The microscope

The microscope is an essential tool in the study of life science. The purpose of using a microscope is to magnify a small object or 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

A light microscope involves the use of optical lenses and light radiation.

The parts of an 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 through 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 has 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 total magnification).

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, which move 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.

7. Light source (illuminator): It sends light upward through the condenser lens and through the hole in the stage onto the specimen on the slide. Older microscopes used mirror to reflect light upwards.

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

9. 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.

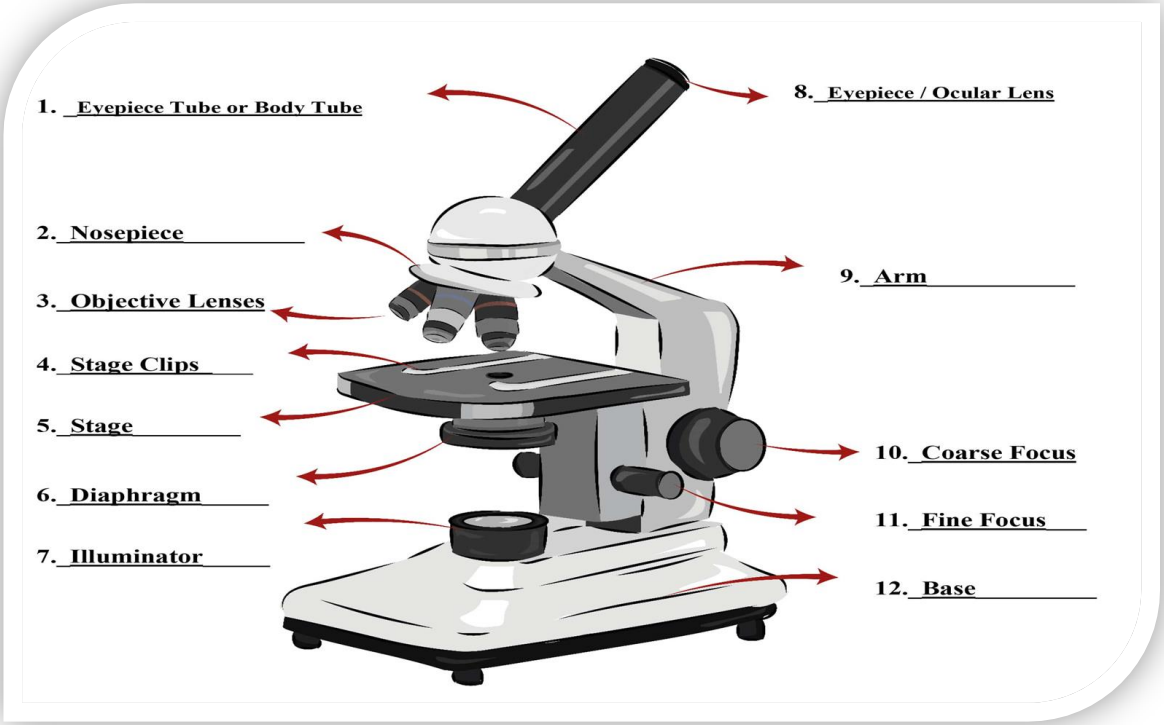
Advantages and Disadvantages of Optical Microscope

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 .



Fig(1) :The optical compound microscope parts

2. Electron microscopes

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

Fig (2) TEM

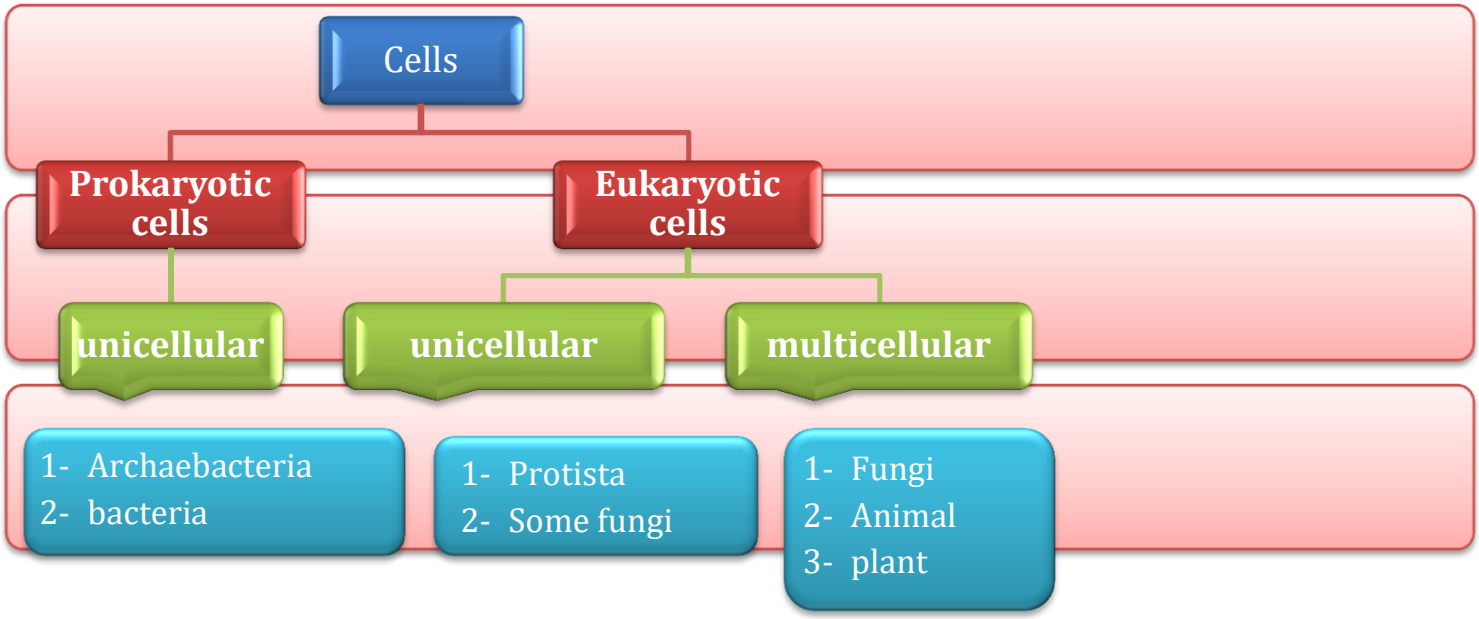
Fig (3) SEM

The Cell

What is a Cell?

- The cell is the smallest, basic unit of life that is responsible for all of life's processes. A cell can replicate itself independently. Hence, they are known as the building blocks of life.
- They provide structure to the body and convert the nutrients taken from the food into energy.
- Every living thing has cells: bacteria, protozoans, fungi, plants, and animals.
- There are many different types, sizes, and shapes of cells in the body.
- Robert Hooke was the first Biologist who discovered cells (1665).

Types of Cells



CELL STRUCTURE AND FUNCTION OF THE ORGANELLES

1. Cell membrane

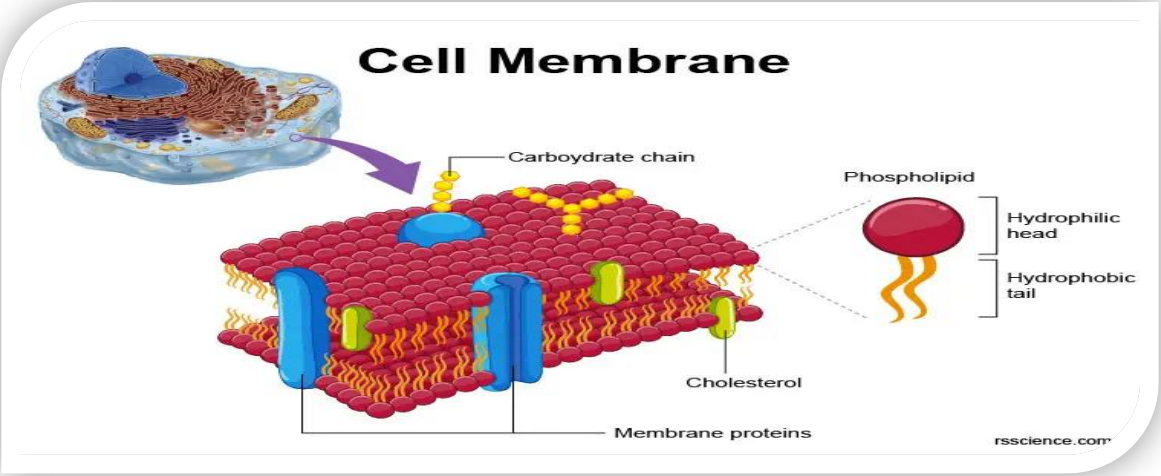
The cell membrane **(plasma membrane)** is the outer coating of the cell. Cell membrane serve to contain and protect cell components from the surroundings as well as regulate the transport of material into and out of the cell. The cell membrane is present in **all** cells.

