الجامعة المستنصرية

كلية العلوم

قسم علوم الحياة

المرحلة الثانية

الأفقريات النظري

إعداد

الدكتورة نبراس فالح

يطلب من

مكتبة حسنين

السعر:

3000

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Lec. 1 Invertebrates

Animals species that do not develop avertebral column. Includes many familiar like insects- worms- clams - carbs - octopus and other.

* The largest phylum Or super - sub phylum is also included within invertebrates:-

① Protozoa.
② Porifera.
③ Cnidaria (Coelentrata).
④ Aschelminthes.
⑤ Mollusca.
⑥ Annelida.
⑦ Echinodermata.
⑧ Arthropoda.
⑨ Chordata.

* Can classified animals kingdom according to cellular constriction to:-

① Protozoa: one cell animals.
② Parazoa: Multicellular animals which loosely aggregated cells.

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③ Metazoa: multicellular animals in which cells are arranged in germ layers.

- Metazoa are classified according to their germ layers into:-

① Diploblastea: with two germ layers, Ectoderm & Endoderm.

② Triploblastea: animals with three germ layers. Ectoderm, Mesoderm, Endoderm.

* Animals also devided according to their symmetry. The concept symmetry allow for division of a whole body into two or more equal portions by separation along lines or planes.

① Asymmetrical animals: There are no planes of regular symmetry. (sponges)

② Spherical sym. : The body is devided into symmetrical halves in all direction and planes (Volvox)

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③ Radial sym.: lines of symmetry exist, but in the vertical planes only. (Cnidaria).

② Bilateral sym.: Found in freely mobile animals with consequent development of dorsal and ventral surfaces and anterior and posterior ends. Only one plane of symmetry devides the animals into symmetrical halves. (Annelida).

* Coelom: The space between the body wall and the alimentary canal.

Triploblast animals may be classified according to their coelom into:-

① Acoelomate: The body volume is fulled with Mesenchyme and other tissues.

② Pseudocoelomate: There is space between body wall and alimentary canal.

③ Eucoelomate: The space between body wall and alimentary canal fulled with Mesoderm & Mesenchymal tissues.

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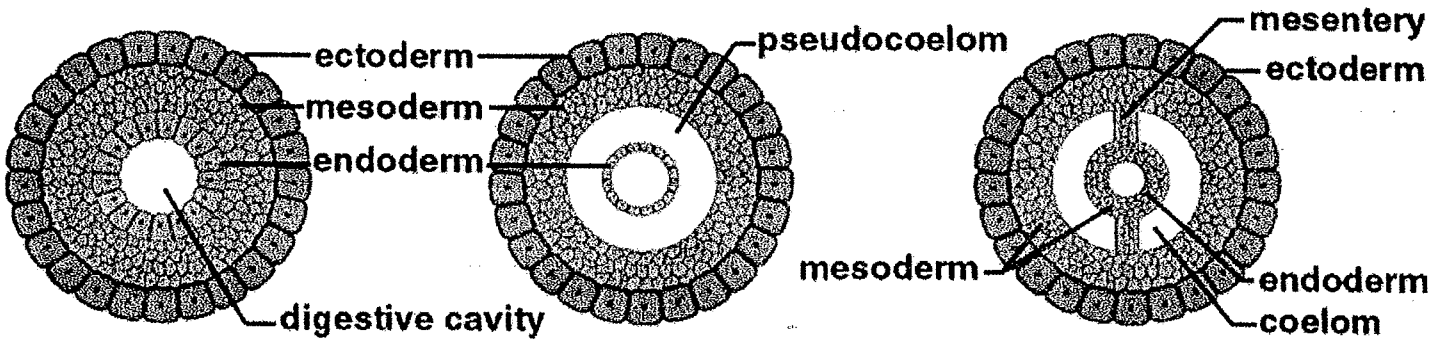
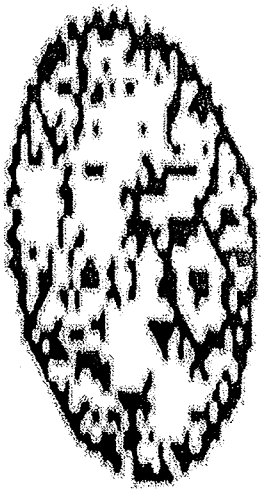
Acoelomate, pseudocoelomate, coelomate comparison



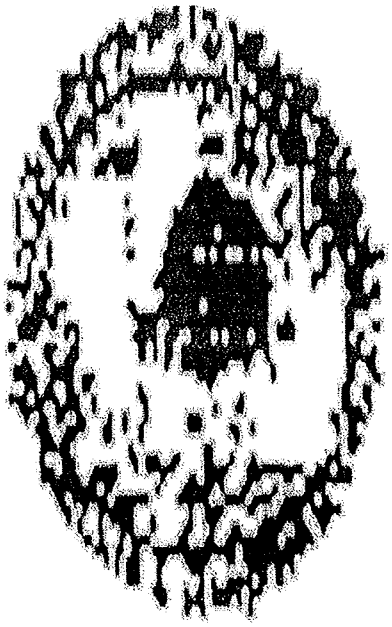
a. **Acoelomate**
flatworms

b. **Pseudocoelomate**
roundworms

c. **Coelomate**
molluscs
annelids
arthropods
echinoderms
chordates



Vesicular Nucleus



Solid Nucleus

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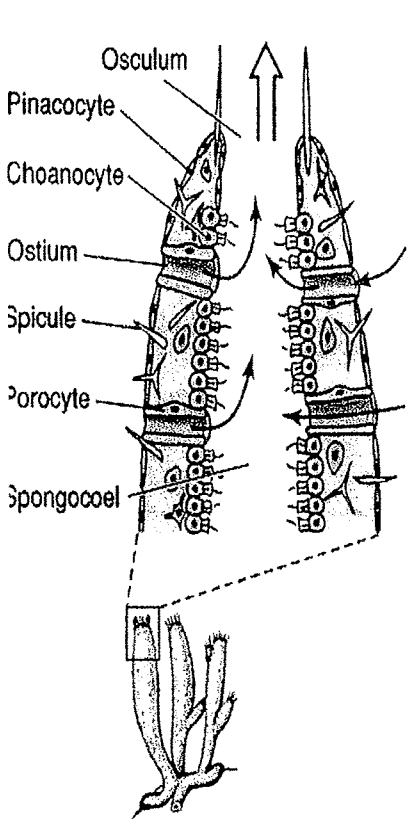
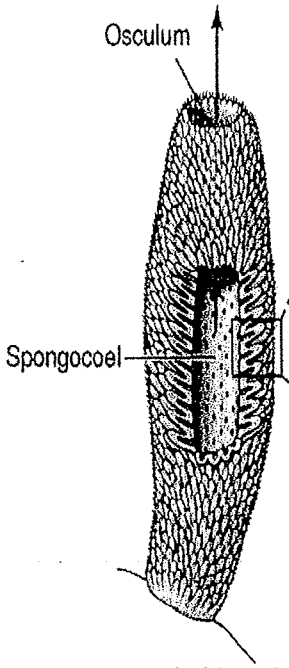
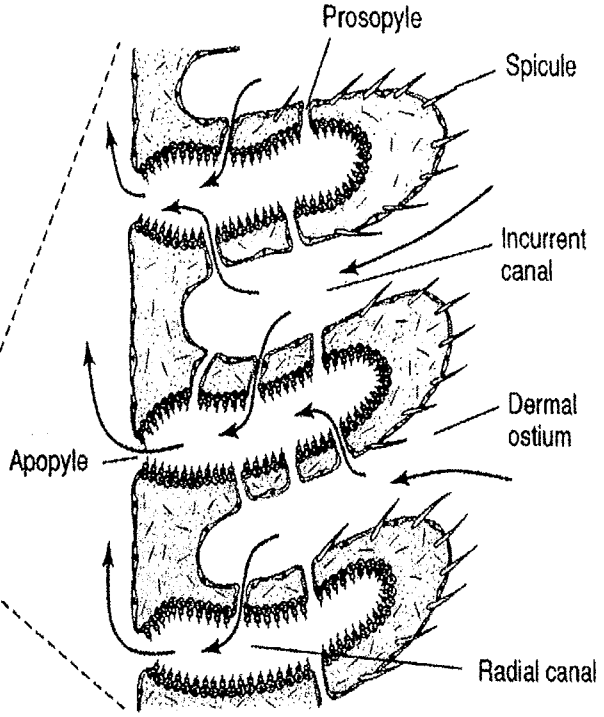
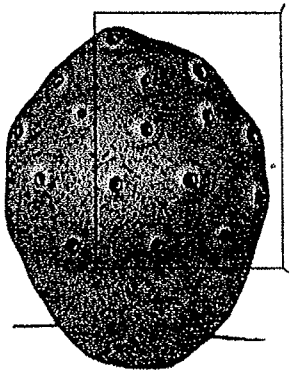


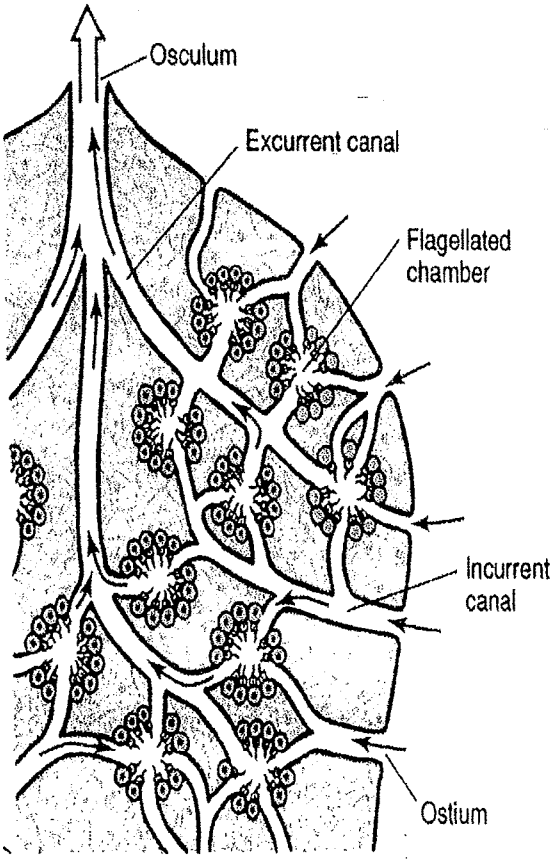
Asconoid (*Leucosolenia*)



Syconoid (*Sycon*)



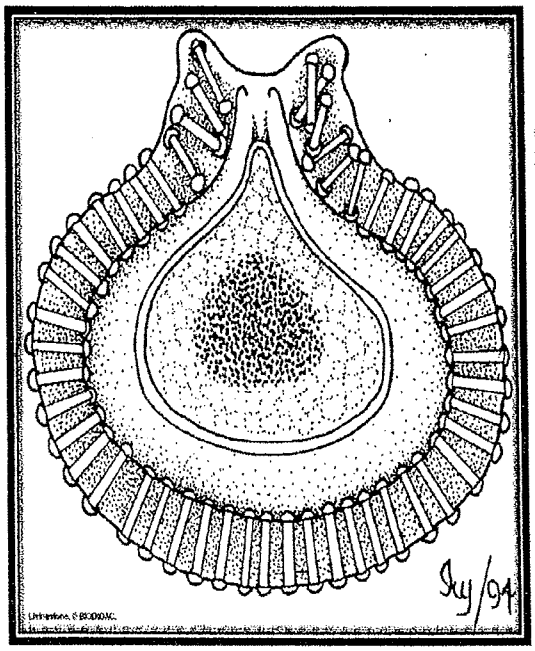


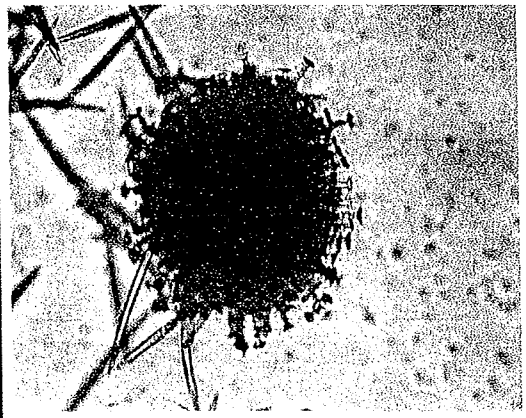


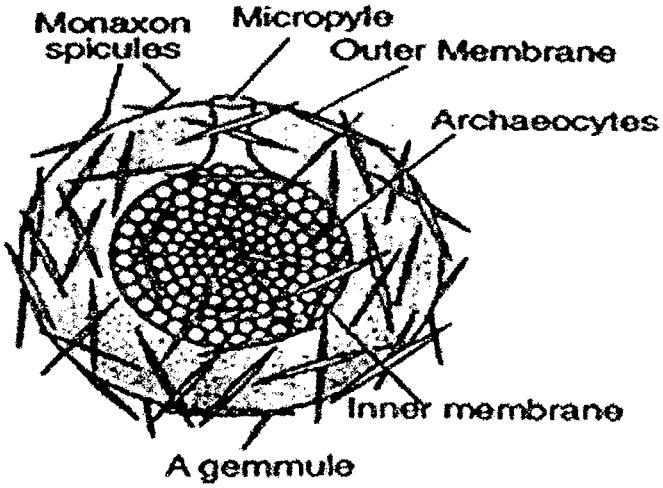
Leuconoid (*Euspongia*)

Reproduction and Development

- **Gemmules**







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Lec-2-

Protozoa

General characters

① Unicellular (or Clonial) and microscopic animals.

② Most are motile by flagella, Cillia Or pseudopodia.

③ Most protozoal species are aerobic, but some anaerobic species have been found in the human intestine and animal rumen.

④ They occur in all habitats including marine, freshwater and terrestrial, including soil.

⑤ The food inter to the cell (body of animal) by mouth of cell or by body wall but the digestive happen in food Vacuole in cytoplasm.

5) Osmoregulation in freshwater protozoans is accomplished by contractile vacuoles that pump ahyposmotic urine from the cytoplasm back into the environment.

6) Most protozoa reproduce by asexual methods (Binary fission, Budding, Multiple fissions Plasmotomy) Or sexual reproduction (syngamy, conjugation).

7) Some species are Parasites of plants and human.

- Classification of protozoa

Phylum: Protozoa.

① Class: Flagellata
- order: Cryptomonadina → Chilomonas
- order: phytomonadina → Volvox
- order: Euglenoidina → Euglena
- order: Diplomonadina → Giardia
- order: Opalinina → Opalina

② Class: Sarcondina
order: Amoebina → Amoeba

③ Class: sporozoa
order: Gregarinida → Gregarina
order: Coccidia → plasmodium

) Class: Ciliata
order: Holotricha → Paramecium

* Nutriation

Heterotrophic, microorganisms, and Most species obtain large food particles by phagocytosis. The food particle is ingested into a food vacuole. lysosomal enzymes then digest the nutrients in the particle, and the products of digestion are distributed throughout the cell. Some species have specialized structures called cytostomes, through which particles pass in phagocytosis.

* Locomotor Organelles

① Flagellia ② cillia ③ pseudopodia.

Cilia	Flagella
① are short hair like appendages extending from the surface of living cell.	① are long, thread like appendages on the surface of aliving cell.
② Rotational, like armotor very fast moving	② wave-like, undulating, sinusoidal, slow movement compared to cilia.

* Nuclei

contain from :-

① Nuclei membrane.
② chromatin
③ plastin
④ Nuclei juce.

- devided into two kind :-

① Compact : contain a large amount of chromatin.
② Vascular : contain a little amount of chromatin, have Endosome (nucleus - like ball shape) devided into :-
   a - plasmosome (empity from chromatin)
   b - Karyosome (contain chromatin).

