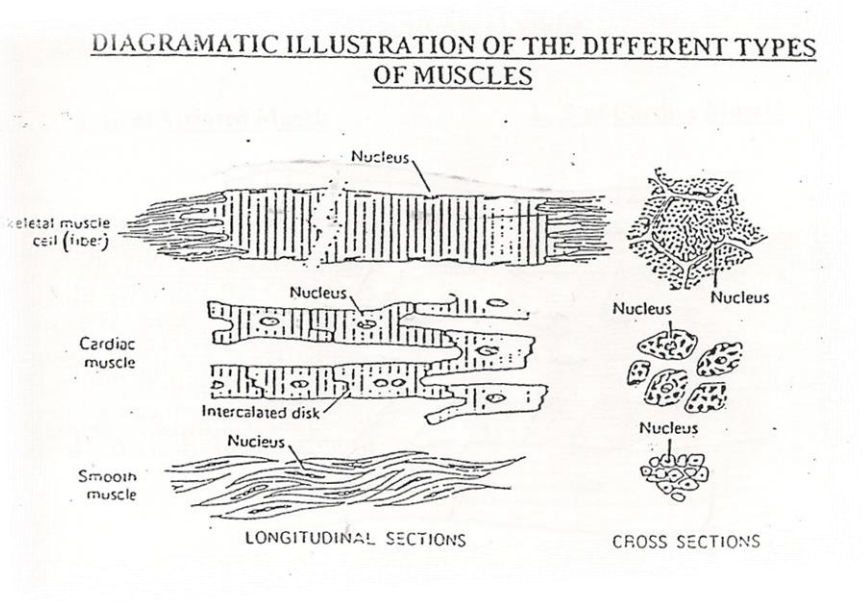


C) The Cardiac Muscles

- These muscles are present in the **heart**.
- The cardiac muscle fibers are **striated** but are **involuntary**.
- Cardiac muscle fibers are **elongated**, **branched**, **mononucleate** or**binucleate** cells.
- The nuclei are **oval** and **centrally** located.
- At the end to end junction of the cells there are **intercalated discs**.

قطاع طولي في عضلة قلبية





A) The skeletal or striated muscles(……X)

Draw ***Draw under the microscope:***

B) The Smooth Unstriated Muscle(……X)

DrawDraw under the microscope:

C) The Cardiac Muscles(……X)

DrawDraw under the microscope:

THE NERVOUS TISSUE

The nervous system is divided anatomically into:-

1. **The central nervous system (CNS)** composed of nerve fibers forming the cranial and spinal nerves and the ganglia.
2. **The supporting cells (glia cells),** which support, nourishes and insulate the neurons and perform the defense processes in the nervous system. They are mainly of two types:
    a. **Neuralgia cells inside the CNS.**
    b. **Schwann cells outside the CNS (in the PNS).**

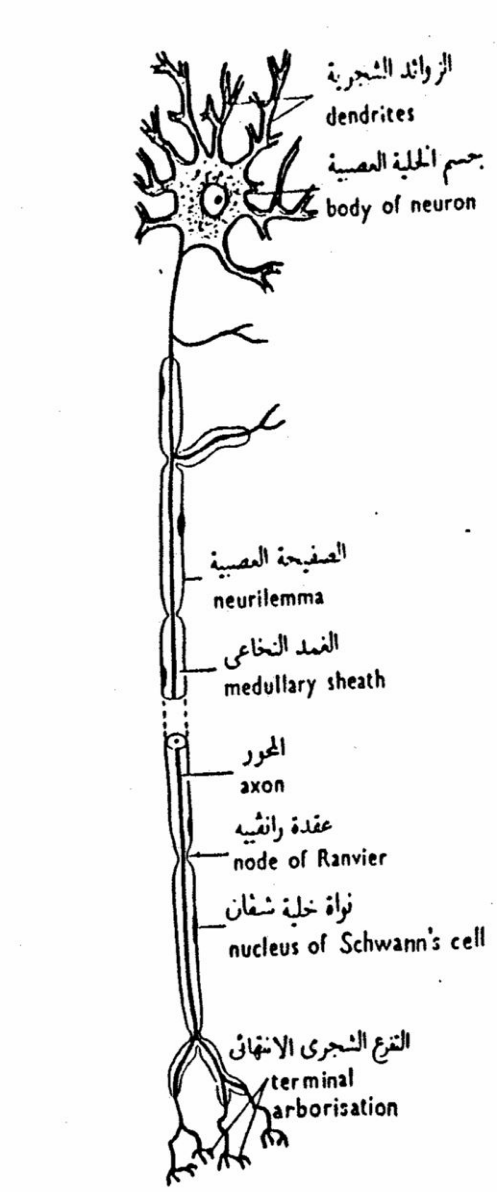
Structure of the Neuron

- Neurons have diverse sizes and shapes, but typically each consists of the cell body, an axon and dendrites:

    - **The cell body:** it is also called the **perikaryon** or **soma**. It contains the nucleus and much of the metabolic machinery of the cell, including the mitochondria, Golgi complexes, endoplasmic reticulum and other cell organelles.
    - **The dendrites:**they are **multiple** cytoplasmic processes specialized in **receiving stimuli** and transmitting them to the cell body.
    - **The axon:** a **single**, usually long process specialized in **conducting nerve impulses to other cells**, e.g. another neuron, a muscle or a gland. The distal part of the axon is usually branched and constitutes the terminal arborization. These arborizations from synapses with other nerve cells. The axon emerges from the cell body at the axon hillock.

Neurons may be classified according to the number of their processes into:

1. **Unipolar**
2. **Bipolar**
3. **Multipolar**



خلية عصبية حركية

Motor Neuron

The body of neuron in grey matter(……X)

DrawDraw under the microscope:

The CELL DIVISTION

Cell division is a process by which the cellular material is divided between 2 new daughter cells.

Mitosis (or indirect division)

- occurs in somatic cells of higher organisms.
- it is the means of population growth in unicellular organisms.
- results in two daughter cells.
- have the same number of chromosomes of the mother cell.

Interphase

- occurs between two successive divisions.
- The chromosomes are thin-long extended threads, too delicate tobe seen with the light microscope.
- certain segments are tightly coiled and, therefore, can beseen as chromatin granules inside nucleus.
- nucleus appears clear with one or 2 nucleoli.
- DNA and other organelles in the cytoplasm are replicated8in preparation for the daughter cells to receive an exactreplica of the chromosomes and about half of thecytoplasm.

The Phases of Mitosis

In a typical cell, mitosis can be divided into 4 principal stages:

(A) Prophase

- The chromosomal threads become tightly coiled:
- become shorter and densercould be seen as chromosomeseach is formed of 2 sister chromatids (replicated chromosome)attached together at the centromere.
- The nuclear envelope dissolves.

- The nucleolus disappears.
- In the cytoplasm of animal cellsthe centrioles, with a surrounding fan of astral rays,start to migrate toward opposite poles of the cell.
- The spindle fibers begin to form.

(B) Metaphase

- The spindle fibers are fully formed and astral rays appear around thecentrioles at the cell poles (in animal cells).
- The chromosomes are arranged in the equatorial plane and theircentromeres appear attached to the spindle fibers at theirkinetochores.
- These kinetochores are 2 disk-shaped structures in eachcentromere.

(C) Anaphase

- The centromeres splitthe 2 chromatids of each chromosome separated and pulledtoward the corresponding cell pole (centriole in animal cells).
- Now each chromatid is a chromosome.

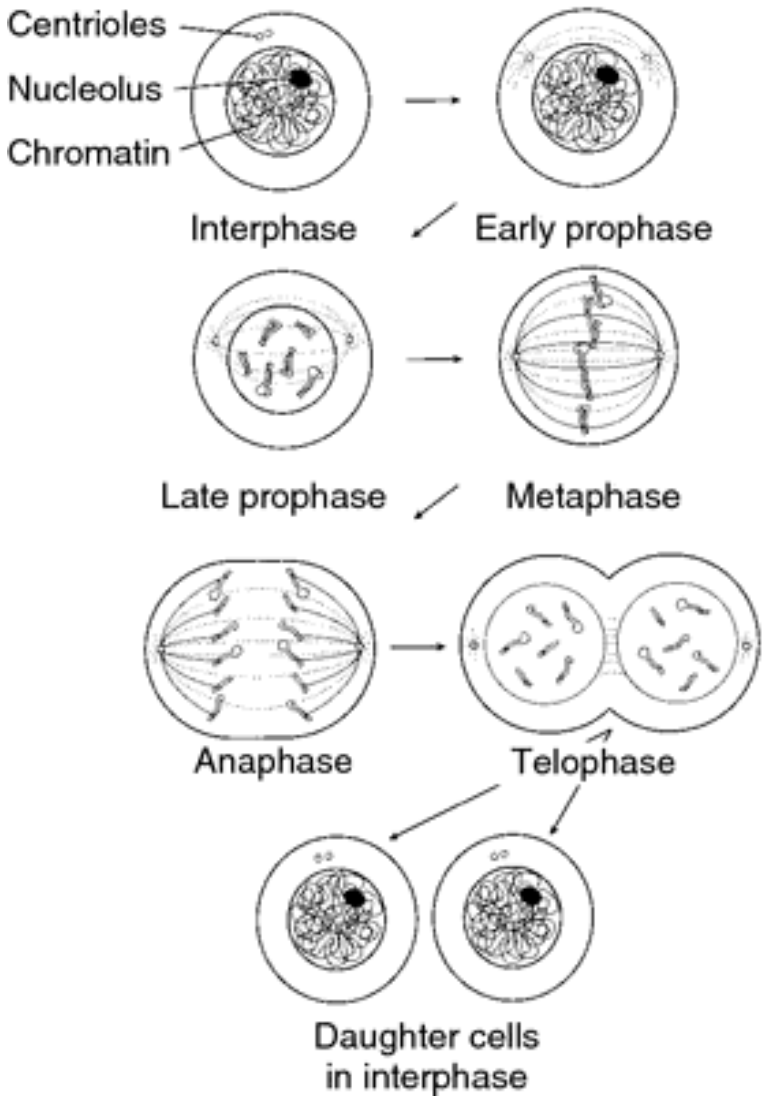
(D) Telophase

- The chromosomes have reached the opposite poles
- The spindle disperses.
- The chromosomes become diffuse.
- The nucleolus reappears.
- A nuclear envelope reforms around each chromosome set, thus anucleus is formed.

Cytokinesis

- This involves the division of the cytoplasm into 2 nearly equal cells.
- This process usually begins during telophase and sometimes duringanaphase.
- The cytoplasm gradually constricts at the equatorial plane (along themidline of the spindle).

- This process is not part of mitosis.



The Mitotic Cell Division

The Phases of Mitosis

DrawDraw under the microscope:

1. Prophase

2. Metaphase

3. Anaphase

4. Telophase