The cell membrane consists of:

- **Phospholipid bilayer** (layer of hydrophobic tails of phospholipids sandwiched between two layers of hydrophilic heads of lipids).
- **Proteins** "float" randomly in this bilayer, and some membrane protein functions: ⟶ Receptors, carriers, channels, and enzymes.
- **Cholesterol** ⟶ Helps to hold and elasticity of the cell membrane together.
- **Carbohydrates** covalently linked to proteins (glycoproteins) or lipids (glycolipids). function ⟶ sites of cell recognition and adhesion, either cell-cell recognition or cell-pathogen interactions.

Cell membrane = **"fluid mosaic".**

The cell membrane is **selectively permeable** some things enter freely, and some things cannot cross or cross only with "help".



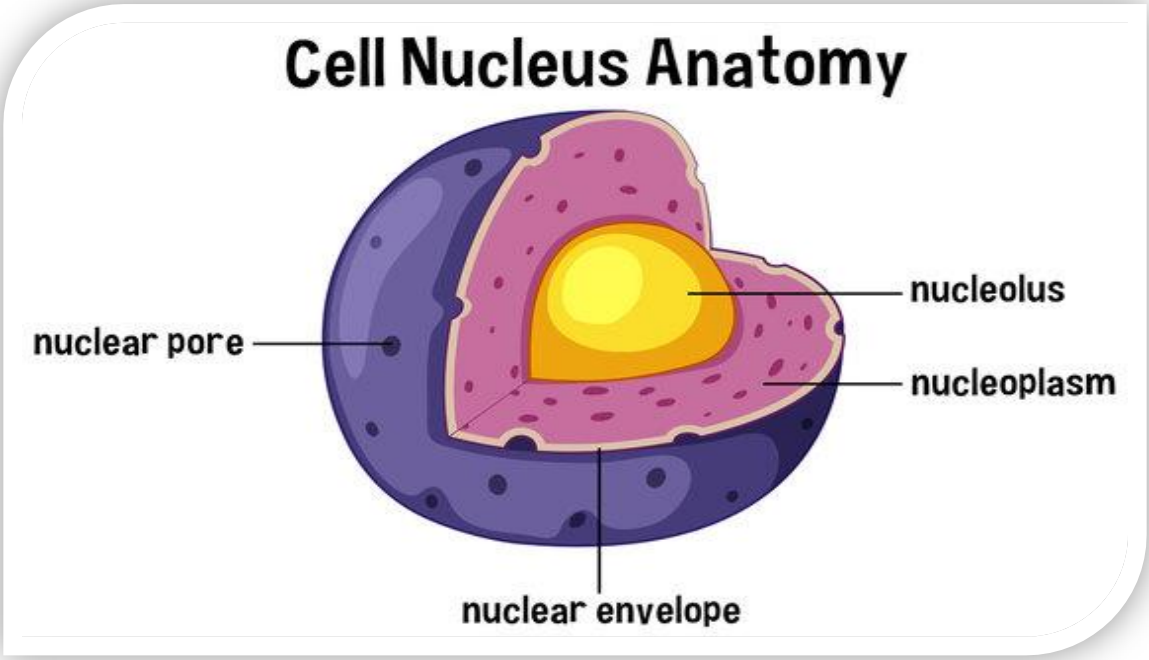
2. Nucleus

The nucleus is an organelle found in most eukaryotic cells, the exception being red blood cells. The nucleus is the control center of the cell because it is responsible for maintaining the integrity of DNA and facilitating its transcription and replication.
The nucleus is surrounded by the nuclear membrane which separates it from the rest of the cell's components. The nuclear membrane has nuclear pores to control the entry and exit of materials (e.g. proteins and RNA).

The functions of the nucleus are:

- Control of the genetic information of the cell.
- Storage of DNA, RNA, and ribosome.
- Control of the protein and enzyme synthesis.
- Control of metabolism, cell division, and cell growth.

The **nucleolus** is a dense region of ribonucleic acid (RNA) in the nucleus and is the site of ribosome formation.

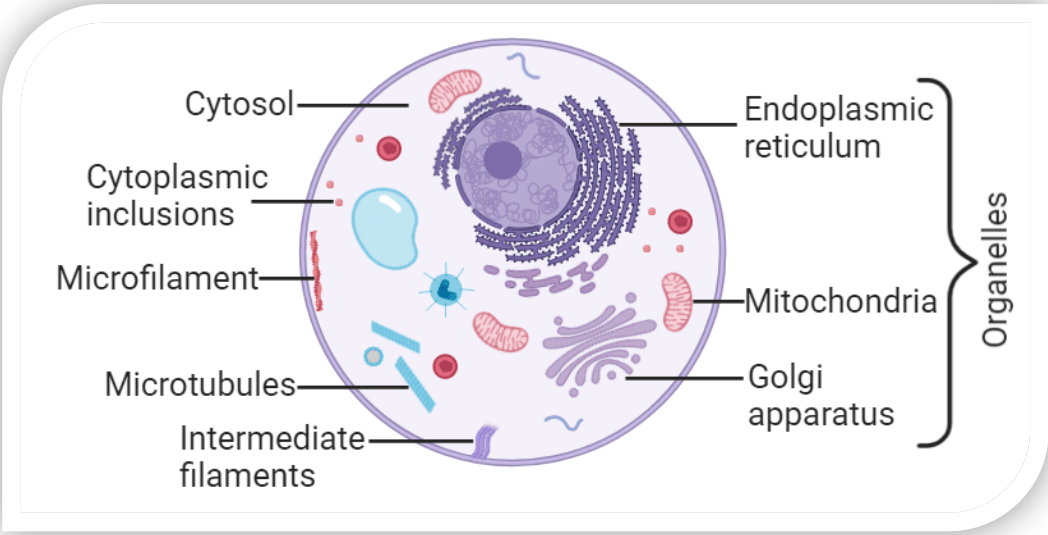


3. Cytoplasm

Cytoplasm is part of the cell located outside the nucleus full of the space between the nuclear envelope and plasma membrane, the cytoplasm is about 80% water and is usually colorless.

The main components of the cytoplasm include:

- **Cytosol –** This is the aqueous portion of the cytoplasm and is composed mostly of water, dissolved minerals, dissolved ions, and proteins. Most of the chemical reactions within a cell take place in the cytosol.
- **Cytoskeleton–** is a complex network of (1) microtubules, (2) actin filaments (3) intermediate filaments. These protein structures determine the shape of cells, the motility of organelles, and also allow the movement of entire cells.
- **Cytoplasmic inclusions –** are the minor cytoplasmic structures that are not usually surrounded by a plasma membrane such as crystals, pigment granules, lipids, glycogen, and other stored waste products.
- **Organelles –** membrane-bound structures inside the cell that have specific functions. Some major organelles that are suspended in the cytosol are the mitochondria, endoplasmic reticulum, Golgi apparatus, vacuoles, and lysosomes.



Kingdom: Animalia

Multicellular animals are called **Metazoa** which have been divided into two branches: **Parazoa** and **Eumetazoa**.

- **In Parazoa**, the body of animal is made up of loose cells, have poorly differentiated tissues and have no organ or digestive cavity. E.g. sponges.
- **In Eumetazoa** the cells are properly arranged into tissues and organs. It is further classified on the basis of (a) the number of germ layers present in the embryo; (b) the symmetry of the body of the organism; and (c) mode of origin of mouth.

The major animals Phyla:

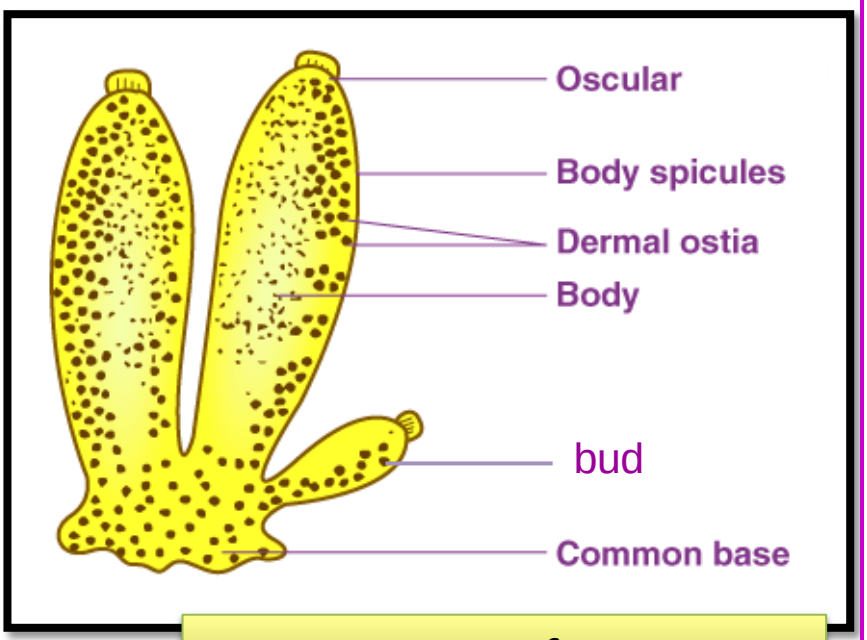
Phylum: Porifera (Sponges).
Phylum: Cnidaria (Jellyfish and Corals).
Phylum: Platyhelminthes (flatworms).
Phylum: Nematode (Roundworms).
Phylum: Mollusca (Molluscs).
Phylum: Annelida (Segmented worms).
Phylum: Arthropod (Arthropods).
Phylum: Echinodermata (Echinoderms).
Phylum: Chordate (Chordates).

Phylum: Porifera

Characteristics of Phylum Porifera:

1. Body with pores (Ostia), canals, and chambers that serve for the passage of water.
2. It has radial symmetry or none.
3. All members are aquatic.
4. They covered by spicules.
5. No true tissues; digestion intracellular; excretion by diffusion.
6. Reproduction asexual by buds or sexual by gametes.
   The example is Sycon.

Kingdom:	Animalia
Phylum:	Porifera
Class:	Calcarea
Genus:	Sycon



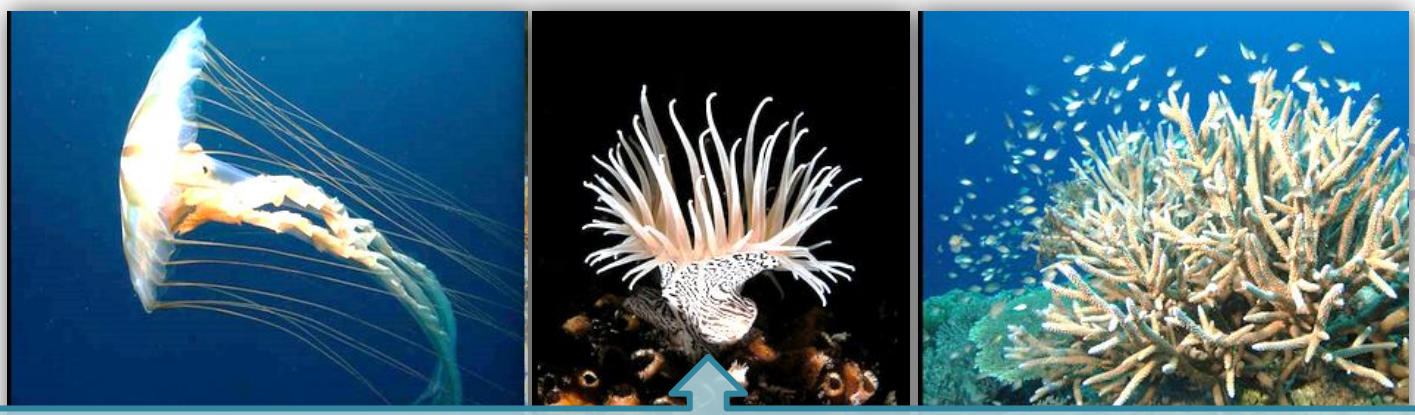
Structure of Sycon

Phylum: Coelenterata or Cnidaria

Characteristics of Phylum Cnidaria:

1. Body with two layers, epidermis and gastrodermis. And has single opening surrounding by tentacles, and act as both mouth and anus.
2. It has radial symmetry .
3. All members are aquatic.
4. It has nerve net with some sensory organs.
5. Reproduction asexual by buds or sexual by gametes.

The example is Jellyfish



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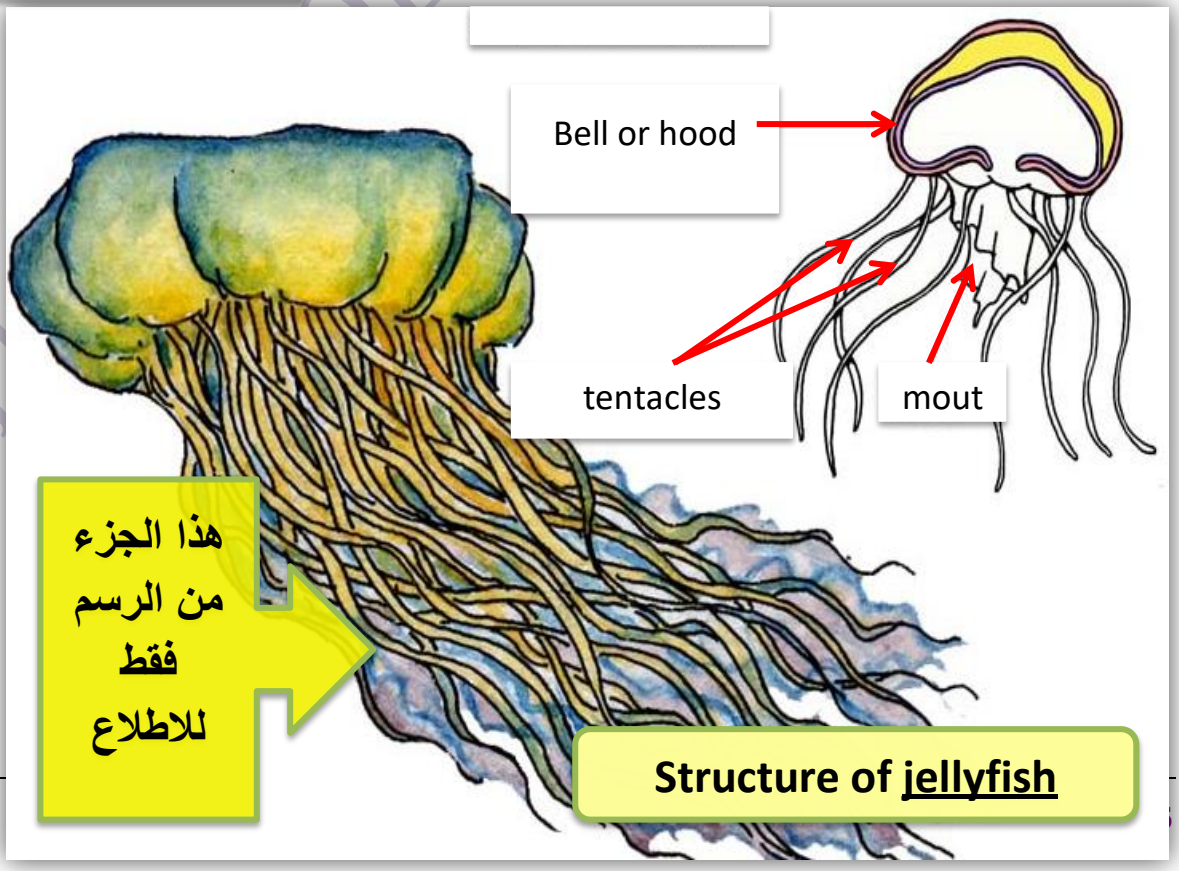
Kingdom:	Animalia
Phylum:	Cnidaria
Class:	Scyphozoa
Genus:	Jellyfish

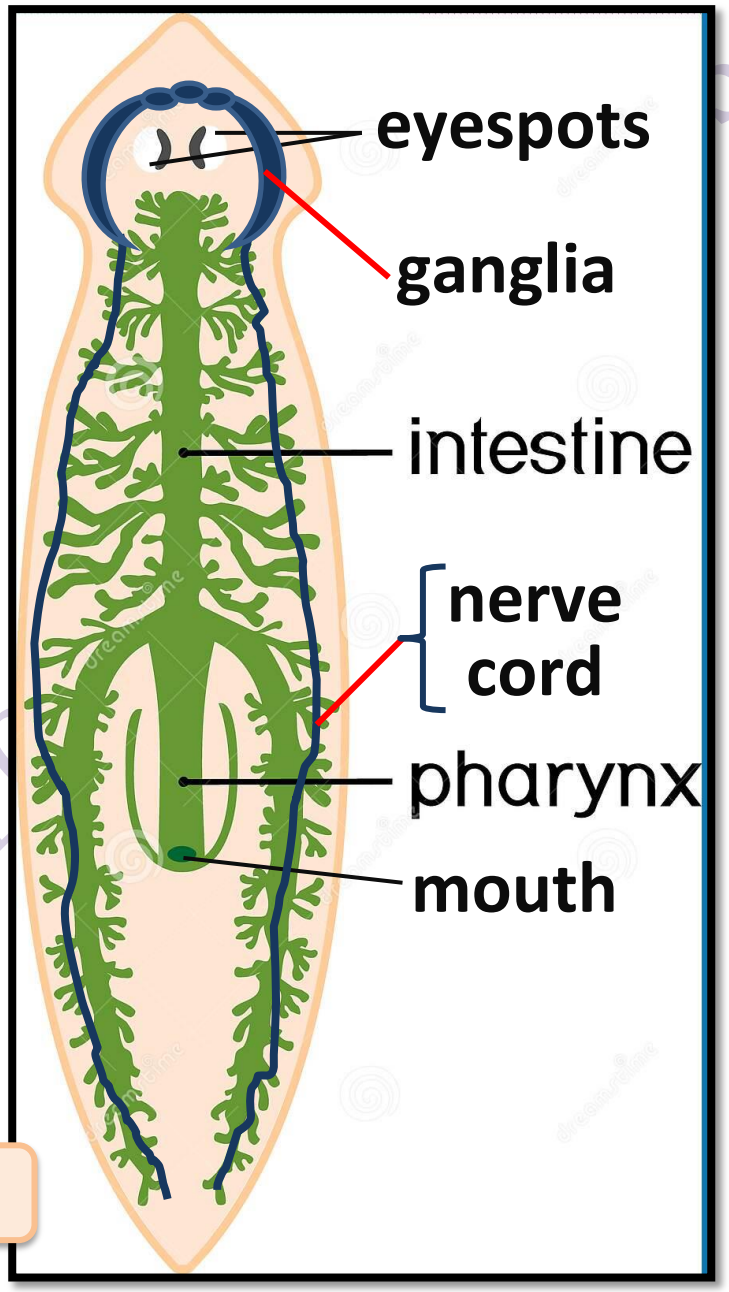


Phylum: Platyhelminthes

Characteristics of Phylum Platyhelminthes

1. It has flattened body ,and bilateral symmetry. The mouth on the ventral surface.
2. It is an acoelomate (without body cavity).
3. It is free-living or parasitic.
4. It has digestive system incomplete or absent.
5. It has excretory system of two lateral branches canals with flame cells.
6. It has nervous system consisting of a pair of ganglia with nerve cords. and sensory organs like eyespots.
7. Reproduction is sexual by gametes.
   The example is Planaria

Kingdom:	Animalia
Phylum:	Platyhelminthes
Class:	Turbellaria
Genus:	Planaria



Structure of Planaria

Cell Division

The cell division mean

is produce two daughter cells which are genetically identical , each daughter cell receives a complete copy of the entire genome.

Why the cells division occur ?

- **In unicellular organisms**, such as (bacteria, amoeba , paramecium), each one cell division produces a complete new organism .
- **In multicellular organism,** division are required - to make a new multicellular organism from a fertilized egg. - or for replace dead cells or for repair a damaged tissue.

There are two types of cell division mitosis & meiosis .

Mitosis (M phase of cell cycle)

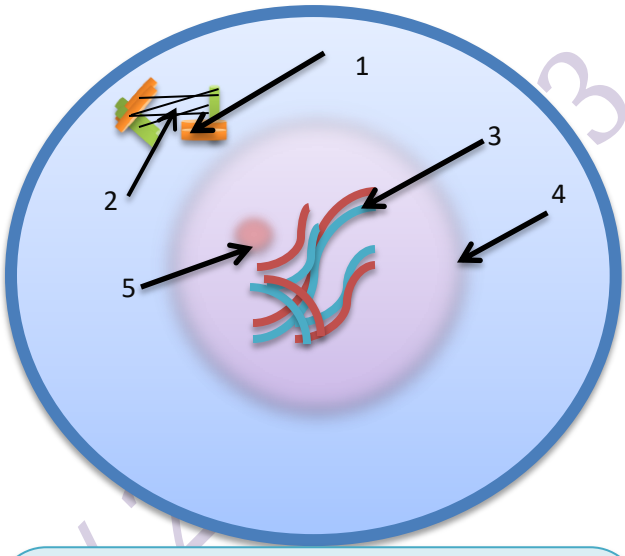
The division occurs in the M phase of the cell cycle. **M phase** (nuclear division) and **Cytokinesis** (cytoplasmic division).

Before M phase begins, two events must be completed:

1- DNA must be fully replicated.
2- Organelles replicated , and in animal cells the centrosome in an interphase cell duplicates begins at the start of S phase and is complete by the end of G2.

The stages of mitosis include:-

1- Prophase First stage of mitosis during which the chromosomes are condensed.



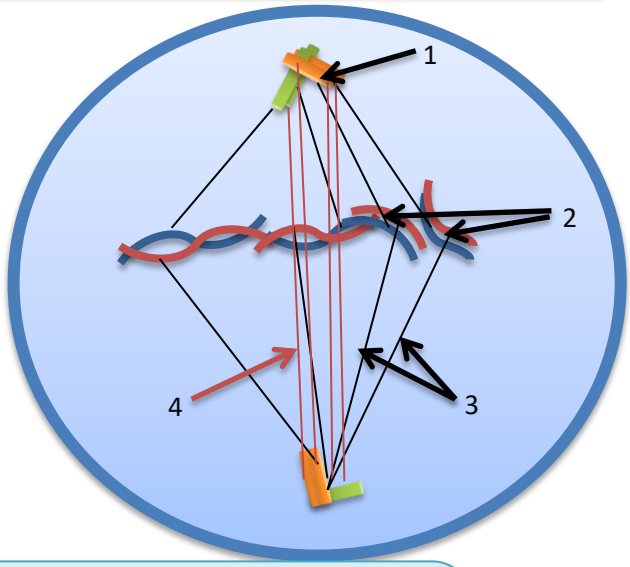
Prophase
1= centrosome : 2=mitotic spindle
3= replicated chromosomes
4= nuclear envelope breaks up
5= nucleolus

The steps of prophase are :

- the replicated chromosomes start to condense, shorten, thicken, and become visible.
- Each replicated chromosome consists of two associated sister chromatids.
- The mitotic spindle starts to form and assemble between the two centrosomes, which have started to move apart.
- The nuclear envelope breaks up.

2- Metaphase

Is stage of mitosis. At metaphase, the chromosomes (sister chromatids) are aligned at the equator of the Spindle or (metaphase plate) or (midway between the spindle poles). The paired kinetochore microtubules on each chromosome attach to opposite poles of the spindle.



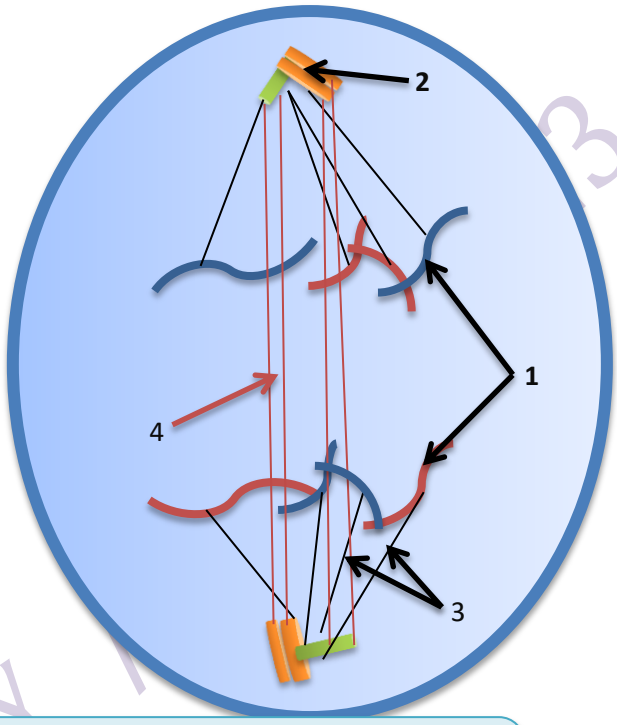
Metaphase
1= centrosome : 2= sister chromatids
3= kinetochore microtubules
4= mitotic spindle

3- Anaphase

Stage of mitosis during that two sister chromatids separate (segregation) and move away from each other. The anaphase composed of:

anaphase A (the daughter chromosome move toward the two spindle poles) and

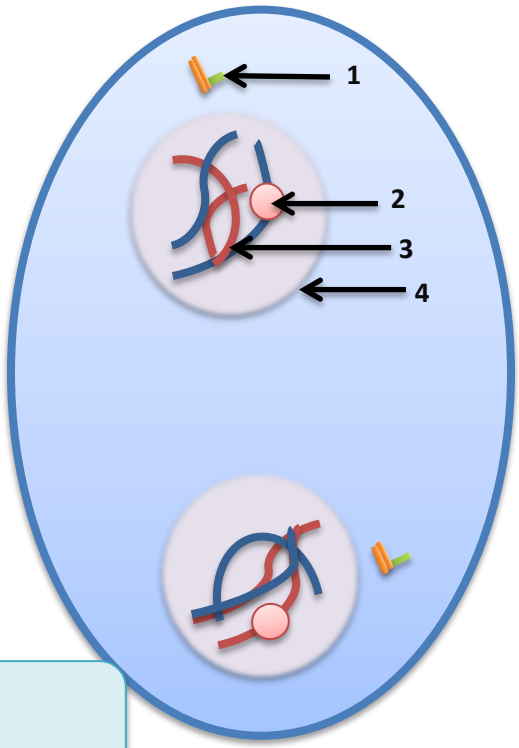
anaphase B (spindle poles move apart).



Anaphase
1= centrosome : 2= daughter chromosome
3= kinetochore microtubules : 4= mitotic spindle

4- Telophase

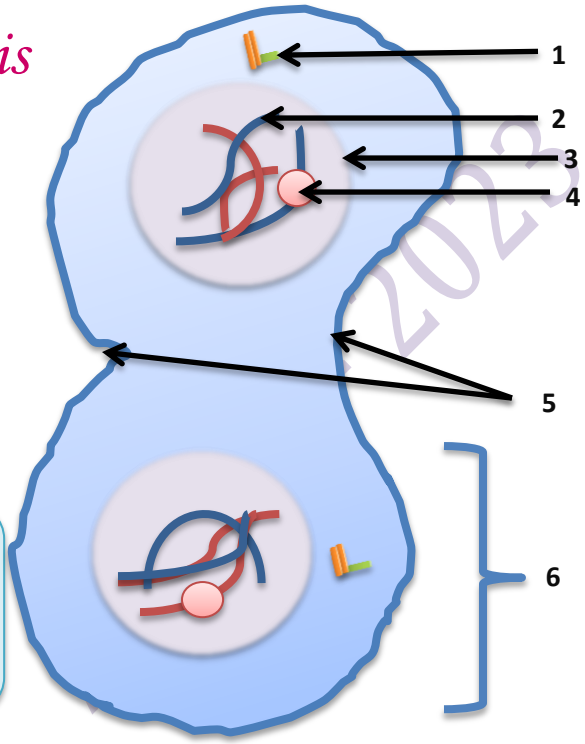
Final stage of mitosis, occur when the two daughter chromosomes arrive at the opposite poles of the spindle. A new nuclear envelope reassembles around each group, and the formation of two daughter nuclei and the end of the mitosis.



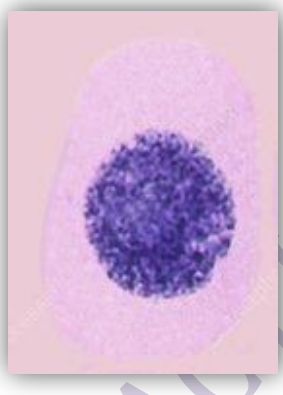
Telophase
1= centrosome : 2= nucleolus
3= new chromosomes : 4= nuclear envelope

Cytokinesis

Cytokinesis, the process by which the cytoplasm is cleaved in two parts by the cleavage furrow . It usually begins in anaphase but is not completed until the two daughter nuclei have formed in telophase.



Cytokinesis
1= centrosome : 2= new chromosomes
3= nuclear envelope 4= nucleolus
5= cleavage furrow : 6= new cell or daughter cell