* Cytoplasm

① Protoplasm part located outside nuclei.
② Homogenous, contain many of vacuoles.
③ Reticullar, not colour.
④ devided into → Ectoplasm (near the cell membrane)
→ Endoplasm (near the nuclei membrane).

- Ectoplasm: is a gel containing the basal bodies of cilia or flagella, micro filaments.
- Endoplasm: Or (sol) more fluid than ectoplasm and contain organelles such as nuclei, mitochondria and vacuoles and vesicles of various types.

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	cilia	Flagella
Division	③ Many (hundreds) per cell.	③ Few (less than 10) per cell.
Nucleus	④ Eukaryotic cells.	④ Eukaryotic and prokaryoti cells.

③ Pseudopodia :- devided into.

① Lobopodia ⟶ Amoeba

② Filopodia ⟶ Euglypha

③ Rhizopodia or (Reticulopodia) ⟶ Elphidium

④ Axopodia ⟶ Actinosphaerium

* Reproduction in Protozoa

Ⓐ Asexual reproduction.

① Binary fission : cell devided into two cells. DNA & the nucleus of amature cell devided first and then the cell devided into two daughter cells of almost the same size. Amoeba

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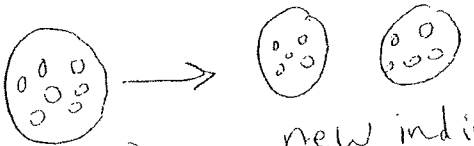
3) Multiple fission (sporulation) :-
one of the cells enlarges and forms the sporangium. The nucleus devided many times and then the daughter nuclei are surrounded with protoplasm bits to form daughter cells called spores, spores are coverd with a thick wall called the cyst. on maturation, the sporangium bursts and releases the spores.

cell one nuclei (parent cell) — devided nuclei — new individual.

4) budding : in which a new individual develops from some generative anatomical point of the parent organism. In some species buds may be produced from almost any point of the body, but in many cases budding is restricted to specialized areas.

5) Plasmotomy : Division of a multinucleate cell into multinucleate daughter cells. cytoplasm devided into two or more masses.



(parent cell) — new individual.

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Sexual reproduction

① syngamy: is the complete and permanent fusion of the two sex cells gametes to form a zygote. which gives rise to adult, and distinguished into following types:-

① Hologamy ② Paedogamy ③ Isogamy ④ Anisogamy

⑤ Microgamy ⑥ Macrogamy.

② Conjugation:- sexual process in which two lower organisms of the same species, such as protozoans exchange nuclear material during a temporary union, completely transfer one organism's contents to the other organism or fuse together to form one organism, The forms may or may not resemable each other in size, shape or mortility, They differ in some physiological or genetic characteristic

* plasmogamy: Fusion of two or more cells or Protoplast without fusion of nuclei. The purpose to Kill the big size prey. like paramecium

it is not method or kind of reproduction

Euglena

① Biflagellated, unicell, spindle shape.

② Most species have photosynthesizing, chloroplast within the body of cell. chloroplasts contain pyrenoid used in the synthesis of paramylon, a form of starch energy storage.

③ Have two flagella rooted in basal bodies located in a small reservoir at the front of the cell. one of Flagellum is very short while the other is long easily visible with light microscopy.

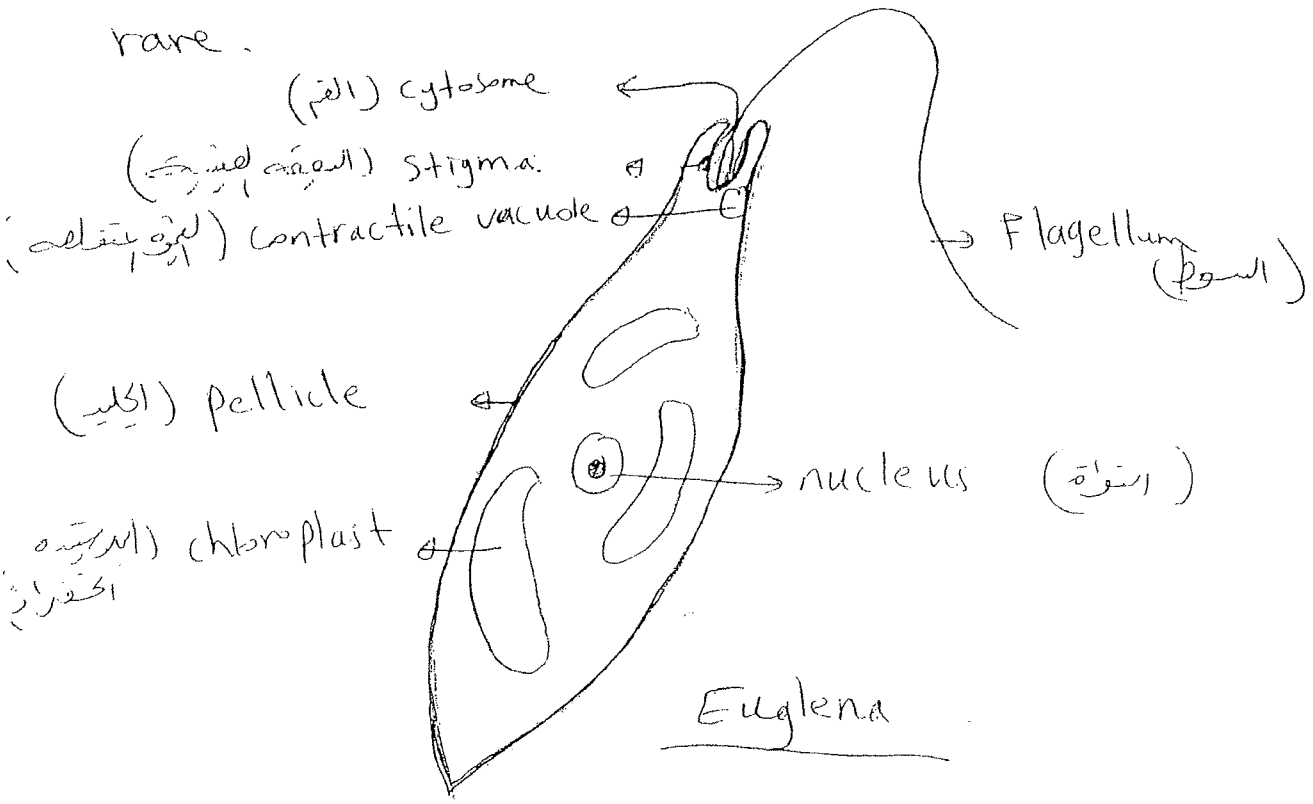
④ possess red eyespot (stigma), an organelle composed of Carotenoid pigment granules. the red spot itself is not throught to be photosynthitic so that ~~the~~ Para flagellar body it filters the sun light located at the base of flagellum.

⑤ Lake a cell wall instead it has pellicle. made of protein layer supported by structure of ~~microtub~~ microtubules arranged in strips spiraling around the cell, pellicle give exceptional flexibility and contractility. There is no cellulose.

6) Euglenoids are found in many freshwater habitats, and are most abundant in those.

7) small and inconspicuous contractile vacuole is located to one side of the reservoir, into which it discharges, it function is osmoregulatory.

8) reproduce asexually through binary fission a form of cell division. deuide ~~longitudinally~~ longitudinally beginning at the front end of the cell with the duplication of flagellar processes, and stigma. a cleavage forms in the anterior and V-shaped moves toward the posterior, until the two halves are entirely, separated. sexual conjugation are rare.



Euglena

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Amoeba

① they so tiny so need microscope to see them.

② Living in water, including lakes, ponds, streams, rivers and puddles. Some can live in the bodies of animals.

③ move by Pseudopoda and help amoeba to eat.

④ Reproduce by Binary fission. it means that one amoeba can split in half and make two identical new amoebas.

⑤ Cytoplasm devided into two parts.
Ⓐ endoplasm Ⓑ ectoplasm, both enclosed within a flexible plasma membrane.

⑥ Cell contain single granular nucleus containing DNA.

⑦ Contractile vacuole is used to maintain osmotic equilibrium by excreting excess water from the cell.

⑧ An Amoeba obtains its food by phagocytosis, and particles of organic matter, Or by Pinocytosis taking in dissolved nutrients through vesicles formed within the cell membrane.

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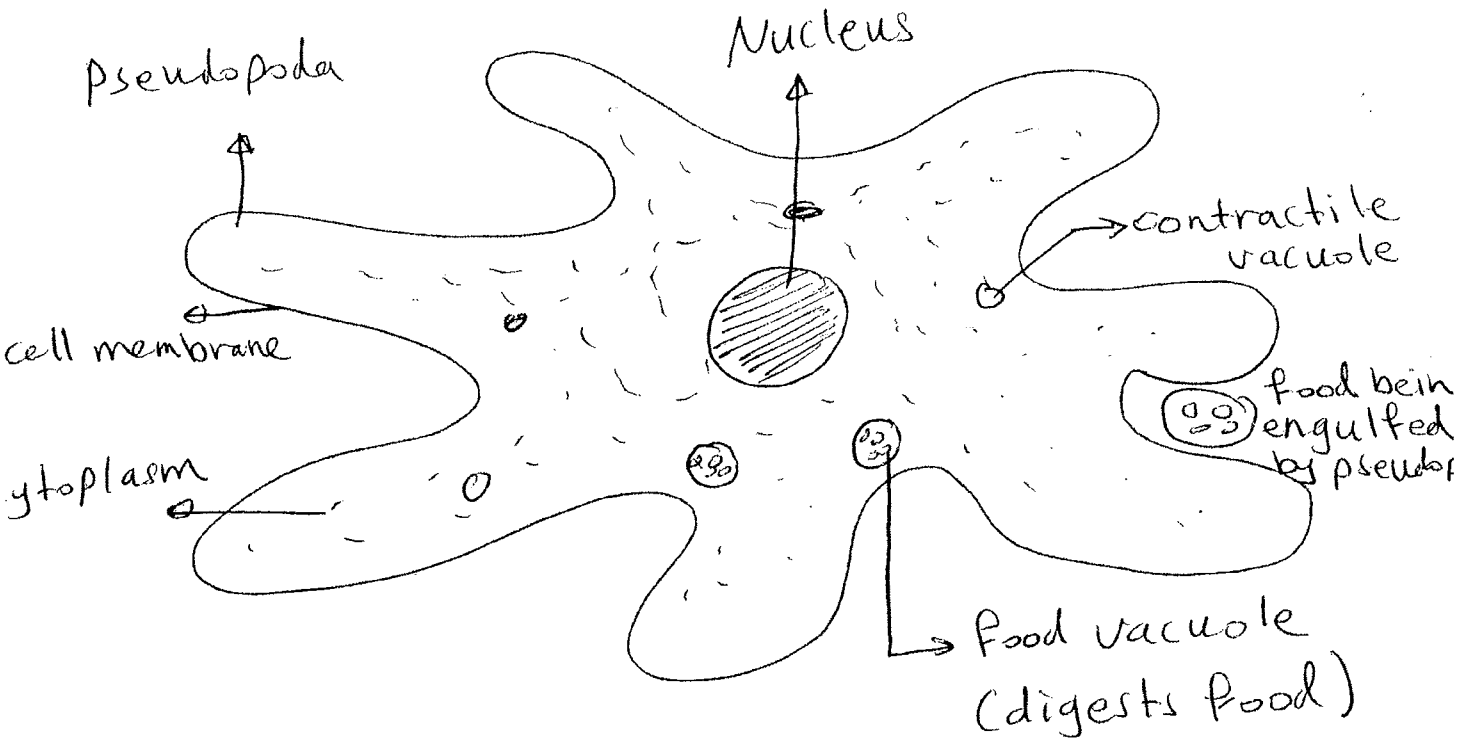

Amoeba

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طائفة الإسفنج:

phylum: Porifera (sponges) (2)

sponges are animals of the phylum Porifera (meaning: Pore bearer). sponges are a diverse group of sometimes common types with about 5000 species known across the world. Sponges are primarily marine, but around 150 species live in fresh water.

General characters

1. include a system of pores (also called ostia) and canals, through which water passes.
2. Sponges are either radially symmetrical or asymmetrical
3. They are supported by a skeleton made up of the protein collagen and spicules, which may be calcareous or siliceous, depending on the group of sponges examined.

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They are multicellular organisms and have unspecialized cells that can transform into other types and which often migrate between the main cell layers and mysophyl in the process.

Sponges do not have nervous, digestive or circulatory systems, instead most rely on maintaining a constant water flow through their bodies to obtain food and O_2 and remove wastes.

1) All sponges are sessile aquatic animals.

2) Many species feed on bacteria and other food particles in the water, some host photosynthesizing micro-organism A few species of sponge that live in food-poor enviroment. have become carnivores that prey mainly on small crustacea

3) Most species reproduction by sexual reproduction and other by asexual reproduction.

Classification:-

phylum: Porifera

- class: Calcarea
  - order: Homocoela — Leucosolenia
  - order: Heterocoela — Sycon
- class: Hexactinellida (Glass sponges)
- class: Demosponges
- class: Homoscleromorpha.

Cell types

1) Pinacocytes: flattened cells, They line the exterior of the sponge body wall. They are thin leathery and tightly packed together. These cells are (skin cells) of sponges.

2) Porocytes: conical-shape, extended through the jelly (Mesenchyme layer), having their base in the covering layer while apex reaches the paragaster between the choanocytes. Each pierced form base to apex by tube, which is one of the pores.

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Amoebocytes: cells change from type to another and found in Mesophyl layer and different in size and structure devided into :-
Chromocytes / Thesocytes / sclerocytes / Archaeocytes.

- Gland cells
- Desmacytes
- Myocytes: like muscle cells, so their movement is rather limited. However, some poriferan cells can contract in a similar fashion as muscle cells.
- Choanocytes: coverd the inner surface of sponge, Cylindrical or conical collar surrounding one flagellum.

Trophocytes. ① Grey cells (imune system).

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Sponge types :-

sponges have three different types of body plans.

) Asconoid: sponges are shaped like a simple tube perforated by pores. The open internal part of the tube is called the spongocoel, it contain the collar cells. There is a single opening to the outside, the osculum.

) Syconoid: sponges tend to be larger the asconoids have a tubular body with a single osculum. The syconoid body wall is thicker and the pores that penetrate it are longer, forming a system of simple canals. These canals are lined by collar cells, the flagellae of which move water from the outside, into the spongocoel and out the osculum.

) Leuconoid: These are largest and most complex sponges. These sponges are made up of masses of tissue penetrated by numerous canals. canals lead to numerous small chambers lined with flagellated cells. water moves through the canals, into these chambers, and out via a central canal and osculum.

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Reproduction:-

- Asexual reproduction:-

occurs by budding or by fragmentation. The buds may remain attached to the parent or separate from it, and each bud develops into a new individual. Freshwater sponges, as well as several marine species, form resistant structures called gemmules that can withstand adverse conditions such as drying or cold and later develop into new individuals. Gemmules: are aggregates of sponge tissue and food, covered by a hard coating containing spicules or spongin fibers.

- Sexual reproduction:-

Most sponges are hermaphroditic, the same individual producing eggs and sperms, but in some species sexes are separate. The larvae are flagellated and swim about freely for a short time. After settling and attaching to a suitable substrate. The larvae develop into young sponges. Male gametes are released into the water by a sponge and taken into the re systems of its neighbors in the same way as food item

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spermatozoa are "captured" by collar cells, which then lose their collars and trans form into specialized, amoeba-like cells that carry the spermatozoa to the eggs. Some sponges are.

1- Monoecious
Dioecious.

eggs
sperm (spermatozoa) → larvae —develop→ young sponges.

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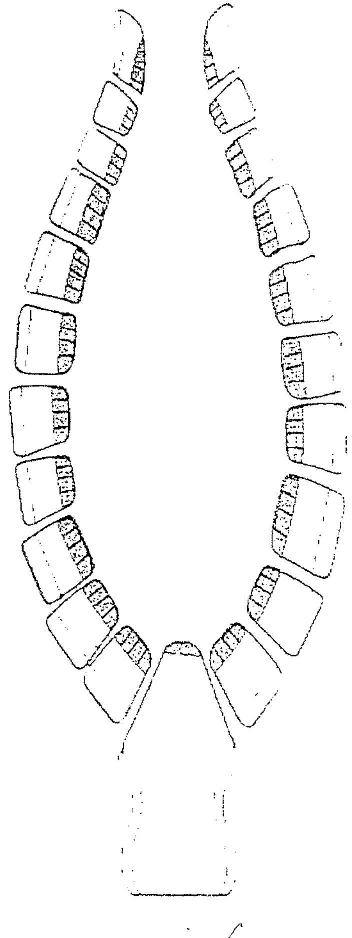
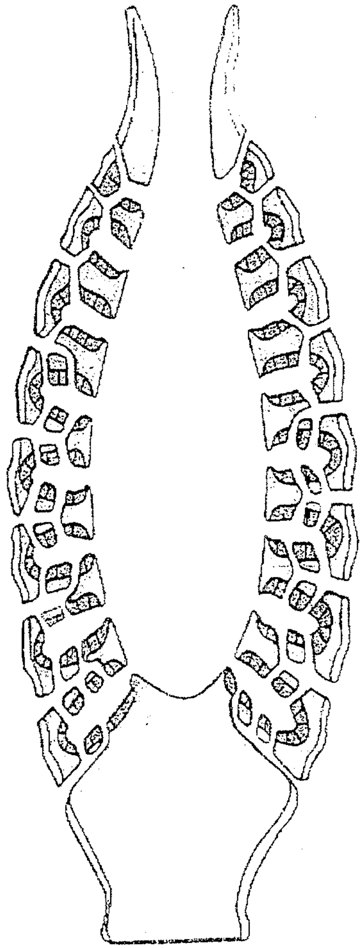
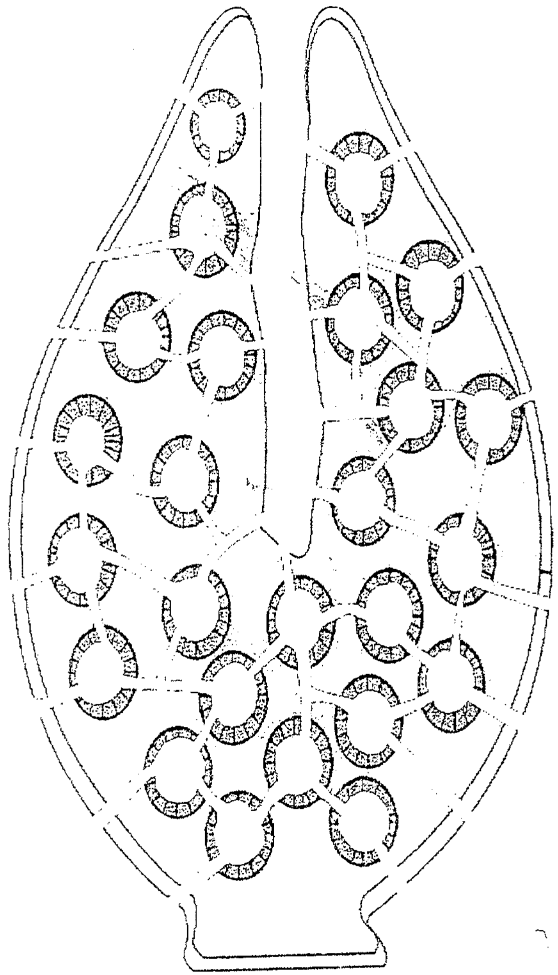
الفتحة الزفيرية
Osculum



الطراز الاسكوني



الطراز السايكوني



الطراز الليكوني

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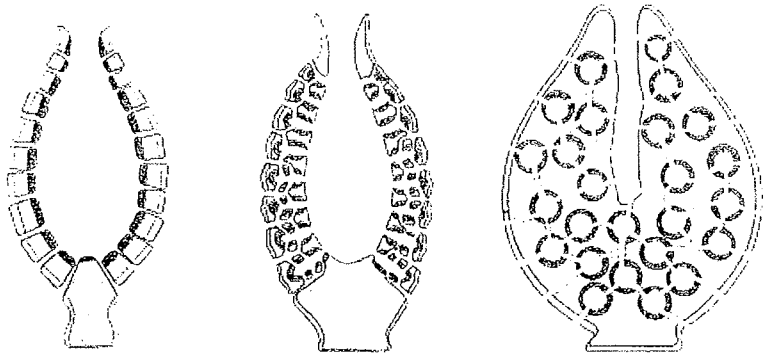
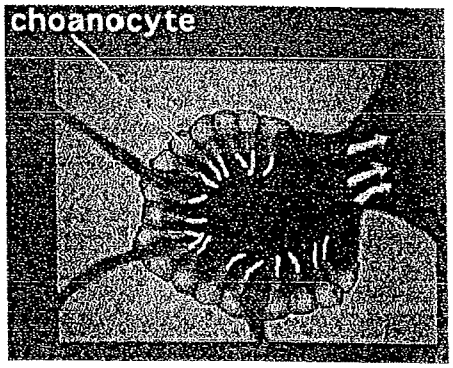
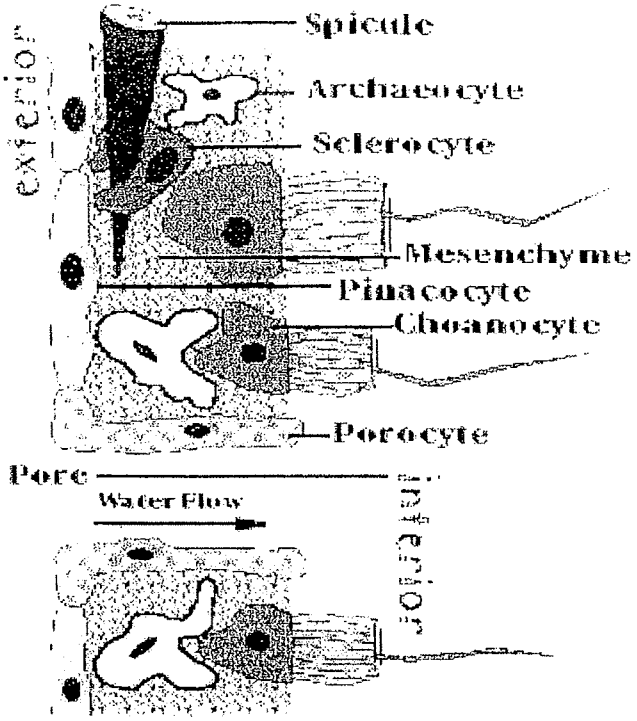
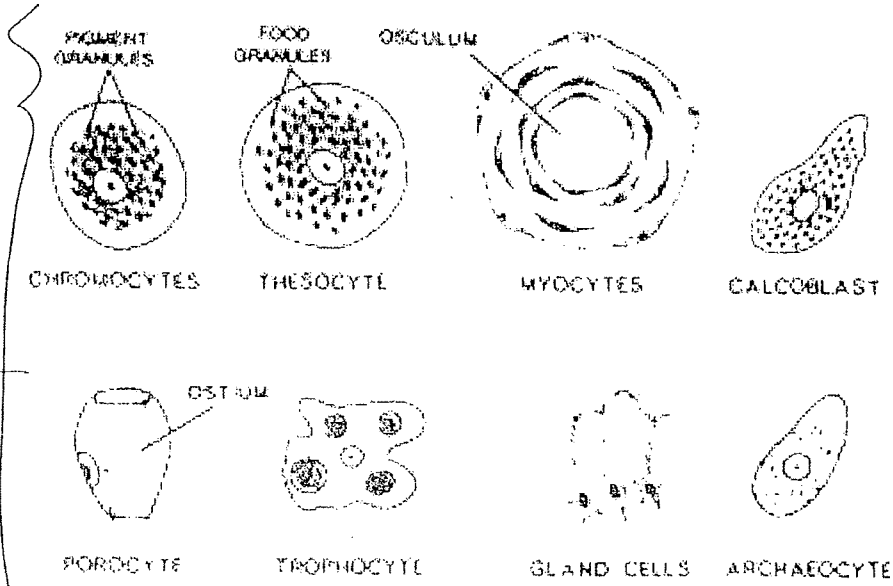


Asconoid
Syconoid
Leuconoid

Pinacocytes
Choanocytes
Mesohyl
Water flow







A porocyte and various types of amoebocytes of sponges

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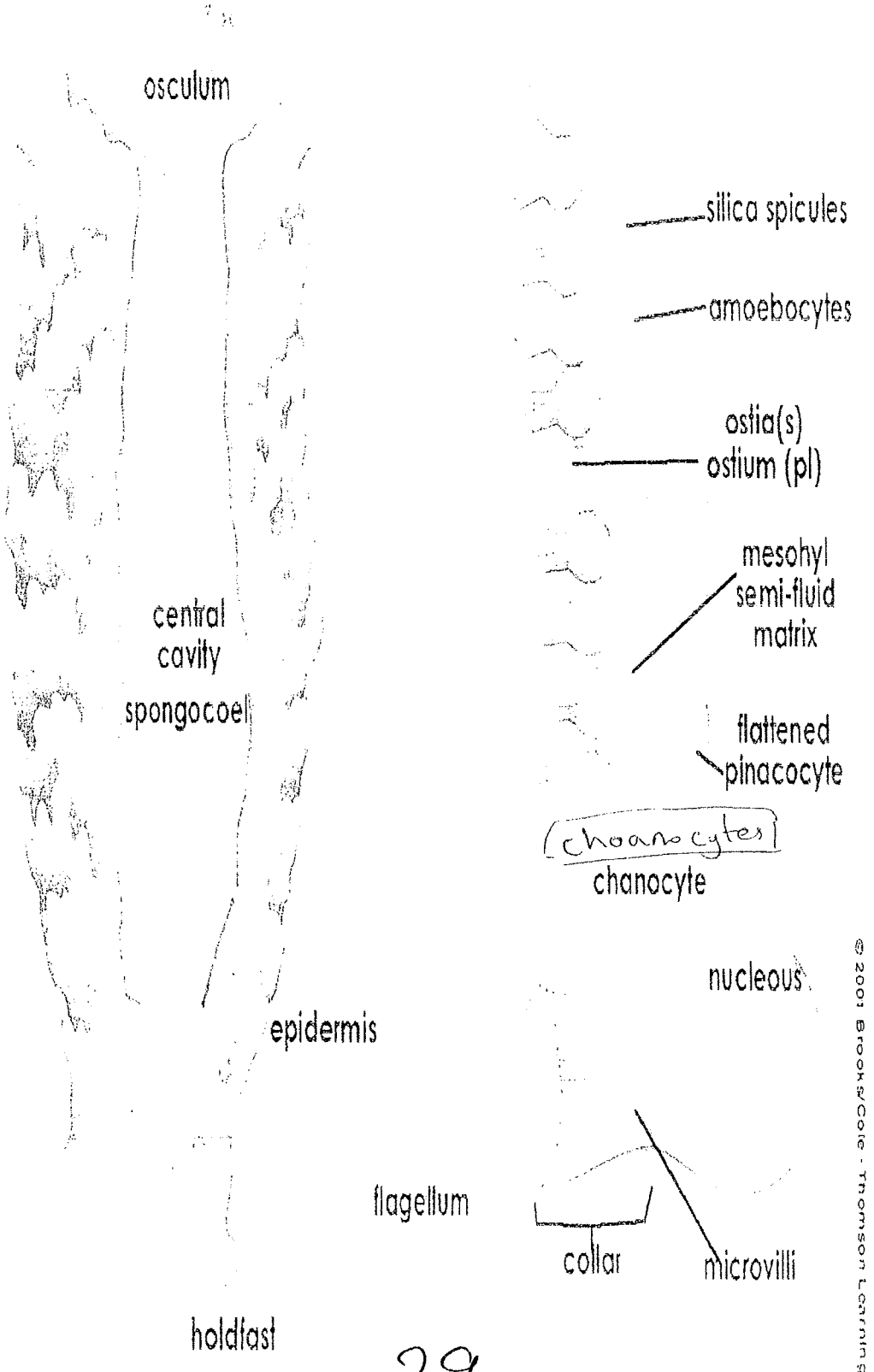

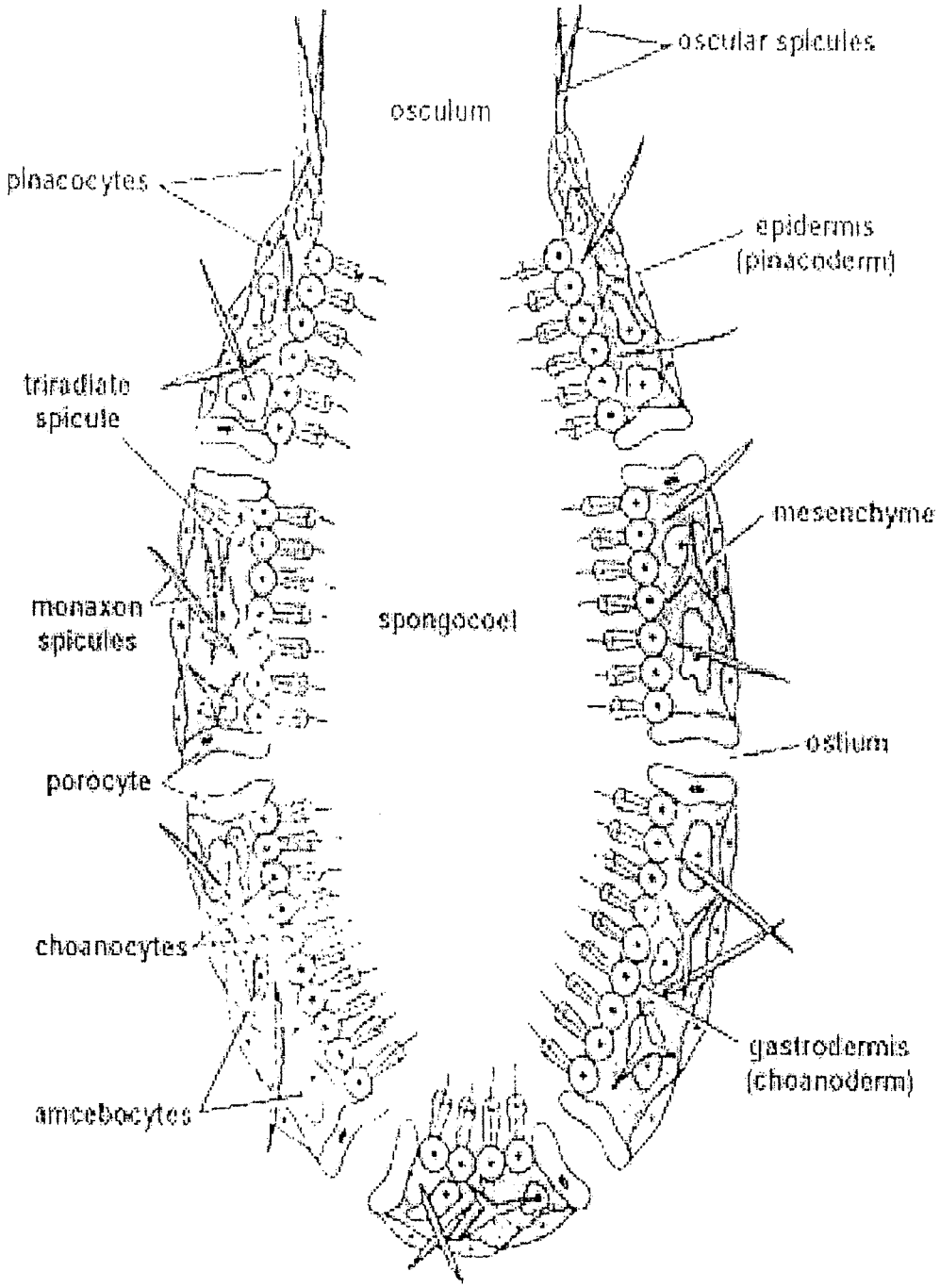

Most Primitive Sponge (*Leucosolenia*)

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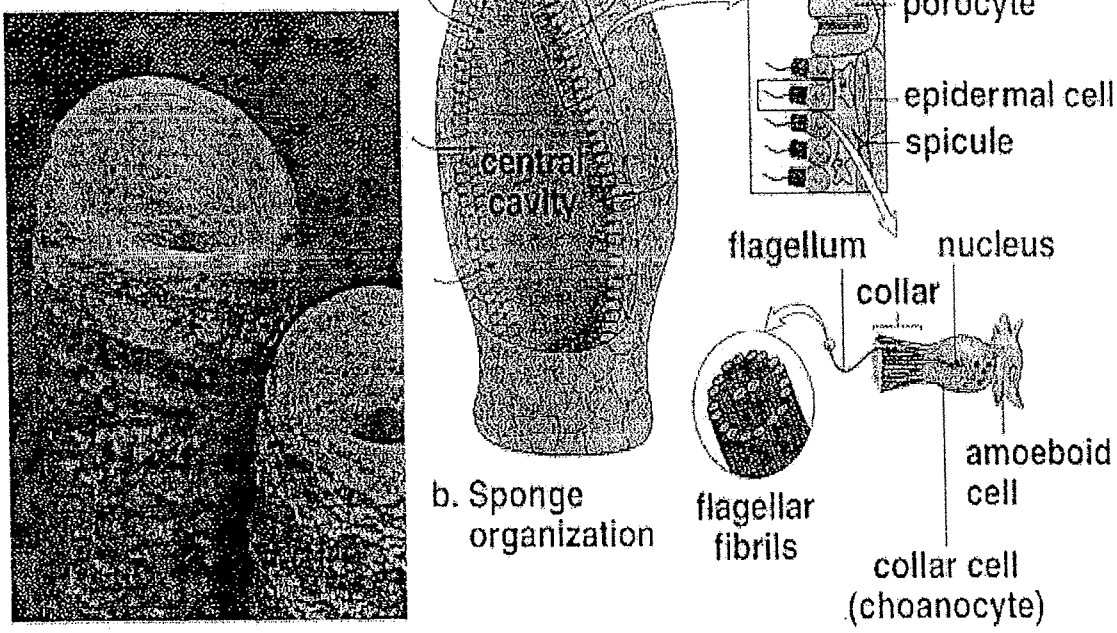

Lec. 4.

Cnidaria = Coelenterata

الاسعات (أمعائية الجوف)

General characteristic of Cnidaria

1. Radial symmetry.
2. Diploblast (two germ layers during development ectoderm and endoderm.).
3. Adult body with an outer cellular layer (epidermis or ectodermis) and an inner cellular layer (gastrodermis) with anon cellular-layer (Mesoglea = Jelly-like material) in between.
4. Some specialized tissues present.
5. Posses unique stinging or adhesive structures (cnidae) found in specialized cells (cnidocytes) most common cnidae called Nematocysts [that fire like harpoons and used mainly to capture prey also as anchors in some species].
6. Simple nerve net forms a nerveous system.
7. Alternation of generation with Asexually reproducing polyp stage and sexually reproducing medusa stage variation of this strategy exist throughout the Cnidaria.
8. Have aciliated, Motile planula larvae.

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Classification of Cnidaria

Phylum: Cnidaria

class: Hydrozoa ⟶ Hydra

- most are marine, a few are freshwater.
- Individuals usually small and inconspicous.
- Polyp is dominant stage, some completely lack medusa.
- Medusa when present has velum around margin.
- Most are colonial - small plant like appearance.
- Most have polymorphism with alternation generations.

3) class: Scyphozoa ⟶ Aurellia

1- Most of larger Jellyfish belong to this group
2. Medusa without velum, cells in Mesoglea.
:- All are marine.
- Polyp stage reduced or completely absent.
- Thick jelly layer (Mesoglea).

:) class: Anthozoa ⟶ Favia

2- Flower animals, all are marine.
- Polyp only, no medusa stage.
- Many cells in mesoglea.
- Some are solitary, most are colonial.
: Most secrete skeleton of calcium carbonate or protein.

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Hydra

phylum : Cnidaria

Class : Hydrozoa

Order : Anthomedusae

Family : Hydridae

Genus : Hydra

* General characteristic of Hydra

1) Small, Multicellular, has tubular body up to 10mm.
2) Radial symmetry.
3) They can found in most unpolluted freshwater, ponds, lakes and streams in the temperature and Tropical regions.
4) Contain in the foot region basal disc, gland cells in the basal disc secrete asticky fluid that accounts for its adhesive properties.
5) Mouth found in free end of the body surrounded by (1-12) thin mobile tentacles, each tentacle or cnida (plural cnidae) clothed with highly specialized stinging cells (cnidocytes) contain specialized structures called (Nematocysts).

د. نبراس فالح

:- The nervous system of Hydra is a nerve net, which is structurally simple compared to mammalian nervous system, and there are sensitive nerve cells located in the body wall and tentacles.

- Reproduction and Excretion occure by diffusion everywhere through the epidermis.

3- Hydra undergoes morphallaxis (tissue regeneration) when injured or severed.

Motion in Hydra

① Somer saulting (looping)
② Measuring worm.
③ Floating.

Feeding of Hydra

Hydra mainly feeed on small aquatic invertebrates such as Daphnia & Cyclops. when feeeding Hydra extend their tentacles. Despite their simple construction the tentacles of Hydra are extra ordinarily extensible and can be four to five times the length

of the body. Once fully extended, the tentacles are slowly manoeuverd around waiting for contact with a suitable prey animal. upon contact nematocysts on the tentacle fire into the prey, and the tentacle itself coils around the prey, within 30 seconds, most of the remaining tentacles will have already joined in the attack to subdue the struggling prey. within two minutes, the tentacles will have surrounded the prey and moved it into the opened mouth aperture. within ten minutes, the prey will have been enclosed within the body cavity, and digestion will have started. Hydra is able to stretch its body wall considerably in order to digest prey more than twice its size. After two or three days, the indigestible remains of the prey will be discharged by contractions through the mouth aperture.

(36)

Reproduction of Hydra

① When the food plentiful and the conditions good Hydra produce asexually by producing buds in the body wall, a new bud can form every two days.

② When conditions are harsh, often before winter or in poor feeding conditions, sexual reproduction occures in some Hydra. Swellings in the body wall develop into either a simple ovary or testes.

The testes release free-swimming gametes into the water, and these can fertilize the egg in the ovary of another individual. The fertilized eggs secrete a tough outer coating and fall to the bottom of the lake or pond to await better conditions.

د. نبراس صالح

Type of cells in Hydra

* Epidermis layer :-

① Epithelio-muscular cells.
② Sensory cells.
③ Nerve cells.
) Interstitial cells.
) Cnidocytes.
) Germ cells.

· Endodermis layer (or Gastrodermis layer) :-

) Epithelio-muscular cells (Digestive cells).
Interstitial cells.
Sensory cells.
Nerve cells.
) Gland cells.

د . بشرى صالح

Cnidocyte

A **cnidocyte** (also known as a **cnidoblast** or **nematocyte**) is an explosive cell containing one giant secretory organelle or *cnida* (plural *cnidae*) that defines the phylum Cnidaria (corals, sea anemones, hydrae, jellyfish, etc.). Cnidae are used for prey capture and defense from predators. Despite being morphologically simple, lacking a skeleton and usually being sessile, cnidarians prey on fish and crustaceans. A cnidocyte fires a structure that contains the toxin, from a characteristic subcellular organelle called a **cnidocyst** (also known as a **cnida** or **nematocyst**). This is responsible for the stings delivered by a cnidarian.

Structure and function

Each cnidocyte cell contains an organelle called a cnida or cnidocyst (e.g. nematocyst, ptychocyst or spirocyst), which comprises a bulb-shape capsule containing a coiled hollow tubule structure attached to it. The immature cnidocyte is referred to as a cnidoblast. The externally oriented side of the cell also has a hair-like trigger called a cnidocil. When the trigger is activated, the tubule shaft of the cnidocyst is ejected and in the case of the penetrant nematocyst, the forcefully ejected tubule penetrates the target organism. This discharge takes no more than a few microseconds, and is able to reach accelerations of about 40,000 *g* Recent research suggests the process to occur as fast as 700 nanoseconds, thus reaching an acceleration of up to 5,410,000 *g* After penetration, the toxic content of the nematocyst is injected into the target organism, allowing the sessile cnidarian to devour it.

Discharge mechanism

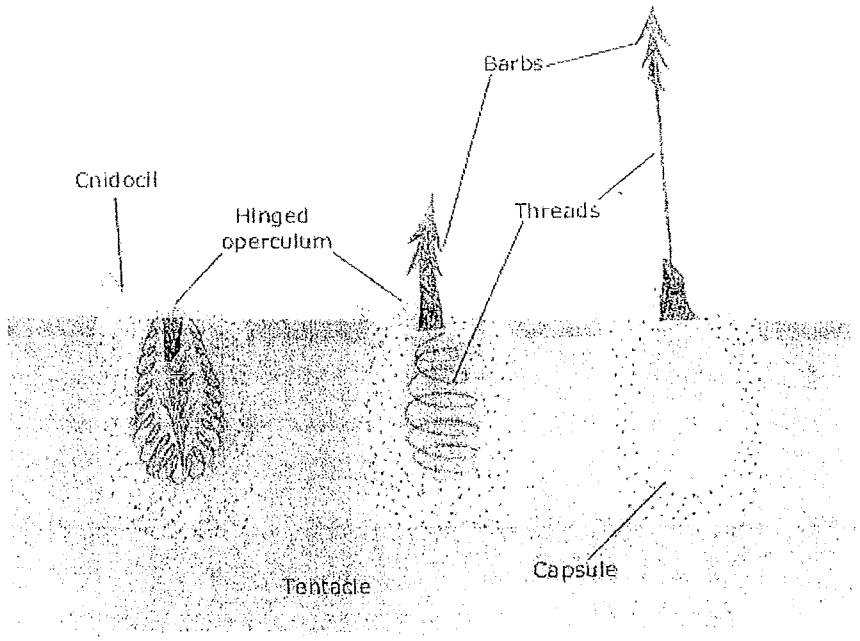
Cnidae capsule stores a large concentration of calcium ions, which are released from the capsule into the cytoplasm of the *cnidocyte* when the trigger is activated. This causes a large concentration gradient of calcium across the cnidocyte plasma membrane. The resulting osmotic pressure causes a rapid influx of water into the cell. This increase in water volume in the cytoplasm forces the coiled cnidae tubule to eject rapidly. Prior to discharge the coiled cnidae tubule exists inside the cell in an "inside out" condition. The back pressure resulting from the influx of water into the cnidocyte together with the opening of the capsule tip structure or operculum, triggers the forceful eversion of the cnidae tubule causing it to right itself as it comes rushing out of the cell with enough force to impale a prey organism.

د . نبراس صالح

Types of cnidae

Over 30 types of cnidae are found in different cnidarians. They can be divided into the following groups:

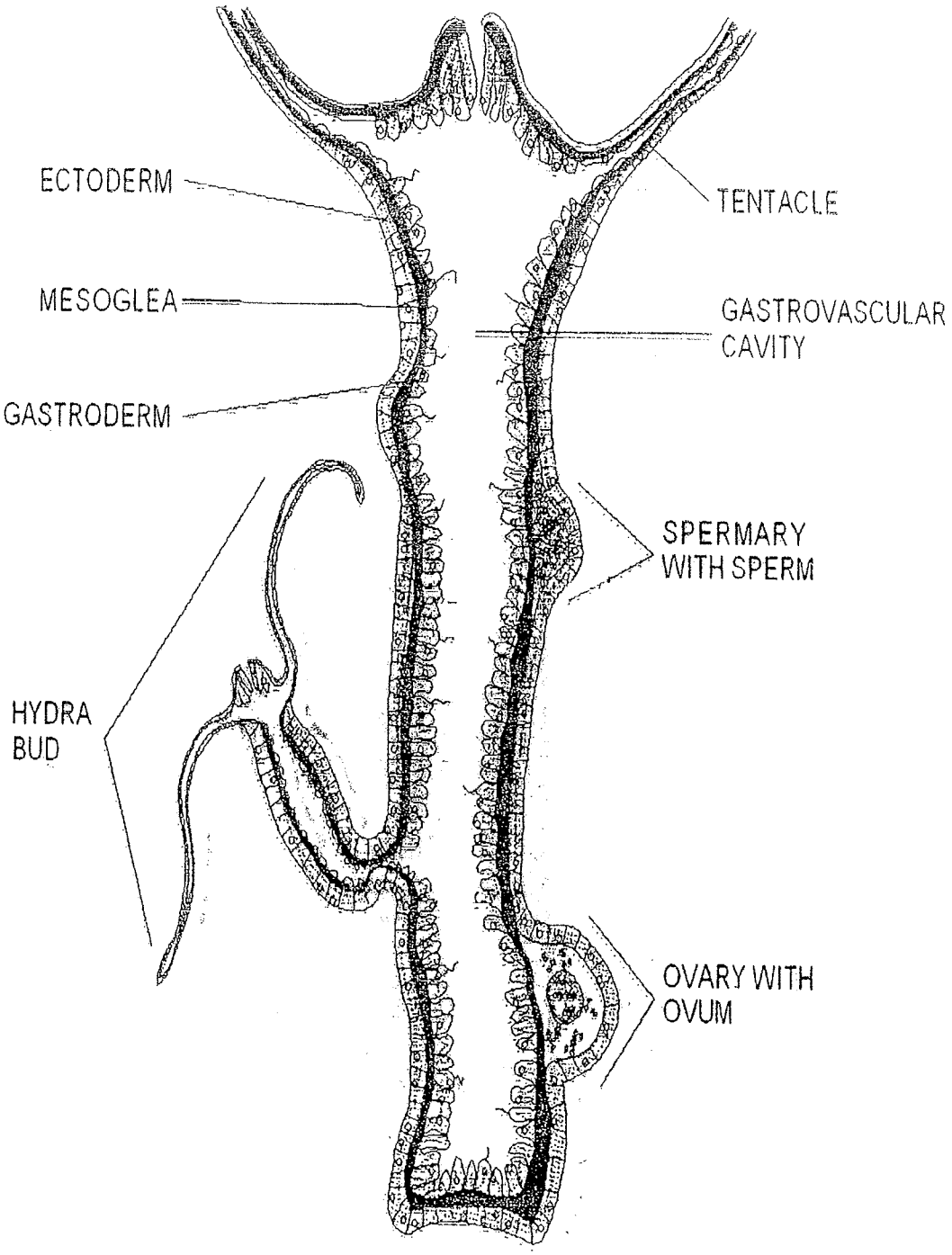
1. Penetrant: a harpoon-like structure used to penetrate, referred to as nematocysts
2. Glutinant: a sticky surface used to stick to prey, referred to as ptychocysts and found on burrowing (tube) anemones, which help create the tube in which the animal lives
3. Volvent: a lasso-like string that is fired at prey and wraps around a cellular projection on the prey, referred to as spirocysts . Depending on the species, one or several types can appear simultaneously on the organism.



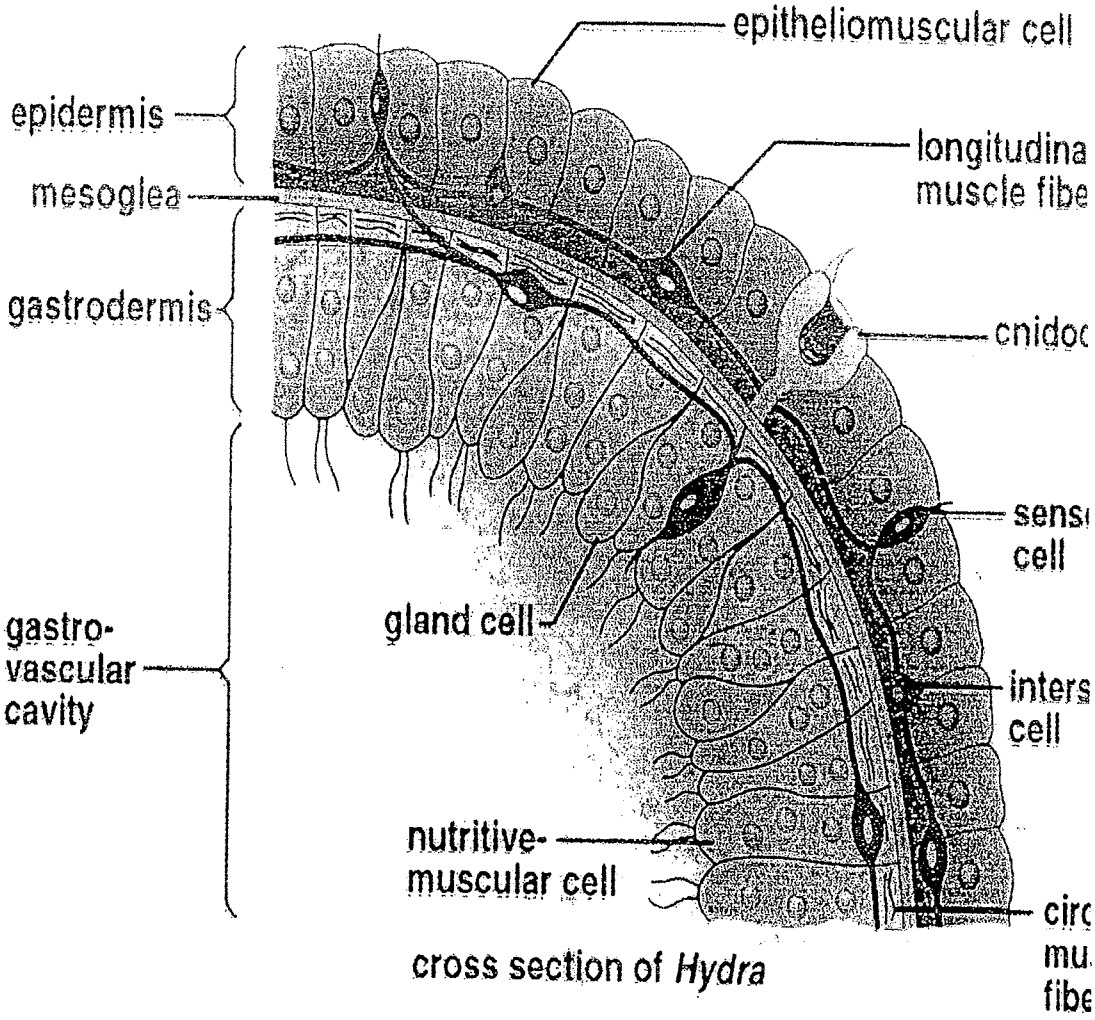
40

د. ليلى صالح

Hydra

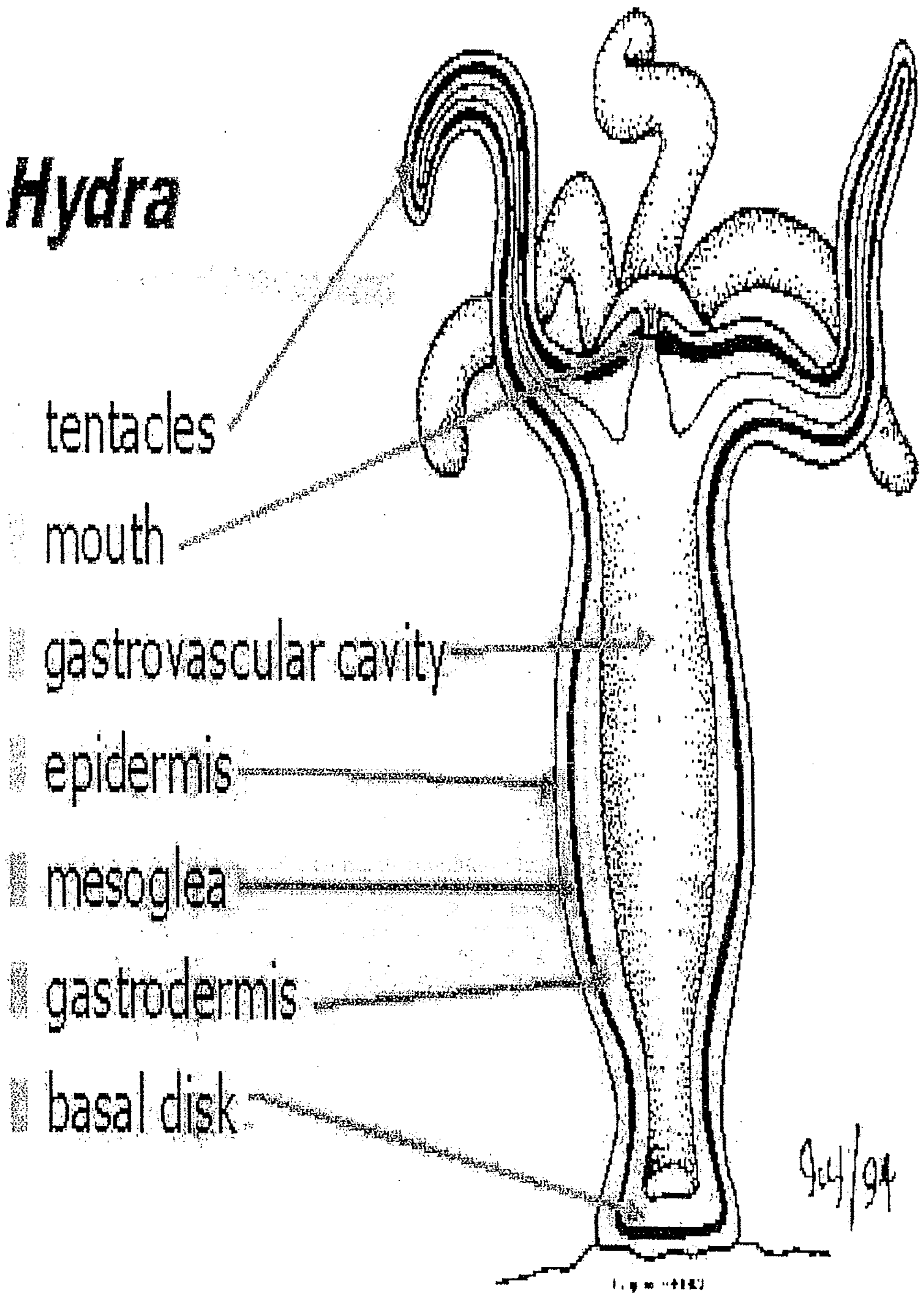


Anatomy of hydra (1)



cross section of *Hydra*

Hydra


tentacles
mouth
gastrovascular cavity
epidermis
mesoglea
gastrodermis
basal disk

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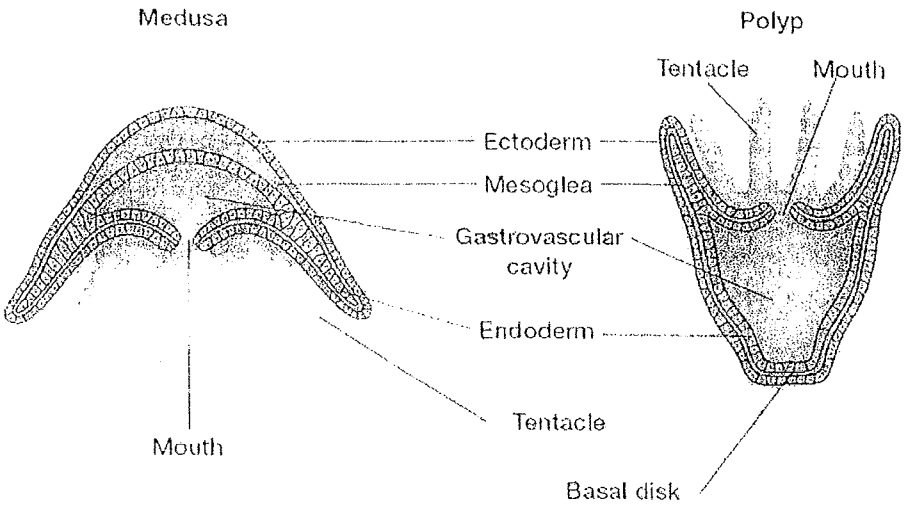

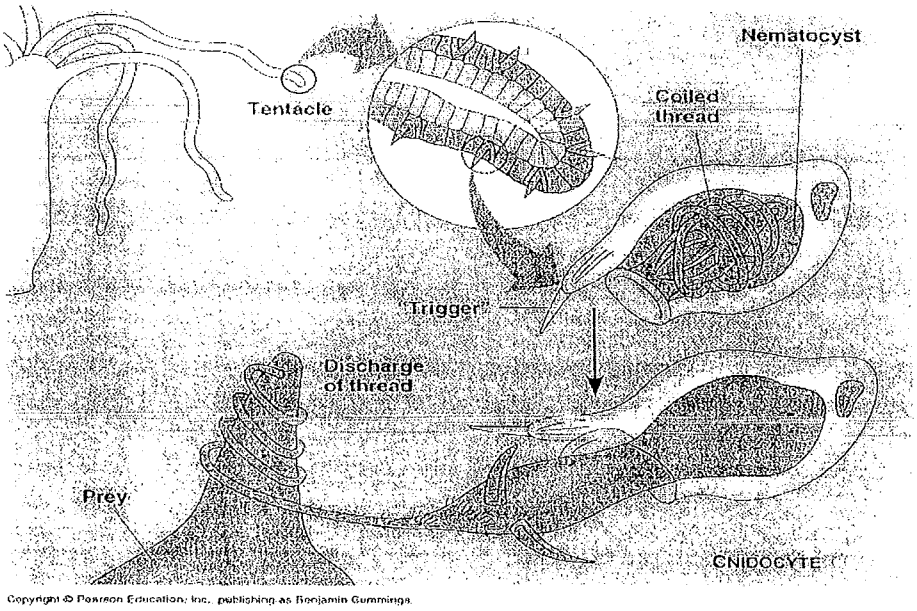

د. نبراس فلاح

Lec. 5.

Mollusca

From the latin Molluscas meaning soft body.

*Characteristic of Mollusca

① Bilaterally symmetrical, Live in most environments.
② Body has more than two cell layers, tissues and organs.
④ Open digestive system (have mouth and anus).
⑤ There is dorsal or lateral shells of protein or calcareous spicules.
⑥ Has a nervous system with a circum-oesophagal ring, ganglia and paired nerve chords.
⑦ Has an open circulatory system with a heart and an aorta.
⑧ Has gaseous exchange organs called ctenidial gills.
⑨ Reproduction is sexual and asexual.
⑩ Feed a wide range of material.

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* classification of Mollusca

① Gastropoda (called stomach-footed Mollusca) Helix
② Bivalva (Lamellibranchiata or Pelecypoda)

[Bi = two (that mollusca possess two shells).]

Anodonta

③ Aplacophora (These benthic (deepwater)) not have shell but have small calcareous spicules embedded in their mantle) ——— Nomenia

④ Monoplacophora [The name (means with one plate)] a single shell —— Neopilina

⑤ Polyplacophora [with 8 plates] — Acanthochitem

⑥ Scaphopoda (boat-footed) —— Dentalium

⑦ Cephalopoda (Head-footed) have large head eyes and tentacles) —— Octopus

* Bivalva

① Live in marine and freshwater, bury themselves in sediment, other lie on the sea floor, attach themselves to rocks, bore into wood, clay or stone and live inside there substances, to save themself from predation.

② The body enclosed by shell consisting of two hinged parts, the shell contain of calcium carbonate, and two similar parts called valves.

③ They have no head, but they also lack radula.

④ Growth happen by increased by length or increases in total or soft body weight, or they vary, and increase the Growth, the growth can vary with season.

* External anatomy

① There is two valves of the shell that may or may not be equal and may or may not completely enclose the inner soft parts, they variety of shapes and colours depending on species.

② The valves are composed mostly of calcium carbonate ($CaCO_3$) and have three layers:

a- Inner or nacreous layer.

b- Middle or prismatic layer (form most of the shell)

c- Outer [redacted] or periostracum layer (brown leathery layer which is often missing through abrasion or weathering in older animals)

③ Bivalves do not have obvious head or tail regions.

د. نبراس فلاح

*Internal anatomy.

① Mantle

a- The soft parts are covered by Mantle, which composed of two thin sheaths of tissue thickened at the edges.

b- Two halves of the mantle are attached to the shell from hinge ventral to the pallial line but are free at their edge.

c- Thickened edges may or may not be pigmented and have three folds, The mantle edge often has tentacles are at the tips of siphon and some species have numerous light sensitive organs - eyes.

d- The main function of mantle
① secrete the shell
② Sensory function and can initiate closure of the valves in response to unfavourable environmental conditions.
③ Respiratory function (control inflow of water into the body chamber.

② Digestive system :-

large gills → labial palps (surround the mouth) →
mouth → oesophagus → stomach (surrounded by liver)
→ intestine (contain crystalline style) → rectum → anus

crystalline style: round at one end and pointed at the other, gelatinous rod can be up to 8cm in length, Mixing food in the stomach and releases enzymes

that assist in digestion, is composed of layers of mucoproteins, which release digestive enzymes to convert starch into digestible sugars. (Bivalves are filter feeders, feed primarily on phytoplankton - microscopic plant life.

3) Circulation and respiration

① Open circulatory system (heart, sinuses) organs baths in hemolymph.

② Heart has three chambers: two auricles receiving blood from the gills, and single ventricle, The ventricle is muscular and pumps hemolymph into the aorta then to the rest of the body.

③ Hemolymph lack any respiratory pigment while in carniverous species, hemolymph has red amoebocytes (containing pigment)

④ Hymolymph in gills (hing down into the mantle cavity) provide primary respiratory surface, capillaries provide secondary respiratory surface with O_2.

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(4) Nervous system

① Have no brain.

② Consist of nerve network and series of paired ganglia (① cerebral ganglia ② pleural ganglia ③ pedal ganglia ④ visceral ganglia)

③ Cerebral ganglia (They two on either side of the oesophagus, all kinds of ganglia connected to the cerebro pleural ganglia by nerve fibers.) Control the sensory organs, while the pleural ganglia supply nerve to the mantle cavity, Pedal ganglia which control the foot, while visceral ganglia which can be quite large in swimming bivalves.

(*) Senses:

① Mechanoreceptors.

② Chemoreceptors.

③ Many bivalves have no eyes, but few members of Arcoidea (order), Some have simple eyes, Some consist of apit of photosensory cells and lens, some have complex eyes with lens.

د. نيراس فالح

⑤ Urogenital system

1) Sexes are separate (dioecious) Or hermaphroditic (monoecious)
2) The gonad is evident during the breeding season.
3) Male gonad is white in colour and female is red even in hermiphroditic species.
4) The animal may spawn originally as amale in a season, refill the gonad with eggs and spawn second time the season as afemale.
5) There are two kidneys, small, brown and sac like bodies that are lie flattened aganist the anterior part of the adductor muscle.
The kidneys empty through large slits into the mantle chamber.

د. ثيراس خالد

Phylum: Echinodermata

means "prickly skin"
6225 living species; >20,000 fossil species

Characteristics of Phylum:

1. most with **pentamerous** (=pentaradial) **radial symmetry**
2. no distinct head or brain (no cephalization)
3. most have **endoskeleton** of calcium plates
4. unique **water vascular system** for feeding and movement
5. **dermal branchiae** for gas exchange
6. no real circulatory system
7. no excretory system
8. sense organs poorly developed
9. **pedicellariae** for protection

Classification

Class: Asteroidea
(starfish, sea stars, sea daisies),
1500 living species

Class: Ophiuroidea
(brittle stars, basket stars, serpent stars)
>2,000 living species;

Class: Echinoidea
(sea urchins, heart urchins, sand dollars & sea biscuits)
950 living species

Class: Holothuroidea
(Sea Cucumbers)
1150 living species

Class: Crinoidea
(sea lilies, feather stars)
625 living species

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Body Form

most evident feature: **radial symmetry**
no distinct head □**oral** vs **aboral** surface
radial symmetry is a secondary trait
larvae are bilateral then after
metamorphosis they become radial
in most its **pentamerous radial symmetry**

Body Wall

epidermis
outer surface covered by **epidermis**
made up of: epithelial cells
ciliated mucous cells
ciliated sensory cells
nerve plexus in basal part of epidermis

dermis
below epidermis is thick dermis
made of connective tissues
lots of collagen fibers
secretes skeletal pieces = **ossicles** = **endoskeleton**
ossicles are bony plates made of **calcium crystals**
each ossicle represents a single crystal of magnesium
rich calcite (6(Ca,Mg)C03) formed within cells of dermis
in many classes ossicles have bony projections for defense unlike
any other phylum, echinoderms can vary
rigidity of dermis pliability of collagen fibers is under nervous
control beneath dermis is layer of outer **circular** and inner
longitudinal muscle true **coelom** lined with **peritoneum**

Movement

movement & food gathering done predominantly by
water vascular system
a second, separate coelomic compartment unique to echinoderms
derived from coelom and lined with ciliated epithelium
the whole system operates hydraulically
filled with fluid (mainly sea water and some
proteins and cells internal canals connect ot the outside through the
madreporite
leads to **stone canal** (contains calcareous
deposits) joins **ring canal** just inside and around the mouth long
radial canals extend into each arm in arm, **lateral canals** branch
off radial canals have valves to prevent backflow

lead to small muscular sacs that serve as fluidreservoirs=
ampullae connected to muscular **tube feet**
tube feet are concentrated in **ambulacral**
groove the tip of the tube feet are flattened, forming **suckers**
suctionlike cups can produce strong force **tube feet** used to cling to substrates, move and to feed most echinoderms don't have large muscles
muscles mainly used to move **tube feet**

but some also attached to ossicles to allow them to bend and flex water vascular system also compensates for the absence of a blood circulatory system (In sea stars, water enters the system through a sieve-like structure on the upper surface of the animal, called the madreporite. This overlies a small sac, or ampulla connected to a duct termed the stone canal, which is, as its name implies, commonly lined with calcareous material. The stone canal runs to a circular ring canal, from which radial canals run outwards along the ambulacral grooves. Each arm of a sea star has one such groove on its underside, while, in sea urchins, they run along the outside of the body.

Each side of the radial canals gives rise to a row of bulb-like ampullae, which are connected via lateral canals. In sea stars these are always staggered, so that an ampulla on the left follows one on the right, and so on down the length of the radial canal. The ampullae are connected to suckerlike podia. The entire structure is called a tube foot. In most cases, the small lateral canals connecting the ampullae to the radial canal are of equal length, so that the tube feet are arranged in two rows, one along each side of the groove. In some species, however, there are alternately long and short lateral canals, giving the appearance of two rows on each side of the groove, for four in total.

Contraction of the ampullae causes the podia to stretch as water is brought into them. This whole process allows for movement, and is quite powerful but extremely slow.

The central ring canal, in addition to connecting the radial canals to each other and to the stone canal, also has a number of other specialised structures on the inner surface. In between each radial canal, in many sea star species, there lies a muscular sac called a polian vesicle. The radial canal also has four or five pairs of complex pouches, called Tiedemann's bodies. These apparently produce coelomocytes, amoeboid cells somewhat similar to the blood cells of vertebrates.

د. نبراس فاخ

Although the contents of the water vascular system are essentially sea water, apart from coelomocytes, the fluid also contains some protein and high levels of potassium salt

Feeding & Digestion

echinoderms are particle feeders, scavengers or predatorsno parasitic species
simple, usually complete digestive tract
but functional anus is often reduced
stomach has 2 chambers: **cardiac** & **pyloric**
digestive enzymes are secreted into stomach by**pyloric caecae**

Respiration

tiny saclike projections extend through epidermis= **dermal branchae** (or papulae)
☐☐exchange respiratory gasses
☐☐get rid of ammonia (N-wastes)
the same functions are also shared by **tube feet** in most groups

Circulation

echinoderms rely mainly on **coelomic circulation** for transport of gasses and nutrients
ciliated lining circulates fluids around body cavity and into dermal branchiae
coelomic fluid contains amoeboid cells
they do have a blood vascular system (= **hemal system**)with heart but its usually rudimentary is rudimentary
and its function unclear
☐☐may play some role in distributing nutrients

Nervous System

no brain or centralized processing area
circumoral ring and **radial nerves** branching from it helps coordinate movement of arms and movement of the starfish in general
tube feet are innervated by nervous sysem
☐☐enables all feet to move in single direction
if circumoral ring is cut, podia in all arms become uncoordinated; no movement is possible
few specialized sense organs
have some simple **tactile**, **chemical** and **photoreceptors** and **statocysts**

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Protection

in many starfish the body surface bears small jaw-like **pedicellariae**
some are stalked, some sessile (unstalked)
□□protect against animals and debris that settle on the animals surface . pedicellariae contain from three calcareous pieces (one piece called basilar and two pieces called valves or jaws and they joins with by adductor muscles and abductor muscles they open and close them) , and there are two type of pedicellariae :

1-Forceps or Straight type .
2-Scissors or crossed type .

Excretion

removal of nitrogen wastes (mainly ammonia) is through the **body surface**, **dermal branchiae** and **tube feet**
some amoeboid cells can also engulf nitrogen wastes and move them to the outside through the dermal branchiae or tube feet

Reproduction & Development

sexes typically separate □□dioecious
external fertilization
produce characteristic ciliated, free-swimming, planktonic larva = **bipinnaria**
bilateral symmetry undergoes metamorphosis to become radially symmetrical adult early developmental stages are similar in all classes
some can also reproduce **asexually** by **fragmentation**
many also have excellent powers of **regeneration**
□□can regenerate from 1/5th of oral disc & a single arm but may require up to a year
some deliberately cast of an arm as a means of asexual reproduction
don't seem to age □□can liver forever?

Ecology

a wide variety of other animals make their homes in or on echinoderms, including:
algae, protozoa, ctenophores, turbellaria, barnacles, copepods, decapods, snails, clams, polychaetes, fish and other echinoderm

Class Asteroidea
(sea stars, starfish)

~1500 species free moving inhabit all seas except low salinity areas
bottom dwellers mostly found on hard rocky surfaces
many live in deep ocean also common along littoral zone in coastal waters where they may congregate in very large numbers
1 cm to 1 M diameter
eg. giant *Pycnopodia* has over 20 arms and is the size of a manhole cover
often brightly colored: red, orange, blue, purple, green etc best representatives of the basic features of the phylum
body composed of rays (arms) projecting from a central disc arms not sharply set off from central disc in some arms are very short
eg. *Culcita* □□a pentagon with no arms
mouth and 100's of tube feet underneath typically pentamerous symmetry most with 5 arms sunstar up to 40 arms some have up to 50 arms

Oral Surface

mouth in center of oral surface
wide furrows project from mouth into each arm = **ambulacral grooves**
each groove contains 2-4 rows of **podia** (=**tube feet**) margins of each groove are guarded by moveable **spines**
tip of each arm has 1 or more tentacle-like sensory tube feet and a red pigment spot (=eye spot)

Aboral Surface

inconspicuous **anus** in center of disc large sievelike **madreporite**
toward one side aboral surface bears numerous **pedicellariae** keeps integument free of sponges, corals also used in feeding and defense

Movement

mainly by tube feet can adhere to any solid surface by the **suction** created and slowly creep along ~few cm/minute

د. نبراس فالح

Feeding and Digestion

many sea stars are **scavengers** a few are **suspension feeders** feed on small plankton and organic debris mucous strands carry food to the mouth most asteroids are **carnivores** feed on molluscs, crustaceans, polychaetes and other echinoderms use **chemoreceoptors** to detect and locate prey some can locate buried prey and dig down to get them eg. some swallow prey whole and regurgitate undigested ossicles & spines, etc
eg. some attack larger seastars and begin eating the end of an arm and work their way up
eg. many are able to evert their stomachs through the mouth to engulf and eat prey
eg. some feed exclusively on bivalves
□□some, such as asterias, are notorious predators of oysters wraps itself around its prey exert steady pull on valves [force of 12.75 newtons (equivalent to human lifting 1000lbs wit 1 hand)] ~ a half hour the adductor muscles of bivalve fatigue and relax slightly only need 0.1mm gap to insert stomach and digest oyster takes 2.5 - 8 hrs to digest a bivalve

digestive system

is arranged radially **mouth** at the center of the disc leads to short **esophagus**
opens to large **stomach** that fills most of the inside of the oral disc stomach divided into large **cardiac region** and small, aboral **pyloric region pyloric ceca** (digestive glands) , 2 per arm, drain into pyloric region
products of digestion in stomach are carried to pyloric caecae to complete digestion and absorption
short tubular **intestine** opens through the **anus** on aboral side

Respiration

dermal branchiae (papulae) extend through ossicles to surface of the skin these plus **tube feet** provide most of the gas exchange for sea stars in burrowing species, dermal branchiae are protected in channels below umbrella-like spines

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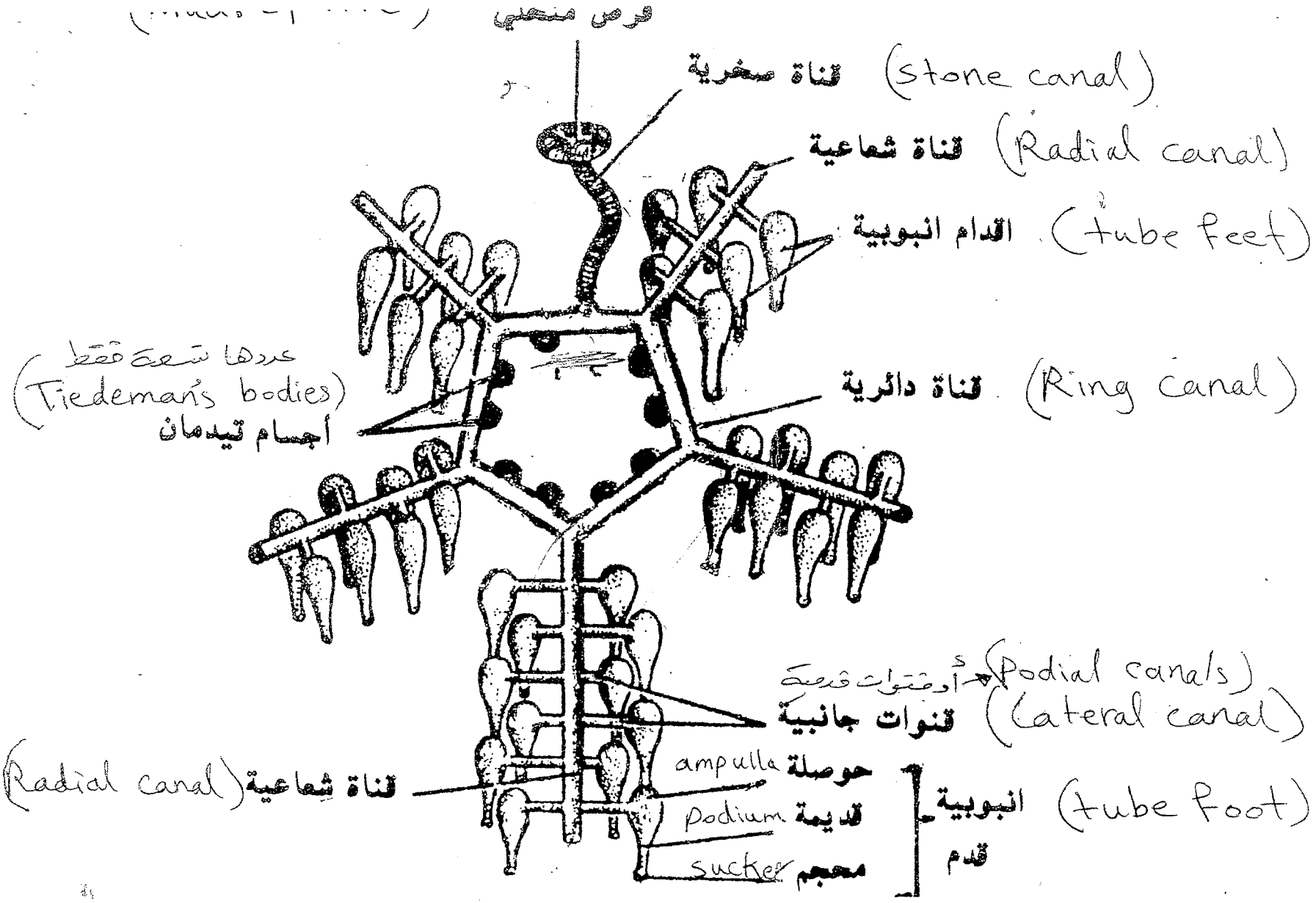
Reproduction & Development

Asexual reproduction

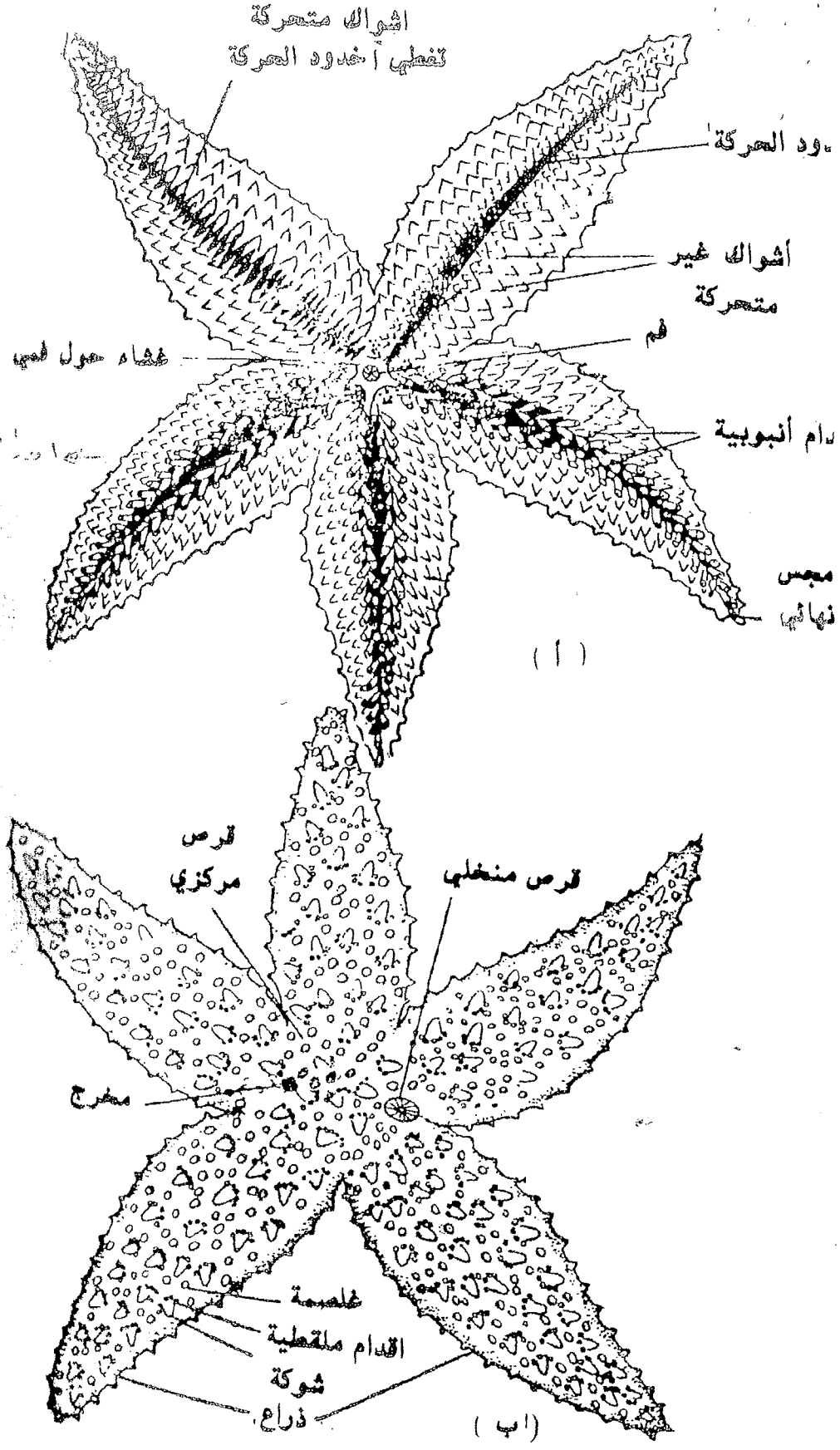
many starfish regularly reproduce asexually
□□central disc divides in half and animal breaks into two parts; each regrows missing part starfish can also **regenerate** from an arm or others an arm and a small piece of the central disc

Sexual Reproduction

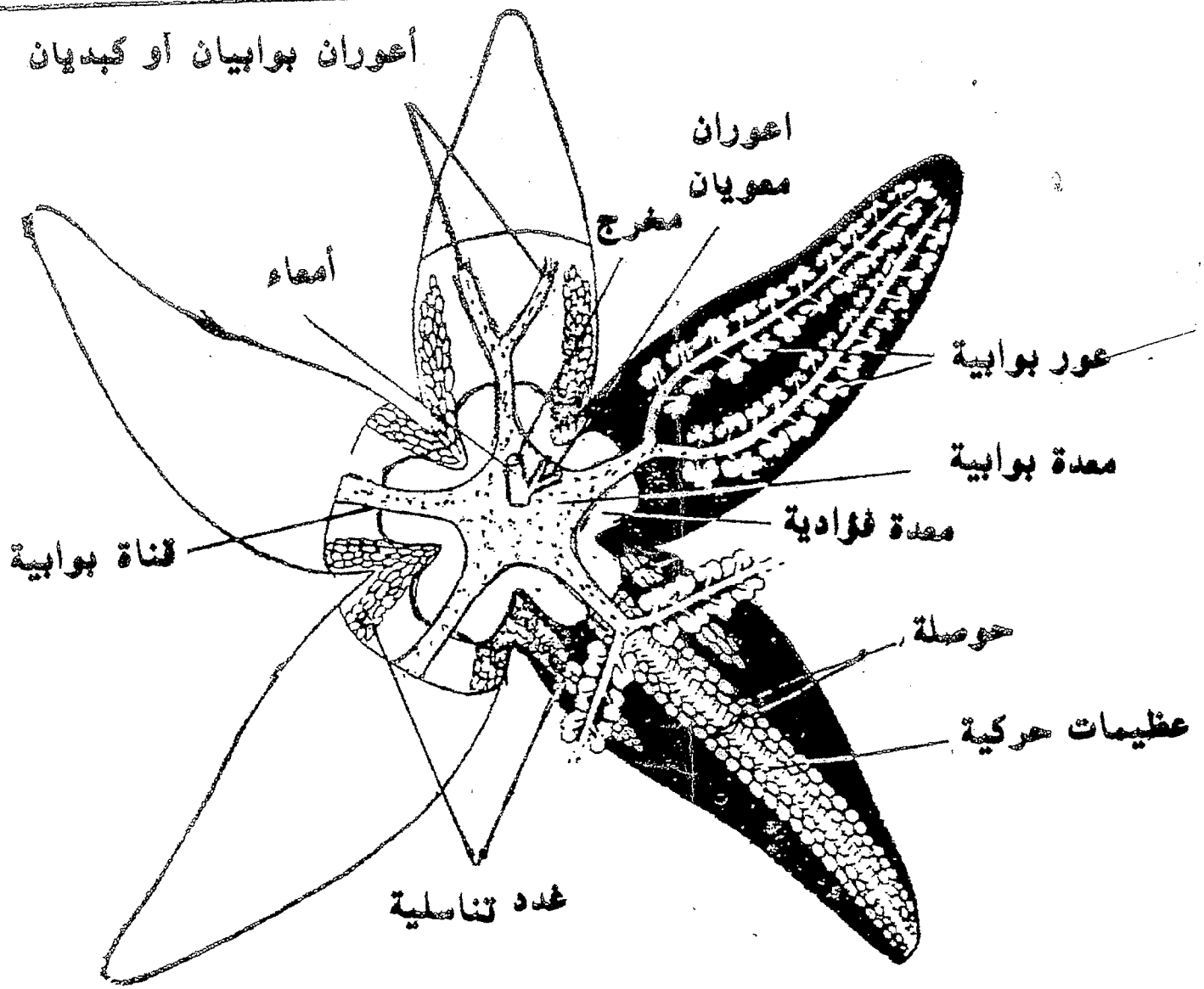
most are dioecious gonads in small area at base of each arm when filled with eggs sor sperm they almost completely fill arm
some lay egg masses others brood eggs
a few are **viviparous** but most produce free swimming larvae
gametes released through pores near base of each arm
1 breeding season per year
1 female may shed 2.5 M eggs
larvae are planktonic, free swimming **bipinnaria** larva
metamorphosis converts bilateral larva to radial juvenile



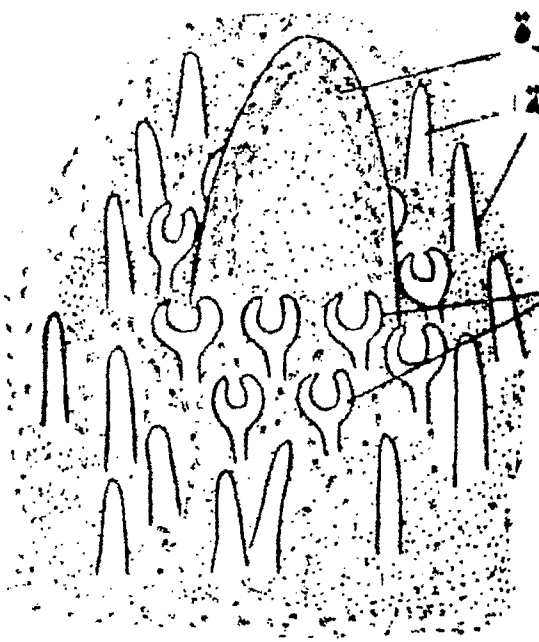
الشكل ١٠ ـ ٨ . الجهاز الوعائي المائي لنجم البحر .



الشكل ١٠ ـ ١. نجم البحر. (أ) جهة فمية . (ب) جهة لاالية.



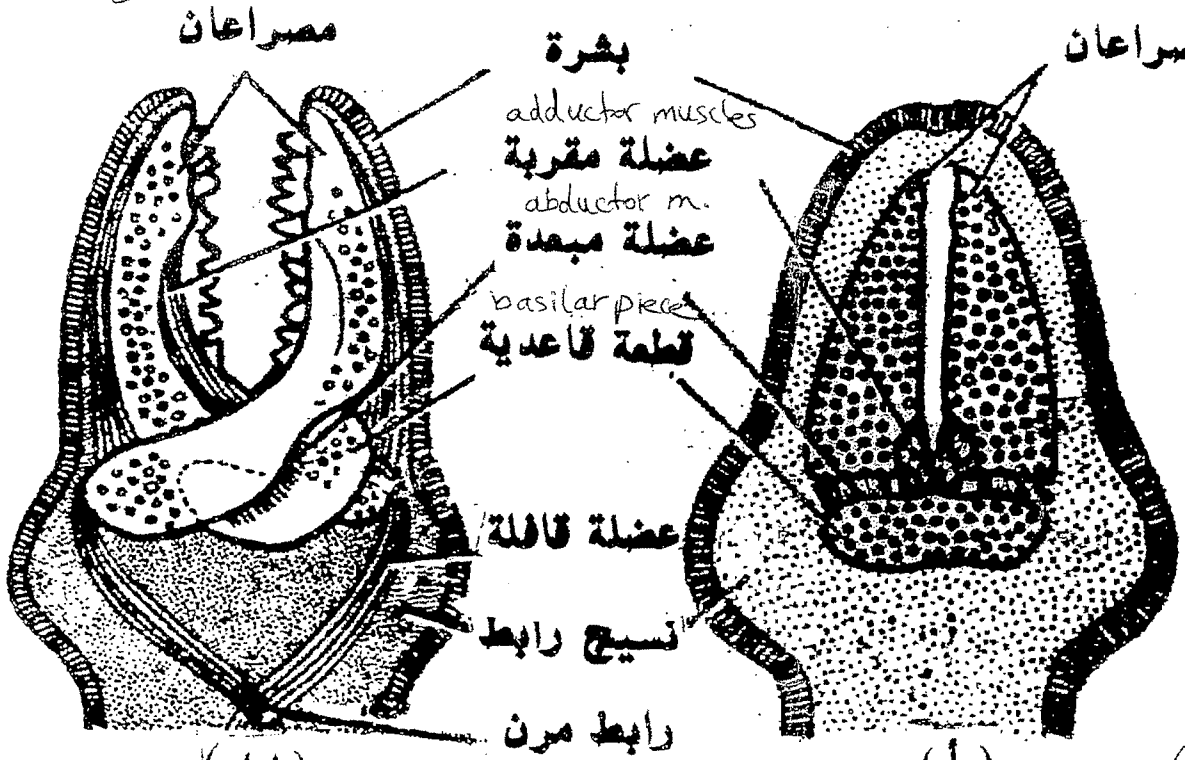
الشكل ١٠ ـ ٦ نجم بحر مشرح يبين التراكيب الداخلية .



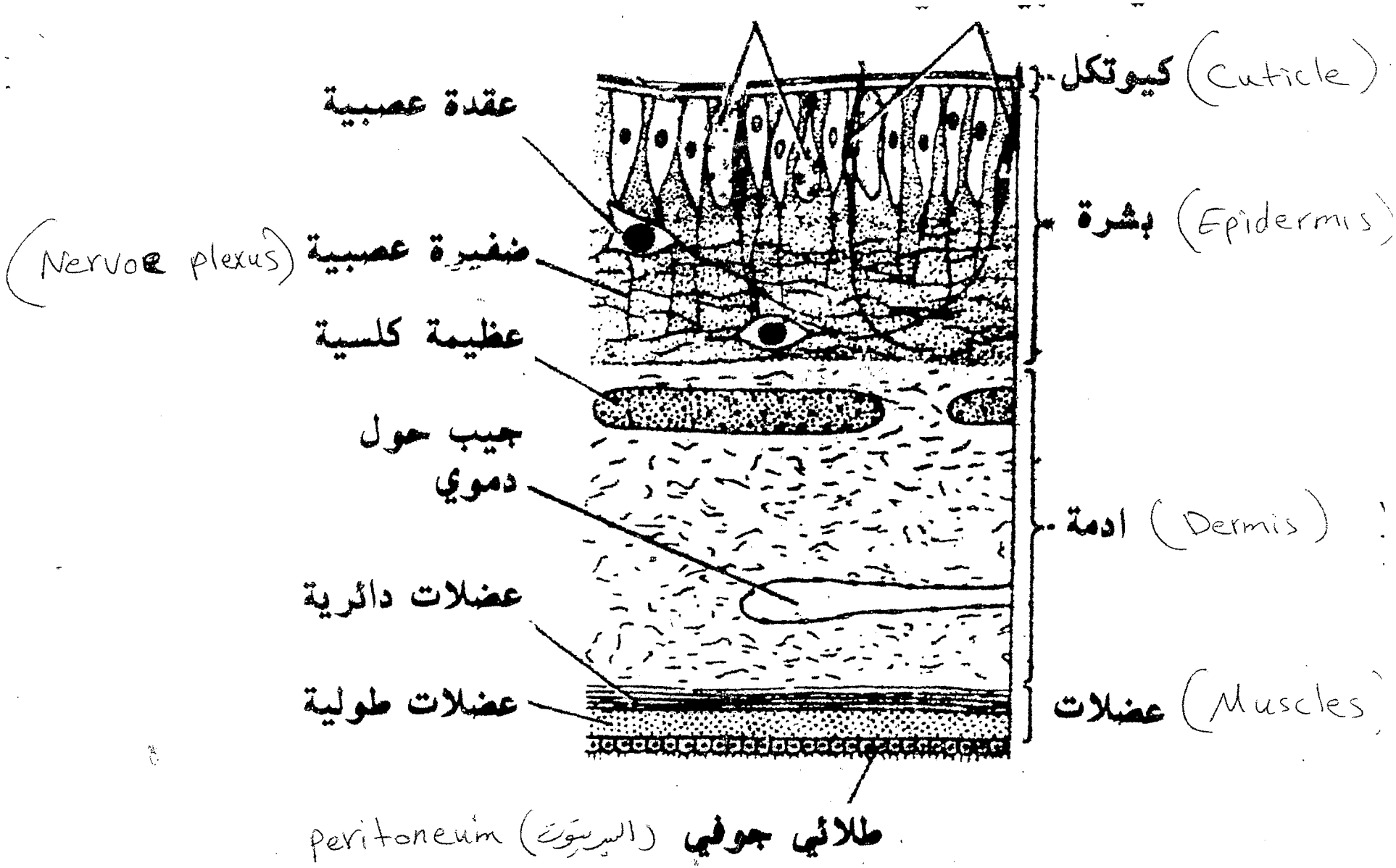
Dermal branchiae Or pa

(pedicellarige)

الشكل ١٠ ـ ٢ . باحة صغيرة من سطح نجم البحر تبين الاقدام الملقطية والغلاصم الجلدية المحيطة بشوكة كبيرة ثابتة .



الشكل ١٠ ـ ٢ . الاقدام الملقطية في نجم البحر (أ) الطراز الملقطي أو المستقيم (ب) الطراز المقصي أو المتصالب .



الشكل ١٠ ـ ٤ مقطع عمودي في جدار الجسم في نجم البحر.

Platyhelminthes = Flatworms

Characteristics of Platyhelminthes:-

1)Bilaterally symmetrical.
2)Body having 3 layers of tissues with organs and organelles.
3)Body contains no internal cavity.
4) Has closed digestive system .
5)Has Protonephridial excretory organs instead of an anus.
6)Has normally a nervous system of longitudinal fibres rather than a net.
7)Generally dorsoventrally flattened (like ribbon) .
8)Reproduction mostly sexual as hermaphrodites , sperm has two flagella
9)Mostly they feed on animals and other smaller life forms.
10)Some species occur in all major habitats, including many as parasites of other animals .

Classification

Phylum Platyhelminthes

Class Turbellaria ---------- Order : Tricladida ------ *Planaria*

Class Monogenea ------ *Polystomum*(life cycle happen in one host , have posterior suker) .

Class Trematoda -------- *Echinostoma* (sucker around the mouth and an additional ventral sucker that is used for locomotion and attachment to the host).

Class Cestoda --------

1- Order :Cestodaria------ *Amphilina*(the body not segmented)

2- Order : Eucestoda ------- *Taenia* (have segmented body)

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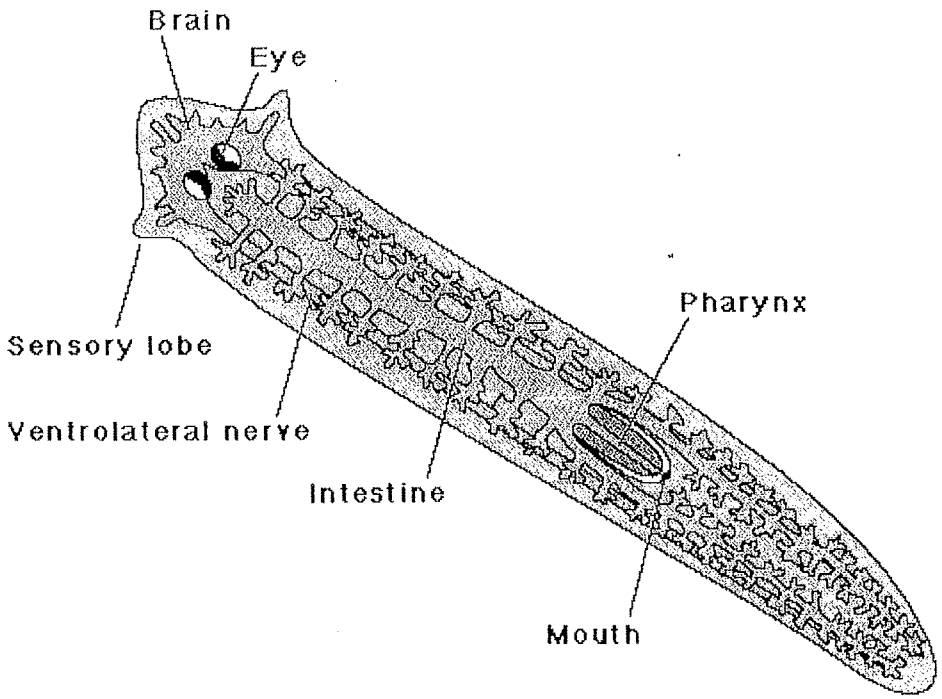
د. ابراهيم فالح

Planaria



The planarian has a soft, flat, wedge-shaped body that may be black, brown, blue, gray, or white. The blunt, triangular head has two ocelli (eyespots), pigmented areas that are sensitive to light. There are two auricles (earlike projections) at the base of the head, which are sensitive to touch and the presence of certain chemicals. The mouth is located in the middle of the underside of the body, which is covered with cilia (hairlike projections).Planaria are common to many parts of the world, living in both saltwater and freshwater ponds and rivers. Some species are terrestrial and are found under logs, in or on the soil, and on plants in humid areas.

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10/60

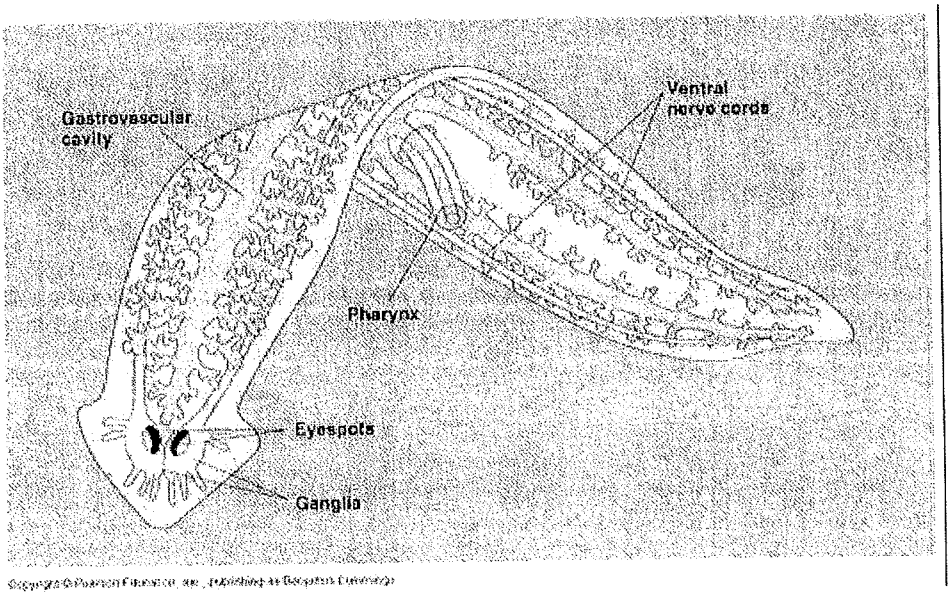
د. عباس خالد

Muscular-Skeletal :

Aflatworm has no skeleton , it has tiny bristles called cilia that help it move as well as two layers of muscles under its skin .

Digestive system :

The digestive system consists of a mouth, pharynx, and a gastrovascular cavity. The mouth is located in the center of the underside of the body. Digestive enzymes are secreted from the mouth to begin external digestion. The pharynx connects the mouth to the gastrovascular cavity. This structure branches throughout the body allowing nutrients from food to reach all extremities. Planaria eat living or dead small animals that they suck up with their muscular mouths. Food passes from the mouth through the pharynx into the intestines where it is digested by the cells lining the intestines. Then its nutrients diffuse to the rest of the body.



3 (61)

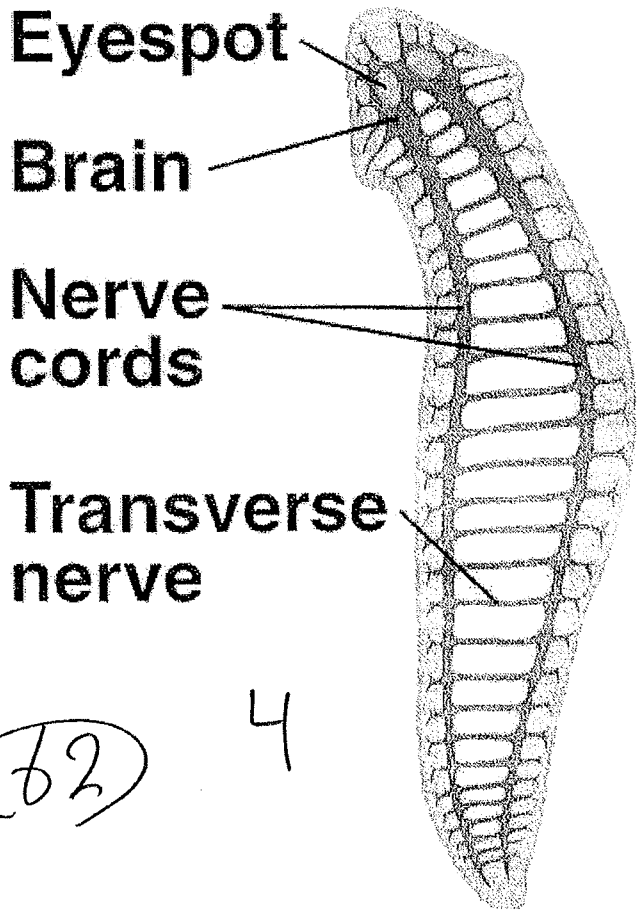
د. منيرا خالد

Respiratory system :

Planaria receive oxygen and release carbon dioxide by diffusion.

Nervous system

At the head of the planarian there is a ganglion under the eyespots. The cerebral ganglia, a bi-lobed mass of nerve tissue, is sometimes referred to as the planarian brain , and has been shown to exhibit spontaneous electrophysiological oscillations , similar to the electroencephalographic (EEG) activity of other animals. From the ganglion there are two nerve cords which extend the length of the tail. There are many transverse nerves connected to the nerve cords extending from the brain, which makes the nerve system look like a ladder. With a ladder-like nerve system, it is able to respond in a coordinated manner.



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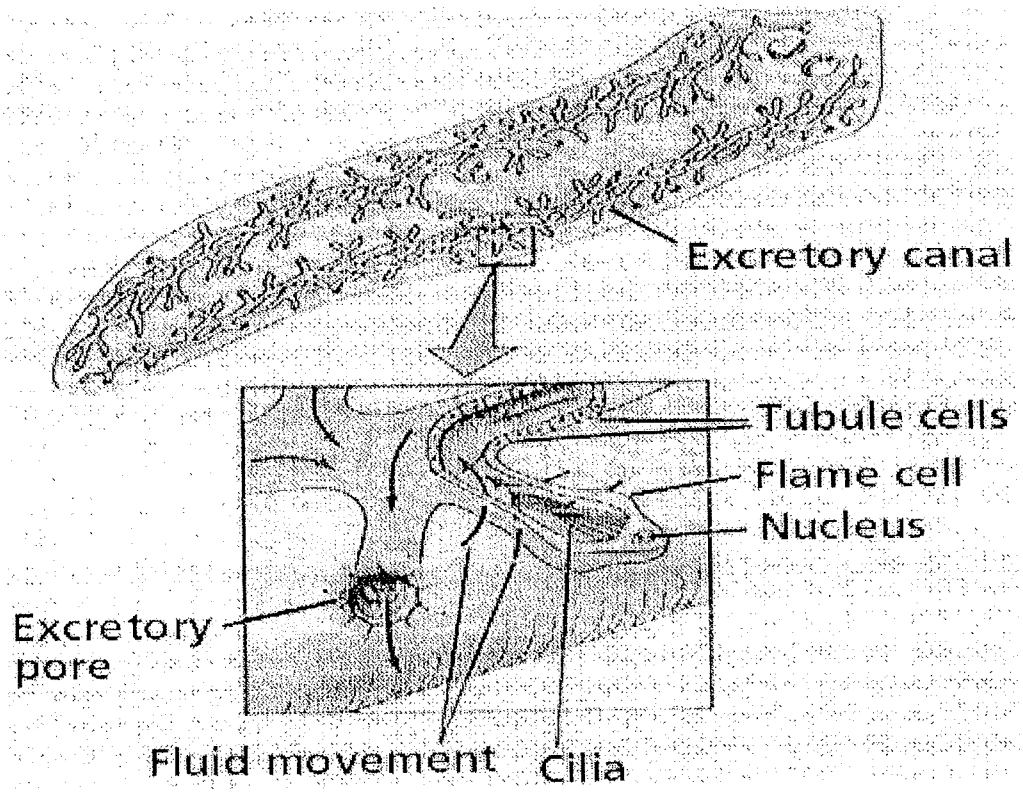
د. بشرى صالح

Excretory system

The excretory system is made of many tubes with many flame cells and excretory pores on them. Also, flame cells remove unwanted liquids from the body by passing them through ducts which lead to excretory pores, where waste is released on the dorsal surface of the planarian.

Flame cell

The flame cell has a nucleated cell body, with a "cup-shaped" projection, with flagella covering the inner surface of the cup. The beating of these flagella resemble a flame, giving the cell its name. The cup is attached to a **tube cell**, whose inner surface is also coated in cilia, which help to move liquid through the tube cell. The tube opens externally through a *nephropore*, or, in the trematoda, into an excretory bladder. The function of these cells is to regulate the osmotic pressure of the worm, and maintain its ionic balance. Microvilli in the tube cell may be used to reabsorb some ions



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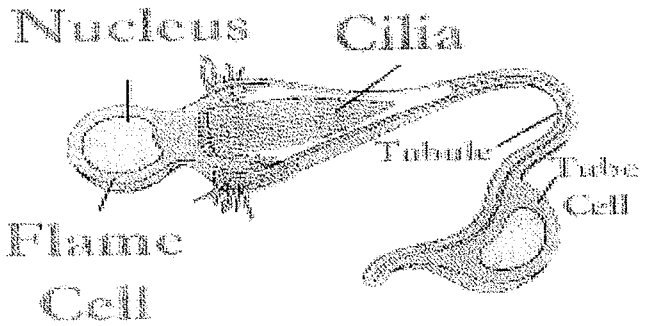
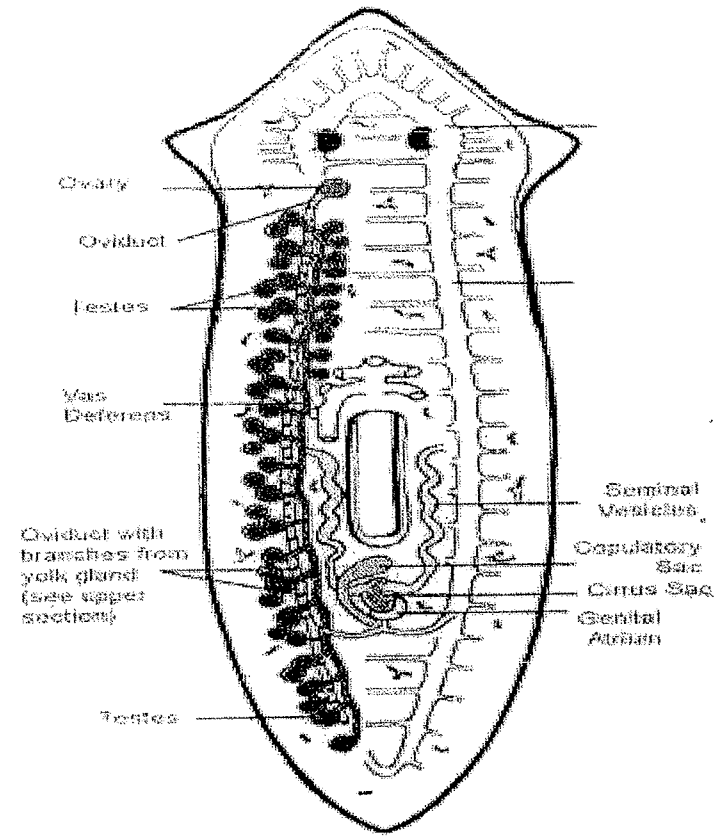


Planarian reproductive system

There are sexual and asexual planaria. Sexual planaria are hermaphrodites, possessing both testicles and ovaries. Thus, one of their gametes will combine with the gamete of another planarian. Each planarian transports its excretion to the other planarian, giving and receiving sperm. Eggs develop inside the body and are shed in capsules. Weeks later, the eggs hatch and grow into adults. Sexual reproduction is desirable because it enhances the survival of the species by increasing the level of genetic diversity. In asexual reproduction, the planarian detaches its tail end and each half regrows the lost parts by regeneration, allowing neoblasts (adult stem cells) to divide and differentiate, thus resulting in two worms. Some species of planaria are exclusively asexual, whereas some can reproduce both sexually and asexually.



Male reproductive system :

1- Many of Testes , spherical shape in two side of the body .

2-Vas efferens from each Testes ,molds in vas deferens then every vas defferens end with seminal vesicle (collect the sperm from the same worm then open in penis) .

Female reproductive system :

1-Two ovaries inner the anterior of the body .

2-Two oviduct molds many of vitellaria (Yolk gland).

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3-Atrium then open by Genital pore located behind mouth , in genital vacuole there is seminal receptacle its open in the open of Vagina , storage the sperms from another worm through copulation .

Hungering and Regeneration in *Planaria*

That worm has faculty to Regeneration , when the worm hunger he absorb his inner organs like :

1-Fertilization oviparous .

2-Yolk glands (Vitellaria)

3-Other reproduction organs.

4-Intestine .

5-Muscles .

Lost two third size of his body in nine months when the food availability the animal begins to return the lost organs (digested) by regeneration because has neoblasts = Interstitial = Archaeocytes .

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د. سناء صالح

Phylum : Aschelminthes

Characteristics of Phylum Aschelminthes are:-

1) Round worms have elongated, cylindrical and vermiform body with tapering ends.
2) Body is unsegmented but may be wrinkled. It is not distinguished two regions.
3) