# Biology Department

# Practical Zoology

# First Class

# First course

## 2020 – 2021

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# CONTINES

# Measuring the Size of a Specimen Using a Stage Micrometer and an Ocular Micrometer

Size is one of the most important physical features employed in identification and characterization of an organism. The exact size of a microorganism can be determined by utilizing a calibrated ocular micrometer.

The size of microorganisms or substructures of organisms can be measured by microscopy using an ocular with a calibrated micrometer disc (Stage micrometer ).

## Stage micrometer:

The stage micrometer is a glass slide (3inch x 1inch) which contains graduations.

In its central region, 1mm is usually divided into 0.1-mm and 0.01-mm subdivisions ( 10 microns ). A stage micrometer is used to calibrate the ocular micrometer.

## Ocular micrometer:

The ocular micrometer also has graduation unit and it is disc shape. The value of division in ocular micrometer is not known.

Compound microscopes have ocular micrometers, or rulers that can help you measure items under the microscope. However, the scale on the ocular micrometer changes with total magnification, and thus has no absolute value. Therefore, the ocular micrometer does not have units and it needs to be calibrated prior to use.

## Calculate

Calculate the proportion of a millimeter that is measured by a single
ocular unit using the following formula:

$$\frac{1\text{mm}}{\#\ \text{ocular units (number of units)}} x \frac{1000\,\mu m}{1mm} = (---)\ \mu m \text{ per ocular unit}$$

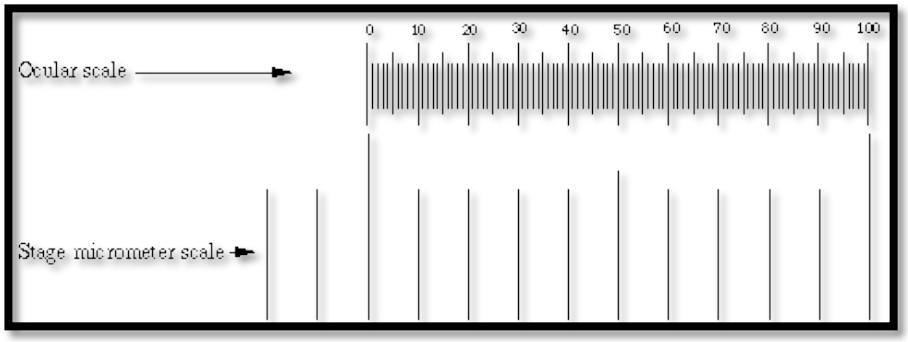
## *Results:*

| Kind of objective | One ocular micrometer Graduation equal to: |
|---|---|
| 4X objective | **41.6 (1000 ÷ 24 )** |
| 10X objective | **16.4 ( 1000 / 61 )** |
| 40X objective | **4.16** |
| 100X objective | **1.64** |

Length of the cell =

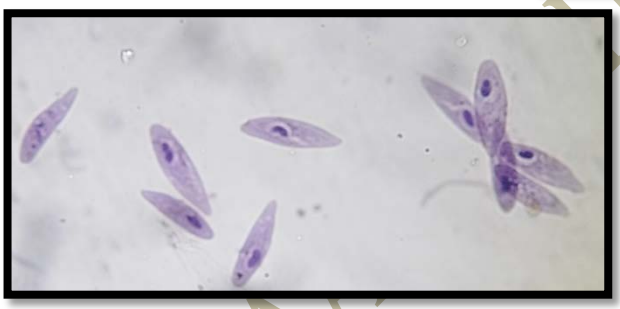
Number of subdivisions of the ocular X The numerical value of one subdivision ( ocular unite )when the objective lens examined

Length of the cell = (----) $\mu m$ at 4X or 10X or 40X or 100X .









***LAB1:PRACTICAL ZOLOGY***

# The microscope

The microscope is an essential tool in the study of life science. The purpose for using microscope is to magnify a small object or to magnify the fine details of a larger object in order to examine minute specimens that cannot be seen by the naked eye.

**Microscopes categories :-**

**1. Light (optical) microscopes** **2. Electron microscopes**

Light microscope involves use of optical lenses and light radiations.

**The parts of optical compound microscope :-**

**1- Base**:- the widest bottom part that supports the microscope.

**2- Arm:-** the straight or curved vertical part that connects the base to the upper portion.

**3-Head(or body tube):-** extends from the arm and contains the ocular lens and the rotating nosepiece with the objective lenses.

**a-Ocular lenses (eyepieces) :-** one or two removable lenses that you look through to observe the microscope slide .Typically ,these lenses have a magnification of 10X. look at the eyepiece and record the magnification .One of the oculars may have a pointer used to identify a specific area on the slide when studying slides with others.

**b-Objective lenses:-**usually a microscope have a three or four objective lenses mounted on a revolving nosepiece .Most microscope have objective lenses with magnifications of 4X(scanning), 10X(low), 40X(high), and 100X(Oil immersion).

**Note :-**

**To calculate the total magnification with which you are viewing an object, multiply the magnification of the eyepiece lens by the magnification of the objective lens you are using. For example, the eyepiece's magnification of 10 multiplied by the low-power objective's10 . 10 X10 =100X**

**4-Stage:-**the flat platform where you place your slides .Stage contain clips hold the slide. If your microscope has a mechanical stage ,you will be able to move the slide by turning two knobs, moves it left and right .

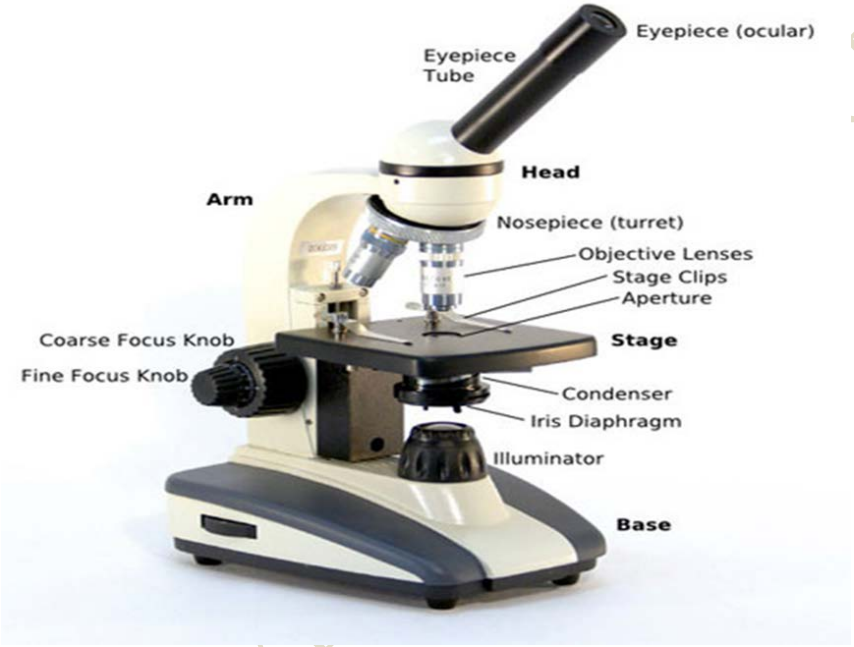
**5-Coarse focus knob:-**on each side of the microscope there is a large knob with a smaller knob in the middle. The large knob moves the stage up or down for ordinary focusing .

**6-Fine focus knob:-**the smaller knob on each side of the microscope that is used for precision focusing.

**when focusing the microscope, be careful that the objective lens doesn't touch the slide, as it could break the slide and destroy the specimen .**

**7-Condenser** :-located just below the stage ,this lens condenses light through specimen on the slide above **.**

**8- Iris Diaphragm :-** located beneath the condenser .By adjusting its lever, the aperture changes diameter and regulates the amount of light that passes through the condenser Figure (1).




**Fig(1) the optical compound microscope parts**

**Note :-**

**Pick up the microscope with two hands ,one holding its arm and the other supporting**

**the base .**

**Carry the microscope upright so that a lens or eyepiece does not fall out and place the microscope on your lab bench in front of you.**

**Advantages and Disadvantages of Optical Microscope**

**Advantages**

*Direct imaging with no need of sample pre-treatment .

*Fast, and adaptable for many types of samples .

*Easy to be integrated with digital camera systems for data storage and analysis.

**Disadvantages**

*Low resolution, mainly due to the light diffraction limit .

**Some types of Optical microscopes:-**

***Phase contrast microscope**

Phase contrast microscope is especially useful for studying microbial motility,

determining the shape of living cells, detecting bacterial components ,and the activity of some substance on the cell.

*** Bright field microscope**

The bright field microscope is routinely used in microbiology labs ,where it can be employed

to examine both stained and unstained specimens.it is called a bright field microscope

because it forms a dark image against a brighter background.

***Dark field microscope**

The dark field microscope produces much more detailed images of living, unstained cell and organisms .the field of view is dark and the organisms are illuminated .

***Fluorescence microscope**

This microscope is based on fluorescent dyes ,where the particles appear glowing with a dark background.

**Electron microscope**

The electron microscope uses an electron beam to create an image with electromagnets acting as lenses .There are two types of electron microscope, Transmission Electron Microscope (TEM)(Figure-2) and Scanning Electron Microscope(SEM) (Figure-3).

**FIG(2) TEM**

**FIG( 3) SEM**

## A cell

Cytology is a branch of biology, which deals with the study of cells in terms of structure.

The cell is the fundamental structural and functional unit of all living organisms

Cells are extremely diverse in their shape and function. For example, muscle cells that allow movement, and gland cells that secrete hormones, the structure of each of these is specialized to perform its particular function .Any living organism may contain only one type of cell either Prokaryotic cells or Eukaryotic cells

All living organisms have cellular organization and may contain one or many cells unicellular organisms are the organisms with only one cell in their body eg. 1-all prokaryotic cell 2- some eukaryotes such as a. Protozoa ( amoeba, plasmodium, etc.) b. algae c. yeast multicellular organisms are the organisms having many cells in their body (majority of eukaryotes Fungi ,plants &animals(

Multicellular organisms has large number of different cells, cells differ in size , shape and their structure according to their location and function.

Cells show in different sizes:

- ☐ very large cells: seen by naked eye (such as eggs of birds(
- ☐ small or micro size: seen by light microscopic and cannot be seen by the naked eye, is measured in micrometers (µm) in diameter ( R.B.C.5 µm; liver cell 20 µm(
- ☐ very small size : cannot seen by light microscopic but seen by electron microscopic ( virus )

## The types of cells

Cells are divided into two main types, according to the way their genetic material is organized.

1- The ***prokaryotic cells*** lack a membrane-bound nucleus. Their DNA is located in a region of the cytoplasm called the nucleoid region.

2- The ***eukaryotic cells*** have a nucleus that houses their chromatin.

## Comparison between prokaryotic & eukaryotic cells

| characteristic | prokaryotic | eukaryotic |
|---|---|---|
| size | Small ( 1 – 10 µm) | Large ( 10 – 100 µm) |
| Genetic system | DNA in nucleoid, it is not membrane bound | DNA in nucleus, with membrane envelope |
| Cell division | Direct by binary fission or budding | By mitosis |
| Energy metabolism | No mitochondria, oxidative enzyme bound to cell membrane | Mitochondria present, oxidative enzyme package therein |
| Intracellular movement | None | Cytoplasmic streaming , phagocytosis, pinocytosis |

## *Some characteristics those are common of cells:*

1. A plasma membrane.
2. A semifluid interior, called the cytoplasm.
3. Genetic material (DNA)

## *Bacterial Structure:*

In bacteria, **the cytoplasm** is surrounded by **a plasma membrane**. Most bacteria Possess **a cell wall**, and sometimes also **a capsule**. The DNA is located in a region of the cell called **the nucleoid**. And some bacteria move with the use of **flagella**. The cytoplasm contains **ribosomes** for protein synthesis.

### *1. A plasma membrane :*

*Plasma membrane* is outer membrane of both prokaryotes and eukaryotes, which acts as the boundary between the outside and inside of a cell.

### *The Plasma Membrane structure*

The plasma membrane is consist of:

1- phospholipid bilayer. Called (The fluid-mosaic model ).

The bilayer role is regulates the passage of molecules and ions into and out of the cell.

2- The proteins embedded in the plasma membrane have a variety of functions.

## Functions of Membrane Proteins

1. Channel Proteins.
2. Transport Proteins.
3. Cell Recognition Proteins. These proteins enable our bodies to distinguish between our own cells and the cells of other organisms.
4. Receptor Proteins. A receptor protein has a shape that allows a specific molecule, called a signal molecule, to bind to it . ***For example, the hormone insulin binds to a receptor protein in liver Cells***.
5. Junction Proteins. Such as **Adhesion proteins**

# Eukaryotic Cells structure

## Nucleus and Ribosomes

- The nucleus houses **chromatin,** which contains DNA, the genetic material. During division, chromatin becomes condensed into **chromosomes.**
- The **nucleolus** is an area within the nucleus where ribosomal RNA is produced. Proteins are combined with the rRNA to form the subunits of ribosomes, which exit the **nuclear envelope** through nuclear pores.
- Ribosomes in the cytoplasm synthesize polypeptides using information transferred from the DNA by mRNA.

## Endomembrane System

- The **endoplasmic reticulum** (**ER**) is part of the endomembrane system (two forms).

a. **Rough ER** has ribosomes, which produce polypeptides, on its surface.
b. **Smooth ER** synthesizes lipids and carbohydrates, but it also has various metabolic Functions, depending on the cell type. It can also form transport vesicles.

- The **Golgi apparatus** is a transfer station that receives transport vesicles and modifies, sorts, and repackages proteins into transport vesicles.
- **Lysosomes** are produced by the Golgi apparatus. They contain enzymes that carry out intracellular digestion.

## Vesicles

Vesicles are small membranous sacs that move materials between organelles in the endomembrane system.

## Mitochondria :

Mitochondria are the site of **cellular respiration.** They break down carbohydrates (and other organic molecules) to produce **adenosine triphosphate (ATP).**

## Cytoskeleton

Cytoskeleton maintains cell shape and allows the cell and the organelles to move., there are three types of cytoskeleton:

- Microtubules
- Intermediate Filaments
- Actin Filaments

## Centrioles

Located in the centrosome, **centrioles** are short, barrel-shaped organelles composed of microtubules . It's possible that centrioles give rise to basal bodies, which are located at the base of cilia and flagella and organize the microtubules in these structures. The centrioles are also organizing microtubules during cell division.

## Flagella and cilia

Involved in moving the cell or moving materials along the surface of the cell.

## Outside the Eukaryotic Cell

- A **cell wall** provides support for plant, fungi, and some protest cells.
- Animal cells have an **extracellular matrix** (**ECM**) that produced by the cells; it helps support cells and provide a communication between them.

## Cells are connected by a variety of junctions:

- **Adhesion junctions** and **tight junctions,** if present, help hold cells together.
- **Gap junctions** allow the passage of small molecules between cells.

# Zoology

**Zoology** is the scientific study of animals ,and it is part of **Biology** (the scientific study of life). Animals and life in general can be identified by attributes that they have acquired over their long evolutionary histories.

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# Classification of living organisms

R.H Whittaker proposed the **five kingdom** classification in 1969 (the most common system of classification in use today):

# Kingdom: Animalia

Members of the animal Kingdom are **distinguished** by sharing the following **characteristics**:

1-Multicellualr, eukaryotic organisms.

2-Cells with no cell wall or chloroplasts and more mitochondria.

3-Cells differentiated into complex tissues : epithelial ,connective, muscular , nervous.

4-Tissues differentiated into complex organs and organ systems.

5-Heterotrophic nutrition (herbivores, carnivores).

6-Most are much more active and have a much higher metabolism than members of any other kingdom.

7-Require free oxygen for energy production.

8-Extra energy usually stored as fats and oils.

9-Most are mobile at some point in their life cycle.

10-Reproduce both sexually and asexually, animals show a great diversity in kinds of reproduction.

11-Most have a relatively complex development phase including an embryonic or a larval stage as they progress from zygote to adult.

12-Most have fairly elaborate behaviors to enhance their survival within their habitat.

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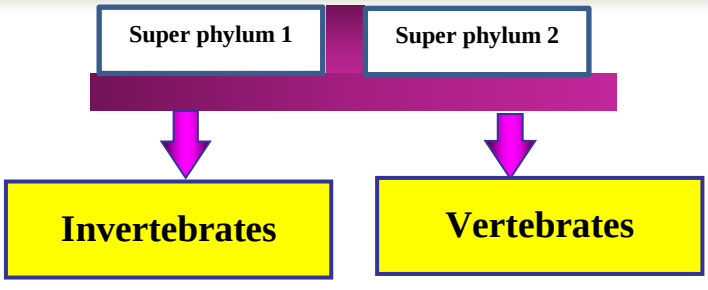
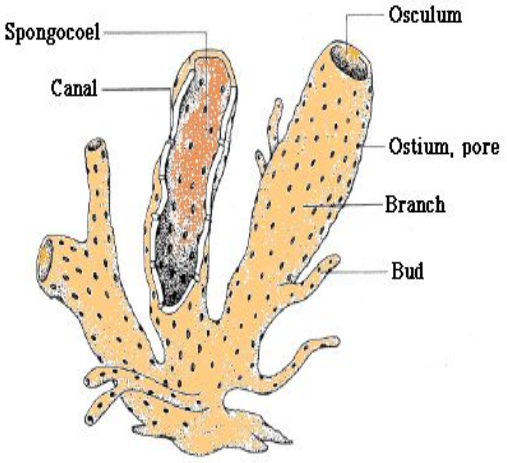
## Classification of Kingdom:



# Super phylum I: Invertebrates

## Phylum 1 : Porifera

Example: Marine sponge




1. These are multicellular.
2- They have a **cellular grade** of construction without the occurrence of tissues.
3- They are characterized by the presences of a **canal system** in their body.
4- The body wall contain **spicules**.
5- They can reproduce both by asexual and sexual method.

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## Phylum 2 : Coelenterata

Example: *Hydra*

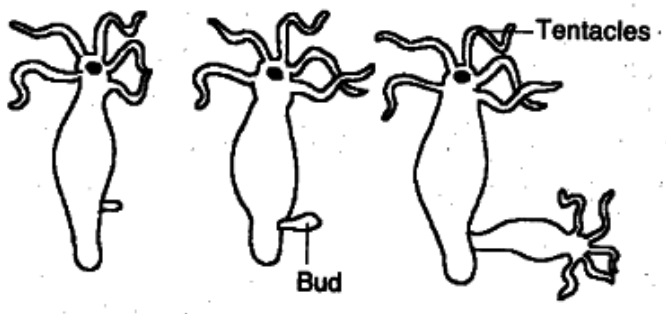
1-All Coelenterata are aquatic animals, they are mostly marine.

2-The body is radially symmetrical.

3-Many Coelenterates exhibit **polymorphism**.

4-The layers in the body wall contain several cells and tissues such as muscle cells epithelial tissues gland cells and sensory cells.

5-They reproduce both asexually and sexually methods.



## Phylum 3 : Platyhelminthes

Example: *Planaria*

4

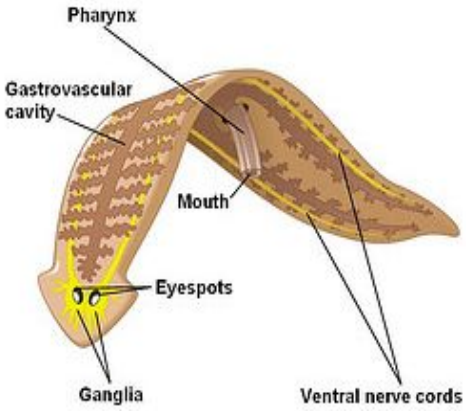
1-This phylum includes **flatworms**.

2-These are **acoelomates**, without a body cavity called coelom.

3-The alimentary canal is either absent or very simple.

4-Excretion and osmoregulation occur through **flame cells**.

5-These worms are mostly having both male and female reproductive organs in a single individual.

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## Phylum 4 : Nematoda

Example: *Trichinella spiralis*

1-The body is narrow and pointed at both the ends.

2-There are no body segments.

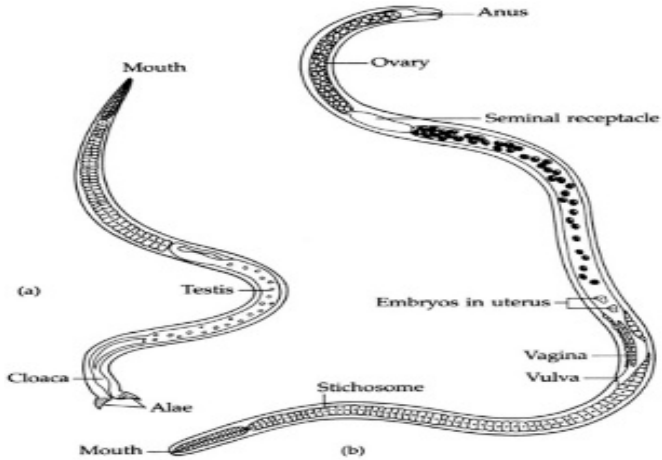
3-The body is covered by a thin cuticle.

4-The body cavity is considered as a **pseudocoelem**.

5-The alimentary canal is a straight tube.

6-They reproduce sexually and the sexes are separate.

7-There are several free living soil nematodes, others are parasites.



## 6 th lec.

## Phylum:Mollusca

**The main characteristic of mollusca members include:-**

1- Mollusca is one of **largest animal phyla** after arthropoda
2- Most live in **the sea or fresh water** and use **gills** for respiration
3- Generally the body is divided into **head ,muscular foot and visceral mass**
4- Mollusks are **Bilaterally symmetrical, unsegmented and soft-bodied animals**
5- Body covered by a cuticle-covered epidermal sheet of skin, **the mantle**
6- Many molluscs have a **radula**, which, in most species, is a rasp-like scraping organ used in feeding
7- The most common larva is **a trochophore larva**

**Example: 1-** Helix sp.
**2-** Octopus sp.

## Phylum: Arthropoda

**The main characteristic of Arthropoda members include:-**

1- Arthropoda is the largest phylum.
2- They may be aquatic, terrestrial or even parasitic.
3- They are triploblastic and segmented invertebrates having head, thorax and abdomen, The head bears a pair of compound eyes
4- Body is covered with chitinous exoskeleton.
5- They are haemocoelomate.
6- Locomotion takes place by jointed appendages.
7- They are unisexual and fertilization is either external or internal.

Example: 1- Butterflies
2- Spider

## Phylum: Echinodermata

**The main characteristic of Echinodermata members include:-**

1-These are exclusively **marine organisms**.

2- the adults are **radially symmetrical** while the larvae remain **bilaterally symmetrical**.

4- the shape of the body is **flat , star – like elongated or spherical**

5-They have a **water vascular system**, with tube feet .

6- The body is **triploblastic, coelomate** and without definite **head and segmentation**.

**Example: 1-** Asterias sp.( sea star)

**2-** Echinus sp.( melon sea urchin )

## 7th lec.

## Phylum: Annelida

**The main characteristic of Annelida members((also called segmented worm) include:-**

1- They are mostly aquatic; marine or freshwater some terrestrial.
2- The Annelids are coelomate , triploblastic, segmented and bilaterally symmetrical.
3- Their body contains hemoglobin, which gives them a red colour
4- Nephridia are the excretory organs.
5- They respire through their body surface.
6- Regeneration is a very common characteristic of the Annelids
7- The body divided into segments by transverse rings
8- Setae help them in movement.

**Example: 1-** Lumbricus sp. ( earthworm)
2- Medicinal leech

## Phylum: Chordata

This phylum derives its name from one of the common characteristics of this group namely the **notochord,** at least during some part of their development, **The notochord** is a rod that extends most of the length of the body when it is fully developed. Lying dorsal to the gut but ventral to the central nervous system .The animals belonging to all other phyla of the animal kingdom are often termed "the non-chordates or the invertebrate**. The main characteristic of Chordata members include:-**

9- Bilaterally symmetrical, triploblastic, coelomic and segmented body.
10- single, dorsal, hollow nerve cord, usually with an enlarged anterior end (brain)
11- ventral heart, with dorsal and ventral blood vessels and a closed blood system
12- complete digestive system
13- bony or cartilaginous endoskeleton usually present.

**Example: 1-** Turties
2- Frogs

8th lec.

# Animal tissues

There are 4 levels of organization in vertebrate body:

1- Cell 2- tissues 3- system( organ) & finally organism body.

*Tissues:* are groups of similar cells that perform a particular function.

There are four types of tissues found in animals: **epithelial tissue, muscular tissue, connective tissue, and nervous tissue.**
Tissue may found of one type of cell or more, we will be studying the human tissues as an example of animal tissues.

## Epithelial Tissue / attributes

1- Covers the external body surface.
2- lines the internal surfaces and cavities of body.
3- Cells are bundle tightly
4- Cell local on the basement membrane.
5- Performs many function such as: Protection, Absorption & Secretion.

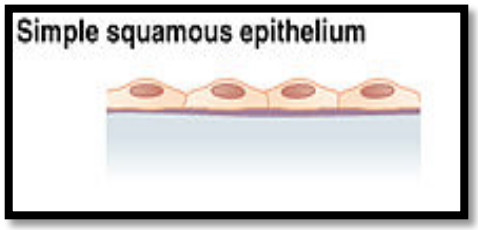
## Types of epithelial tissues:

according to the number of cell layers and the shape of the cells , there are two types:

1- Simple Epithelium: contains a single layer of cells, classified according to the shape of cell.

2- Stratified Epithelium: contains multiple layers of cells, classified depending on the shape of superficial cells.

### ❖ Simple squamous epithelial tissue:



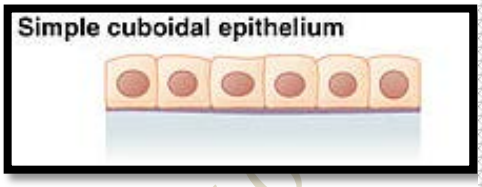

Structure: Simple squamous epithelium is Thin and flat cells , one-cell layer. Nucleus has a spherical or oval shape centrally located. The cells lie on basement membrane

Location: lining of lung, mouth and wall of all blood vessels,

forming blood capillaries and Bowman's capsule

Function: Responsible for diffusion substances across the cells.

## ❖ Simple Cuboidal epithelial tissue:

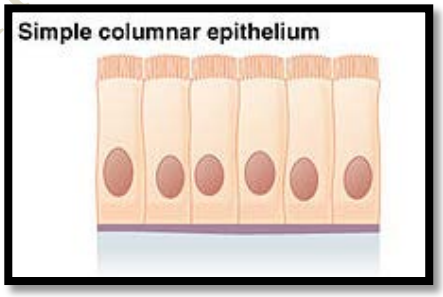



Structure : Cubic-like with large spherical central nuclei

Location: lining ducts of most glands and kidney tubules, forming Secretory portion of some glands covering of ovaries

Function: secretion and absorption.

## ❖ Simple Columnar epithelial tissue:

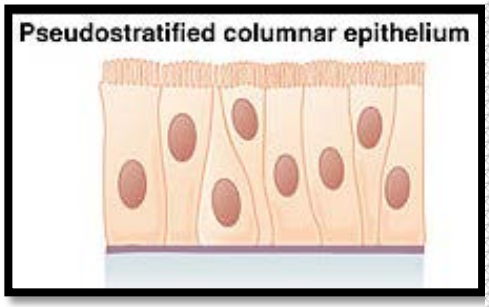



Structure: Elongated cells, with oval nuclei located at the base of the cell.

Location: lining of digestive tract, parts of respiratory tracts, reproductive system

Function: secretion and absorption. Have goblet cells that secrete mucus.

## ❖ pseudo stratified epithelial tissue:




Structure : appears to be stratified, but is not. (why?) it's The single layer of different shape of cells and all cells are in contact with the basement membrane, and contain nuclei that are arranged at different levels, making it appear to be stratified

Location: lining trachea and larger passage-ways of Respiratory system with cilia

Function: protection.

## *3-Muscular Tissue*

contains contractile protein fibers **(** myofilament **)**, called actin and myosin filaments, that interact to produce movement. The three types of vertebrate muscles are skeletal, cardiac, and smooth.

The cells of muscle tissue are long and contain protein fibers capable of contracting to provide movement. The bulk of muscle tissue is made up of two proteins, myosin and actin. These proteins are organized into muscle fibers called myofilaments,

*depending on the arrangement of these myofilaments There are three (3) types of muscular tissue*

1. Skeletal Muscle (Tissue):

Skeletal muscle is also considered "voluntary muscle" and attached to skeleton by tendons., These muscles can be generated body movements (limb movement, jaw movement, breathing, etc.). About 35-45% of the human body is made up of skeletal muscle tissue

The skeletal muscle cells (fibers) are long and cylindrical, with multiple peripherally located and oval nuclei. just under the thin elastic membrane ( sarcolemma) the sarcoplasm also has many alternating light and dark bands that result from arrangement of actin and myosin(*These proteins are organized into muscle fibers called myofilaments*) giving the fiber a cross striated appearance

2. Smooth Muscle (Tissue):

Smooth muscle (is an involuntary, non-striated muscle ) Smooth muscle tissue is found in the walls of hollow organs, such as the digestive system, blood vessels and the bladder . Contractions role of these muscles drive fluid or materials through the organs

Smooth muscle made of thin - elongated muscle cells ( fibers) are not striated (hence the name "smooth" muscle); they have a single large oval-elongate nucleus, and have tapered ends .

each fiber has many myofibrils located parallels to the direction of the long axis of the fiber.

## 3. Cardiac Muscle (Tissue)

Cardiac muscle is the major tissue making up the heart. It is an involuntary muscle that is striated in appearance

fibers like those of skeletal muscle have cross- striations and contain single nucleus, the sarcoplasm has *myofilaments* but this fiber are short, branched and contain intercalated discs *which represented area of folded plasma membrane( sarcolemma) between fibers help with coordinated contractions of the heart.*

Cardiac muscle tissue has a very large number of mitochondria to provide the energy source for the continuous contracting action of the heart.

9th lec.

# Nervous Tissue

Nervous Tissue controls the body's responses to the changing conditions. and is found in the brain, spinal cord, and nerves . there are two main cells that make up nervous tissue

1. Nerve Cells (also known as Neurons or Neurones):

It is transmit nerve impulses that move information around the body.

Neurons communicate with each other via electrical and chemical signals. They have nucleated cell bodies and two types of elongated cellular dendrites – which receive signals, and axons which send signals.There are 3 form multipolar neurons, bipolar neurons and unipolar neurons.

Neuroglia (also known as simply Glia) : which provide support , nutrients for neurons and protect nerve cells, depending on the particular type of glia. (types of glia include astrocytes, oligodendrocytes and Schwann cells.)

- Connective tissues:

- Function: The many types of **connective tissue** are all involved in binding structures of the body together and providing support and protection.
- Structure : connective tissue cells are separated by a **matrix,** a noncellular material, that varies from solid to semifluid to fluid. The matrix usually has fibers— especially collagen fibers, that it's most common protein in the human body.

1- *Loose Connective tissue:*

Adipose tissue is a type of loose connective tissue in which, the fibroblasts enlarge and store fat, and there is limited matrix. Adipose tissue is located under the skin and around organs, such as the heart and kidneys,

2- *Dense Connective tissue* :

It's contains more collagen fibers, which are packed closely together. For example:

a- Tendons, which connect skeletal muscles to bones.

b- Ligaments, which connect bones to other bones at joints.

### *3- Cartilage:*

In **cartilage,** the cells is inside a small, open cavities called *lacunae,* separated by a matrix that is semisolid ( flexible ).

- ☒ *Hyaline cartilage*, the most common type of cartilage, contains only very fine collagen fibers and The matrix has a white appearance when unstained. Hyaline cartilage is found in the nose, at the ends of the long bones, in the ribs, it forms rings in the walls of respiratory passages, And The human fetal skeleton .
- ☒ *Elastic cartilage*: is present outer ear and larynx.
- ☒ *Fibro cartilage*: is intervertebral disc.

# Cell Division

*There are two types of cell division:*

*1- Mitosis* *2- Meiosis*

In mitotic division (Mitosis), two genetically identical daughter cells are produced from the original cell.
The daughter cells, could be used for replace dead cells or for repair a damaged tissue

## Interphase

Non-dividing state, with 3 sub-stages

- **Gap (G1)** * cell grows in size * organelles replicated
- **S** *synthesis of DNA
- **Gap (G2)** * synthesis of proteins associated with mitosis

## Stages of mitotic division

### 1- Prophase

- Chromosomes are become condense, shorten, thicken, and visible.
- Each duplicated chromosome appears as two identical sister chromatids.
- The nuclear (envelope ) membrane breaks up.
- The mitotic spindle begins to form.

### 2- Metaphase

- The chromosomes assemble at the equator = metaphase plate

### 3- Anaphase

- The spindle fibers begin to contract
- This starts to pull the sister chromatids apart
- At the end of anaphase a complete set of daughter chromosomes is found

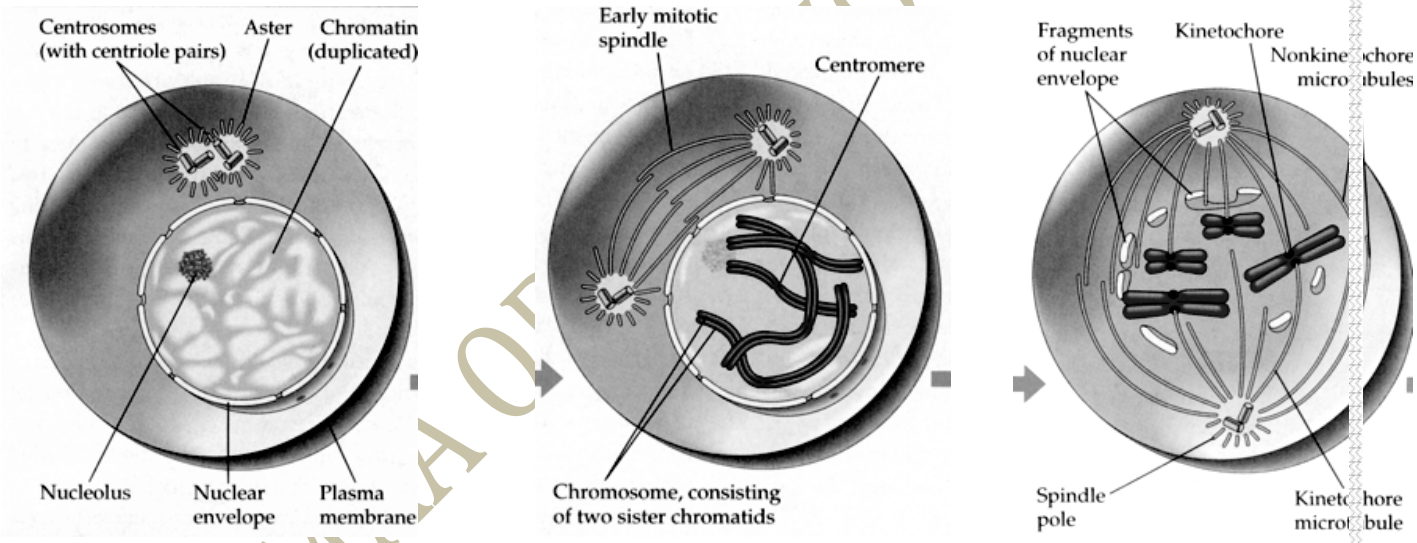
At opposite poles of the spindle.

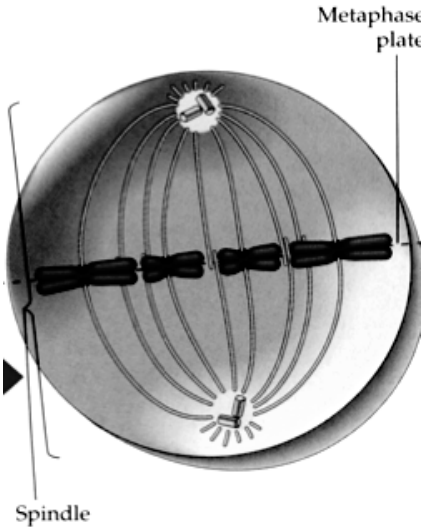
## 4- Telophase

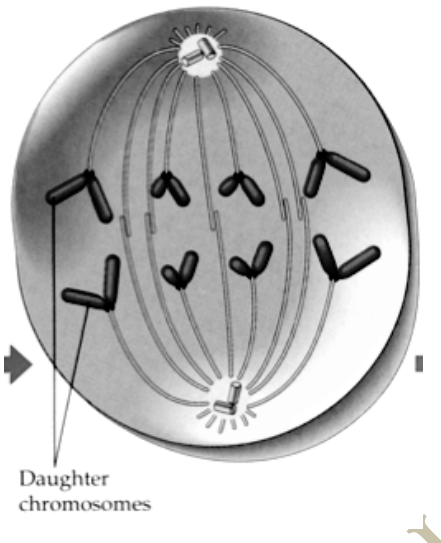
• Chromatids which are now become new Chromosomes are gathered and around by nuclear membrane on both sides of the cell.

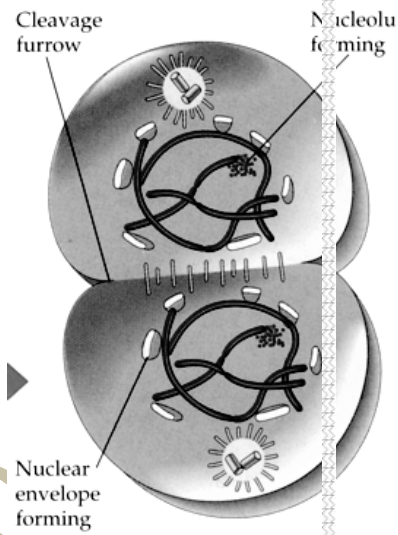
# Cytokinesis / Cytoplasmic division

- In animal cell by
  A cleavage furrow divides the cytoplasm Into two part
- In plant cell the cleavage occurs by composition of the Cellular lamina





10 th lec.

## 1- Bones:

Bone is the most rigid connective tissue . It consists of hard matrix of inorganic salts, primarily calcium salts, which are found around collagen fibers. The inorganic salts give bone rigidity, and the collagen fibers provide elasticity and strength.

- ☒ *Compact bone*: the most common type of bone in humans, consists of cylindrical structural units called osteons. The central canal of each osteon is surrounded by rings of hard matrix. Bone cells are located in lacunae between the rings of matrix. And blood vessels in the central canal.

## 2- Blood: ( why)

Blood is classified as connective tissue because the cells are separated by a matrix—plasma, the liquid portion of blood. The cellular components of blood are red blood cells, white blood cells, and platelets (which are actually fragments of larger cells).

Components of blood:

- *matrix—plasma :* is a pale colored liquid, Composed of water, ions (such as Na+ and Cl ) ,plasma proteins (such as albumin, fibrinogen, globulins), hormones, fats, amino acids, vitamins as well as other substances.

- *Blood cells:*

✓ **Red blood cells** are small, biconcave, disk-shaped cells without nuclei. With the red pigment hemoglobin makes the cells red. Hemoglobin binds oxygen and allows the red blood cells to transport oxygen to the cells of the body.

✓ **Platelets** are another component of blood, but they are not complete cells, they are fragments of giant cells present only in bone marrow. When a blood vessel is damaged, platelets form a plug and it release molecules that help the clotting process.

✓ **leukocytes (white blood cells or WBC)**

Thy classified according to their granules to:

*A) Granular cells :*

1- Neutrophils (neutrophilic granulocytes):

- Description: nucleus multilobes (2-5), Cytoplasm contains two major types of granules. small with a pinkish & larger stain reddish purple
- function: phagocytosis.

2- Eosinophils

- Description: contains a bilobed nucleus, The cytoplasm has specific granules are stain bright orange (eosinophilic)
- function: increased in some parasitic infections.

3- Basophils

- Description: nucleus containing 2-3 lobes which are often difficult to see because of the large, dark-staining specific granules. The cytoplasm contains numerous metachromatic granules of varying size that stain a deep purple color
- function: release histamine.

*B) A granular cells*

1- Monocytes: (tissue histiocytes)

- Description: They are the largest cell in the blood. They contain a large nucleus which is ovoid, kidney- or horseshoe-shaped, often located in an eccentric position. The cytoplasm is pale
- function: they ingest and remove particles ,tissue debris, and microorganisms in many tissues.

2- Lymphocytes:

- Description: They contain a single, deeply-stained, spherical nucleus, The nucleus is surrounded by a thin layer of pale blue cytoplasm.
- function: has important role in immune response by direct cell attack (T cell) or via antibodies (B cells)

# Meiotic division (Meiosis)

In meiotic division (Meiosis), chromosomes in a diploid cell segregate (separate), producing four haploid cells, this division only occurs in reproductive cells which are called germ cells.

Meiotic division consists of two successive phases **Meiosis I** and **Meiosis II**

## First Meiotic ( Meiosis I ):

In this stage the chromosome content of the daughter cell is reduced to half of that of the mother cell,

### First Meiotic Prophase:

The first phase of **Meiosis I** is the prophase. This goes through 5
stages as follow:

### Leptotene:

- The chromosomes become more apparent as along filament showing bead – like thick areas called chromomeres.
- The nuclear membrane and nucleolus will be visible.

### Zygotene:

- The homologous chromosomes begin to pair.
- The two homologous do not fuse during pairing, but remain separated by a space of about 0.15 to 0.2µm, which called synaptonemal complex (the process is called synapsis).

### Pachytene:

- The chromatids of homologous chromosomes are also visible as a tetrad.
- The nucleus appear to contain half number of the chromosomes.

### Diplotene:

- crossing over is happened in this stage (chromosomal are exchange between the nonsister chromatids of homologous chromosomes, in certain point called chiasmata )

### Diakinesis:

- Continue contraction of the chromosomes.
- The nucleolus disappears and the nuclear membrane breaks down.

### First Meiotic Metaphase:

- The nuclear membrane disintegrates and chromosomes migrate to the equatorial plate of the dividing cell.
- The two centrosomes are in the opposite poles of the cell.

### First Meiotic Anaphase:

- Homologous chromosomes break up and each member migrates randomly to opposite poles of the cell.

### First Meiotic Telophase:

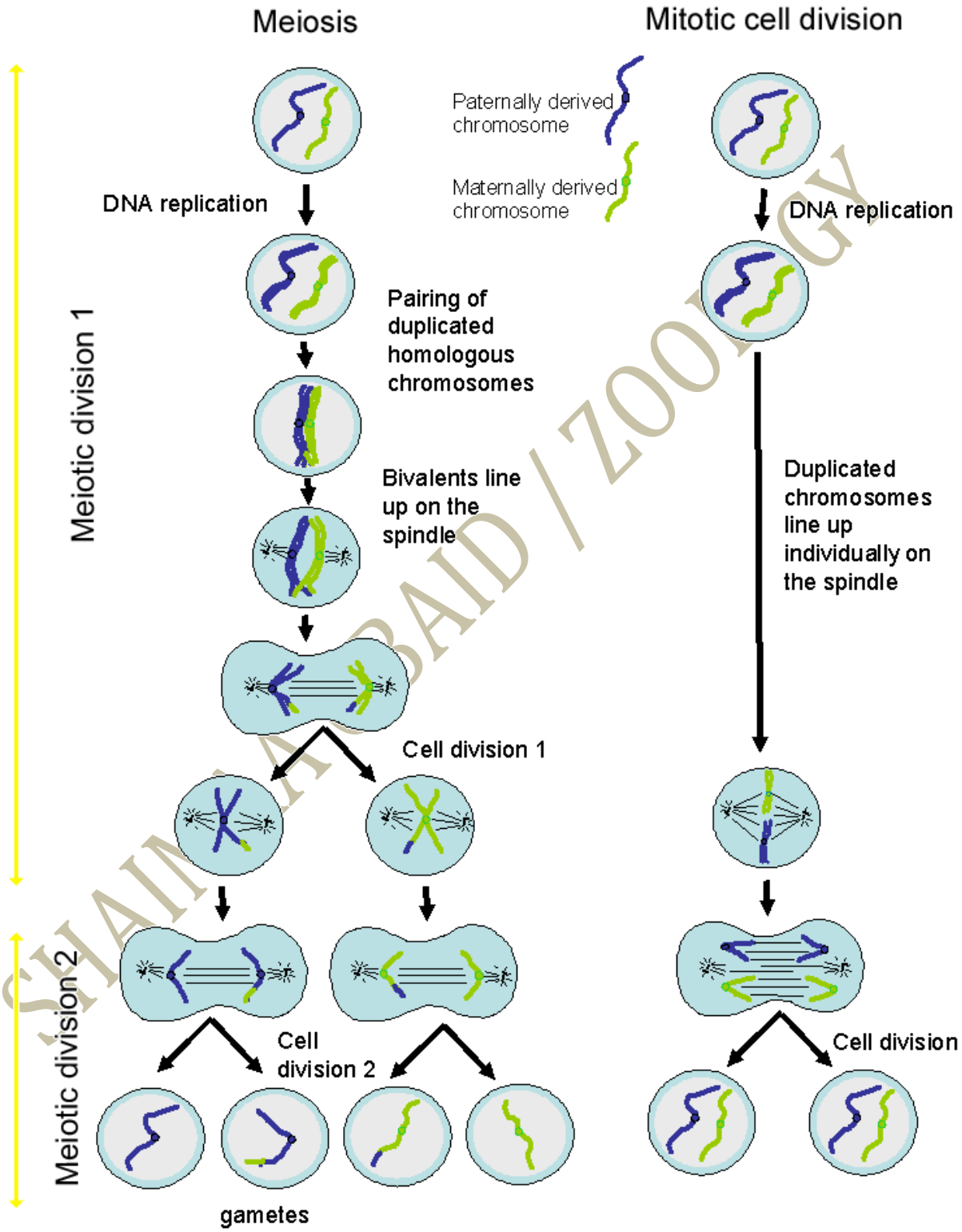
- Chromosomes are assembles and enclosed in nuclear membrane .
- The cytoplasm is divided into two part (Cytokinesis) to form two daughter cells. Each daughter cell now has the haploid number of chromosome (23 in the human).

## Meiosis II

- ❖ The stages of Meiosis II are similar to those of Mitosis.
- ❖ The two daughter cells lead directly into Meiosis II.
- ❖ The production of two daughter cells from each daughter cell that was produced from first meiotic division.
- ❖ The chromosomes of the last two daughter cells are not genetically identical. The end result of Meiosis is the production 4 daughter cells, each with haploid number of chromosomes

- The end result of Meiosis is the production 4 daughter cells, each with haploid number of chromosomes

| | Mitosis | Meiosis |
|---|---|---|
| 1 | Take place in the somatic cells of the body | Take place in the germ cells. |
| 2 | Occurs in both sexually and asexually reproducing organisms. | Occurs only in sexually reproducing organisms |
| 3 | The cell divides only once. | There are two cell divisions, the first and the second meiotic divisions. |
| 4 | Interphase occurs before each division. | Interphase occurs only before in meiosis I. |
| 5 | Prophase is comparatively simple | Prophase is complicated and divided into 5 stages. |
| 6 | There is no synapsis | Synapsis of homologous chromosomes takes place during prophase. |
| 7 | Each chromosome consists of two chromatids united by a centromere. | The two homologous chromosomes consisted four chromatids and two centromeres |
| 8 | Crossing over is absent | Crossing over of homologous chromosomes usually takes place during diplotene stage. |
| 9 | Anaphase 's chromosomes are single stranded. | Chromosomes are double stranded in anaphase I, but single stranded in anaphase II. |



# 13 th Frog Anatomy

Phylum: Chordate
Sub-phylum: Vertebrata
Class: Amphibian
Order: Anura
Genus: Bufo
Species: *Buforegularis*

Frogs and toads belong to the class Amphibia (amphi = both, bio = Life) which means they are adapted to living on land, in moist places, or in water. They have a backbone, three chambered heart, fertilize their eggs externally and lay their eggs in water.

Frogs are preferred for dissection because their organs can be compared to those of the human and they are small and inexpensive,live specimens are used for the study of behavior and for many physiological experiments.

Specimens for dissection are killed with an anesthetic such as ether. They may be dissected immediately but commonly are preserved against decay in formalin (5 to 10 per cent solution). Preserved specimens should be washed well before being handled and at times during dissection, because the formalin tends to harden human skin and its vapors are irritating to the mucous membranes of the eyes and nose.



**Orientation**

When dissecting the frog it is important to communicate about the location of structures.

- **Dorsal**: the back side
- **Ventral:** the lower/belly side
- **Anterior (Cranial):** the forward part towards head
- **Posterior (Caudal**): the hind part towards tail
- **Medial:** toward the central longitudinal axis of the body
- **Lateral:** toward the longitudinal line along the sides of the body; away from the central longitudinal axis

**Medial:** toward the central longitudinal axis of the bodyor toward the middle of the body.

**Lateral**: On or toward one side; away from the central longitudinal axis

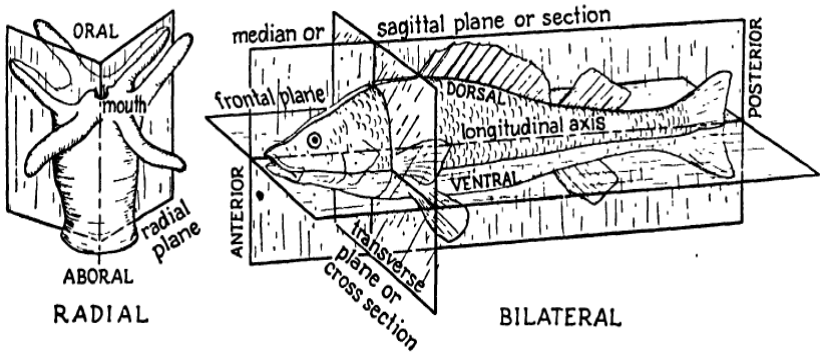



Fig. 1.—Types of symmetry and the axes and planes in animal bodies.

**External anatomy**

The skin of a frog serves several functions, including(a) physical protection of the body; (b) biological protection against theinvasion of foreign organisms; (c) respiration, the exchange of oxygenand carbon dioxide; and (d) production of useful secretions to keep theskin moist for respiration and slippery to avoid capture by enemies.

The skin consists of two major parts, the outer epidermis, which is stratified,and the dermis (corium) .

**A.Head** – the anterior end of the frog extending to and including the eardrums

**mouth** – the large opening at the anterior end of the head made up of a maxilla and mandible

**external nares** (i.e. nostrils) – On the dorsal anterior end of the frog two small openings near the tip

**eyes** – two eyes protrude from the head just posterior to the external nares

**nictitating membrane** – an extension of the lower eyelid that can come up to protect the eye

**tympanum** (i.e. eardrum) – round membranes just posterior and ventral to the eyes

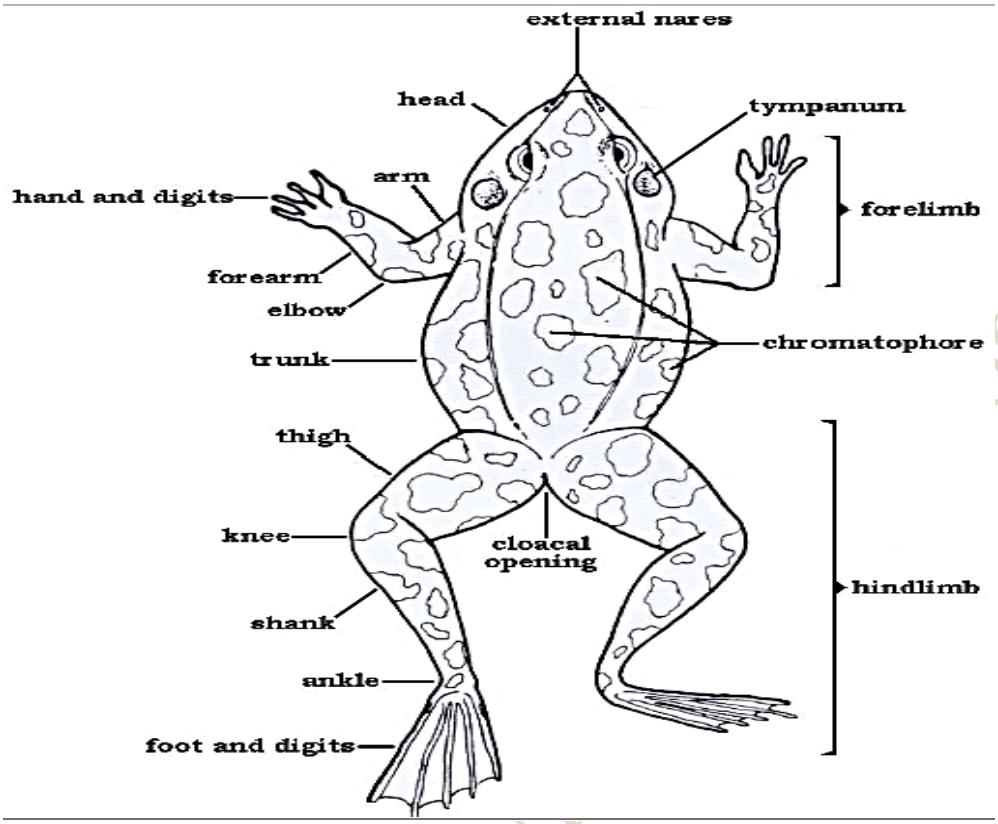
**B. Trunk** – the posterior end of the frog extending from the head to the hindlimbs

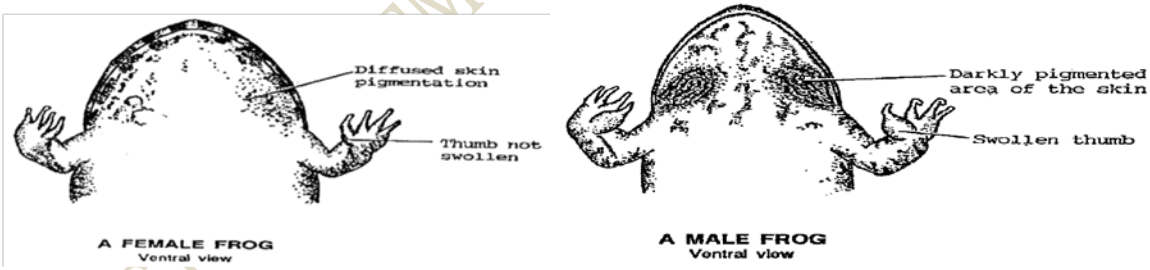
**Cloaca** (within pelvic girdle; common end of digestive, excretory, and reproductive systems)

**Anus**

**C. Appendages** – the limbs that extend from the trunk including the forelimbs and hindlimbs;foot and digits .In the male, the second digit bears a nuptial pad,

prominent andbrown in the breeding season(The thumb pads of males are enlarged at the base). This is absent in the female.



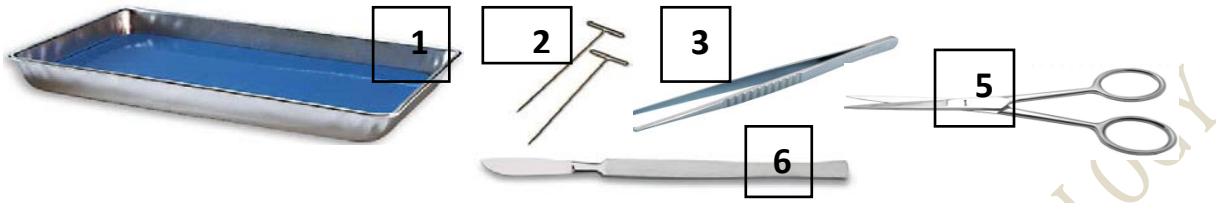




## Dissection Instructions for the Frog Internal Organs

The names and proper use of the following dissection tools:

1. Dissecting Tray –to hold down the organism.
2. Pins –for holding the organism open.

3. Forceps (tweezers) – for holding and identifying parts to see other organs.
4. Dissecting Probe – for exploring and pushing organs aside.
5. Scissors – for cutting. Use scissors for most of your incisions.
6. Scalpel

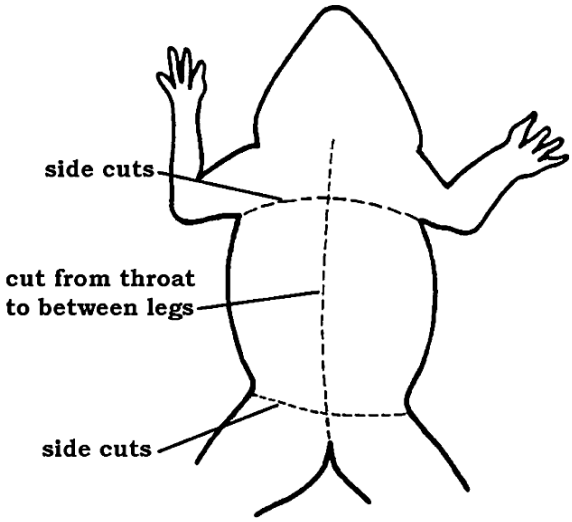



**INTERNAL STRUCTURE AND DIGESTIVE SYSTEM**

The internal organs, collectively termed the viscera, are contained in the largebody cavity or coelom inside the trunk.

**Dissection Preparation**:

In order to dissect a toad , one has to kill it ,either by knocking, pithing or anaesthetizing it.




1. Place Frog in PanThe frog should be lying on its dorsal (back) side with the belly facing up.
2. Pin the Frogfor dissection by securing each of the four limbs to the pan.
3. Begin the First Skin Incision

Using the scalpel,make a cut along the center, or midline, of the frog, bisecting it equally.

4. Continue the Skin Incision
6. Separate the Skin & Muscle Once you have finished the incisions between the front and rear legs of the frog. To do this: Pick up the flap of skin with the forceps, and use a scalpel to help separate the skin from the muscle below.
7. Pin Skin Flaps
8. Internal organs. Beginning anteriorly, and using only the forceps, identify:

**Heart** (reddish, conical, muscular; enclosed within a delicate membrane, the pericardialsac)

**Lungs** (2, dorsal to liver, soft, thin-walled, often shriveled)

**Liver** (large, firm, reddish brown, of 3 lobes)

**Gall bladder or bile sac** (thin spherical greenish sac between middle and right lobes ofliver)
**Stomach** (long, whitish, along left side, dorsal to liver)
**Small intestine** (yellowish or grayish; slender, irregularly coiled)
**Large intestine or rectum** (dark, passes into pelvic girdle)
**Spleen** (small, spherical, dark reddish, posterior to stomach)
**Kidneys** (2, elongate, dark brown, on dorsal wall above peritoneum)
**Fat bodies** (2, soft, finger-like lobes, yellowish, attached anterior to kidneys)
**Ovaries** (2, in female; either small and granular or distended with small black andwhite eggs)
**Oviducts** (2, in female; long, wavy, whitish, along either side of middorsal line) -
**Testes** (2, in male; bean-shaped, pink or yellow, at antero-ventral ends of kidneys).