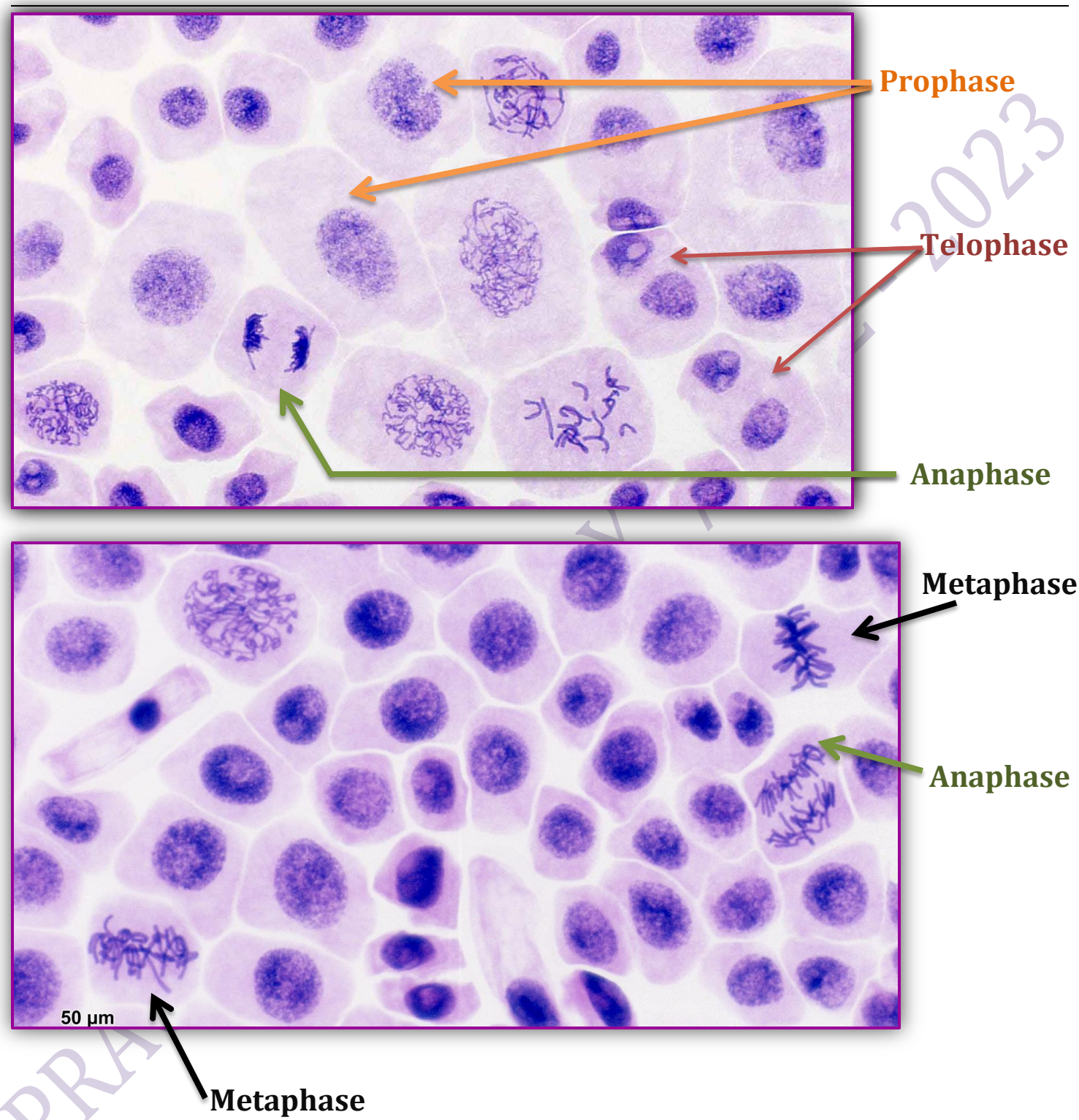
Prophase

Metaphase

Anaphase

Telophase

The stages of mitosis



The stages of mitosis

Kingdom: Animalia

The major animals Phyla:

Phylum: Echinodermata

Characteristics of Phylum Echinodermata or The members of this phylum have:

1- Body like star shape , with radial symmetry.
2- It has coelom (body cavity) .
3- It has a spines covering the dorsal surface.
4- The movement by tube feet.
5- The digestive system is complete, mouth in ventral surface.
6- The nervous system with a ring around the mouth, and radial nerves.
7- It has a few sensory organs.
8- Reproduction is sexual by gametes.

The example of Echinodermata is black sea urchin

Kingdom: Animalia
Phylum: Echinodermata
Class: Echinoidea
Genus: black sea urchin

التصنيف مطلوب

هذه الصورة للاطلاع

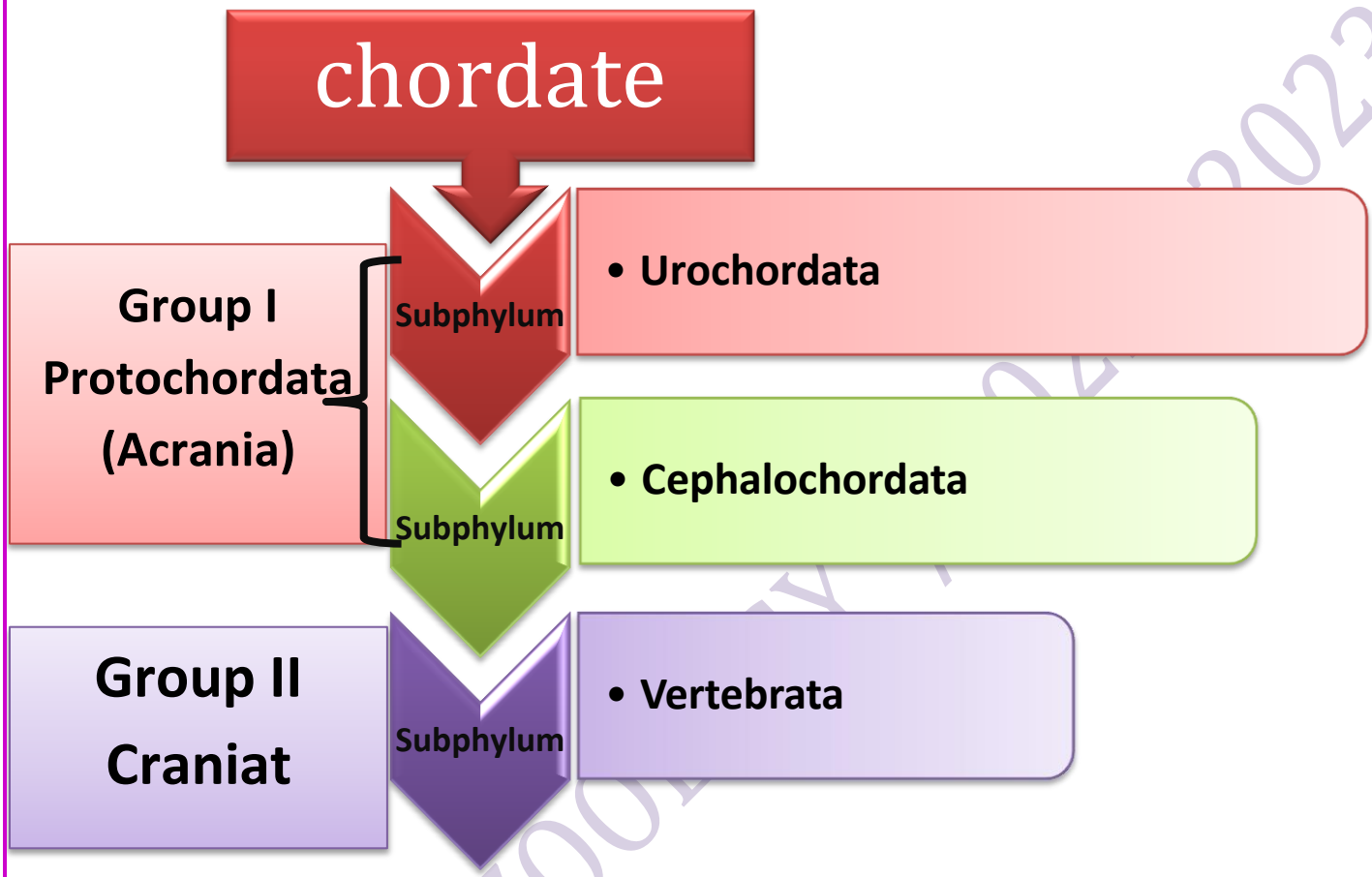
Phylum: Chordate

Characteristics of Phylum Chordate:

1- Bilateral symmetry, with three germ layers; well-developed coelom
2- Notochord (a skeletal rod) present at some stage in the life cycle

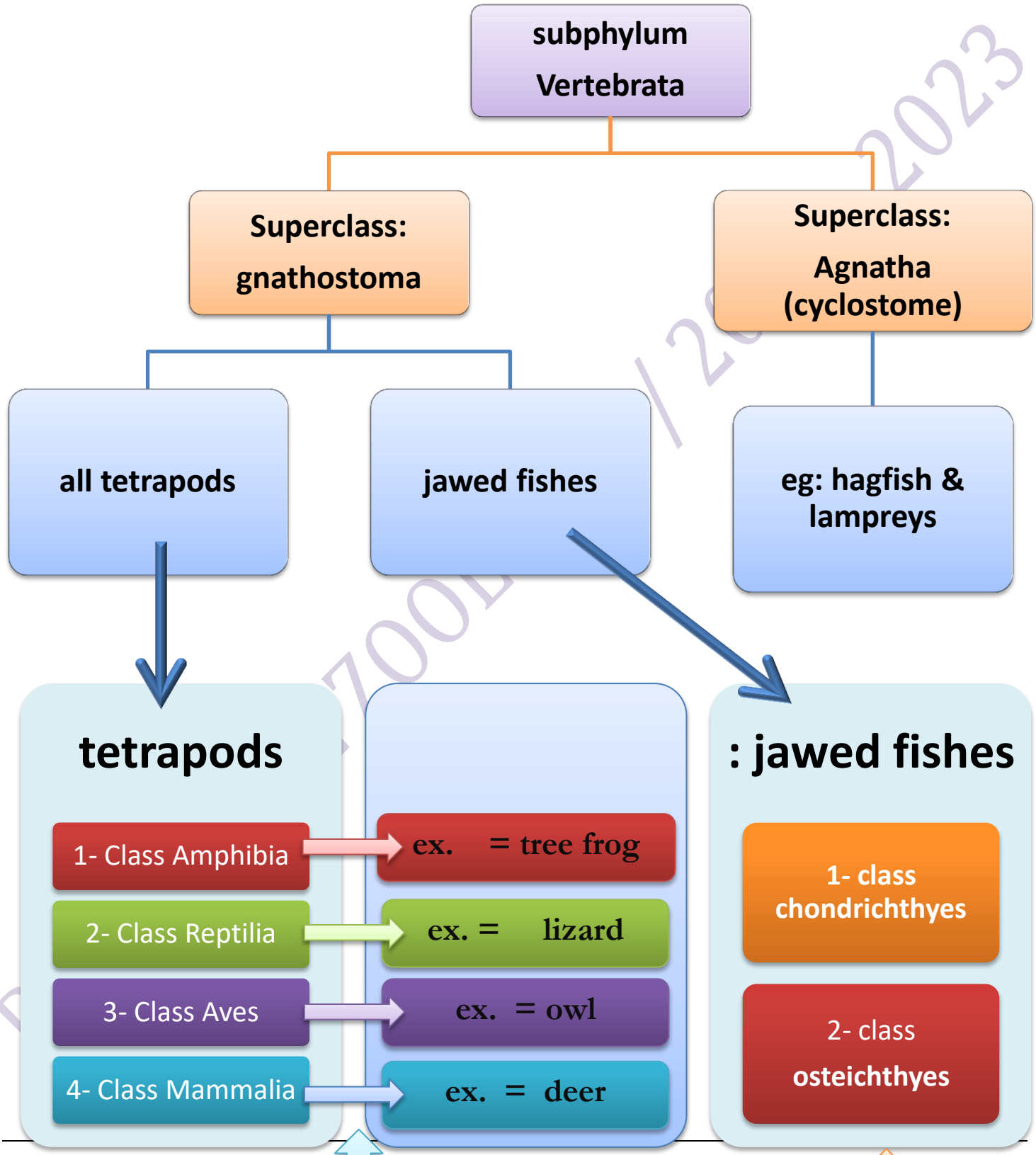
The main distinguishing feature of subphylum vertebrates is :

1- It has column, or backbone, which is core of the endoskeleton.
2- It has a closed circulatory system with a heart.
3- have a system of muscles attached to the endoskeleton to enable movement.
4- have an excretory system that includes a pair of kidneys.
5- have an endocrine system of glands that secrete hormones.
6- it has a central nervous system.

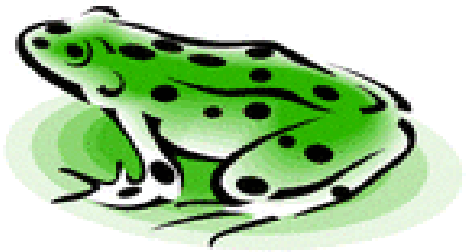


Kingdom:	Animalia
Phylum:	Chordate
subphylum	Vertebrata
Class:	
Genus:	

مطلوب للأمثلة وكافة class
في الصفحة القادمة

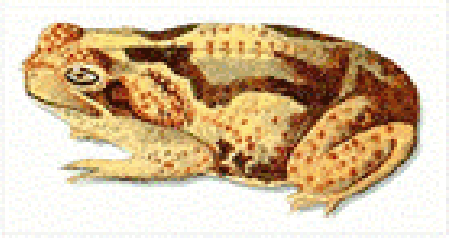

subphylum Vertebrata
Superclass: gnathostoma
Superclass: Agnatha (cyclostome)
all tetrapods
jawed fishes
eg: hagfish & lampreys
tetrapods
: jawed fishes
1- Class Amphibia
ex. = tree frog
2- Class Reptilia
ex. = lizard
3- Class Aves
ex. = owl
4- Class Mammalia
ex. = deer
1- class chondrichthyes
2- class osteichthyes
مطلوب class مع الامثلة
مطلوب class فقط

Amphibians



frog

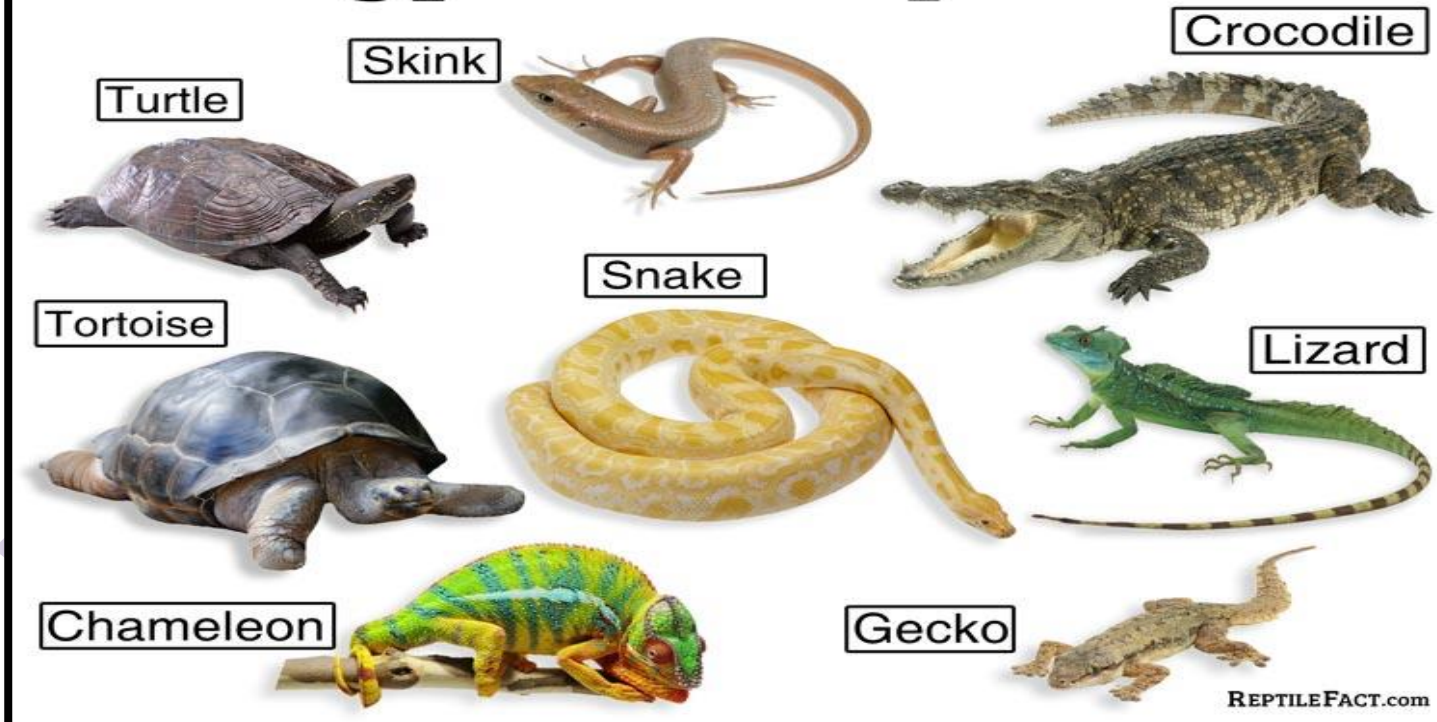
salamander



toad

newt

Types of Reptiles




Class Chondrichthyes

Kingdom: Animalia

The major animals Phyla:

Phylum: Nematode

Characteristics of Phylum Nematode:

1. Their body is a cylinder shape, and bilateral symmetry .
2. It has pseudocoelom.
3. It is free-living or parasitic.
4. Digestive system is tube.
5. Excretory system of canals or protonephridia .
6. They contains dorsal or ventral nerve cords. and They have chemosensory organs on the lips.
7. Reproduction is sexual by gametes.

Phylum: Mollusca

Characteristics of Phylum Mollusca:

1- Body consist of head, muscular foot, and visceral mass.
2- It has bilateral symmetry .
3- It has a limited coelom just around the heart.
4- It has complex digestive system; and anus opining into the mantle cavity.
5- It has one or two kidneys (metanephridia).
6- It has open circulatory system with a heart.

7- Nervous system is ring of ganglia, with nerve cords. and has good sensory organs.

8- Reproduction is sexual by gametes.

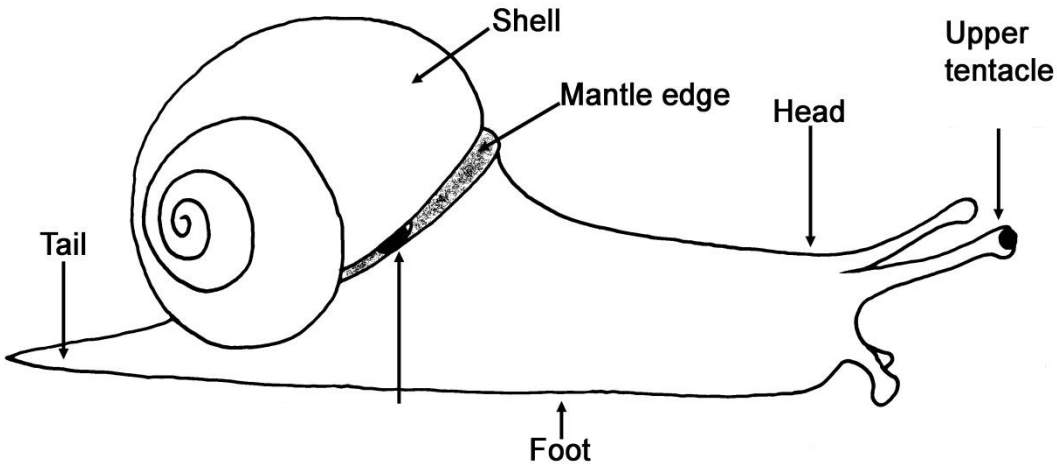
The example is freshwater senile

Kingdom: Animalia

Phylum: Mollusca

Class: Gastropoda

Genus: freshwater senile



Structure of freshwater senile

Phylum: Annelida

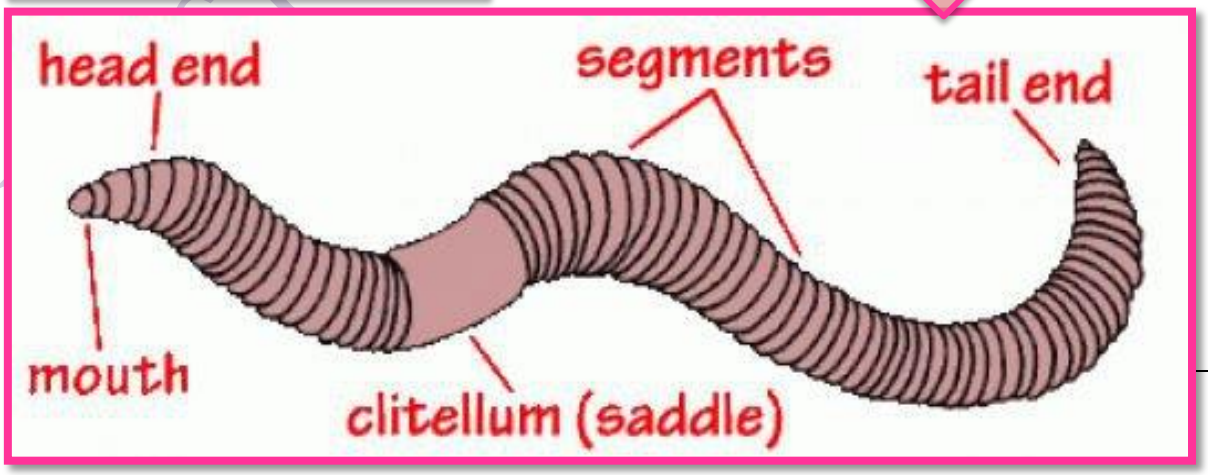
Characteristics of Phylum Annelida:

1- Body consist of rings (consisting of several similar segments)
2- It has bilaterally symmetrical.
3- It has coelom divided by septa.
4- Digestive system complete and not spilt.
5- Excretory system consists of a pair of nephridia in each ring.
6- It has closed circulatory system.
7- Nervous system with a double ventral nerve cord and a pair of ganglia. and it has good sensory organs.
8- Reproduction is sexual by gametes. and sometimes asexual reproduction by budding.

The example of Annelida is earthworm

Kingdom:	Animalia
Phylum:	Annelida
Class:	Clitellata
Genus:	earthworm

Structure of earthworm



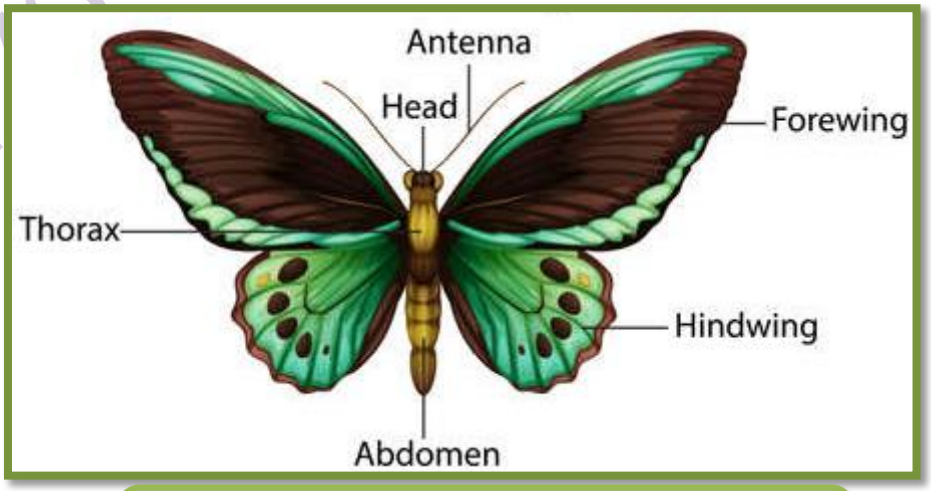
Phylum: Arthropoda

Characteristics of Phylum Arthropoda:

1- The body is segmented. With bilateral symmetry .
2- It has Reduced coelom in adults.
3- It has exoskeleton of cuticle .
4- It has complete digestive system.
5- It has paired of excretory glands called coxal.
6- It has open circulatory system, with dorsal heart.
7- It has nervous system with dorsal brain and a double ventral ganglia.
8- Reproduction is sexual by gametes

The example of Arthropoda is butterfly

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Genus:	butterfly



Structure of butterfly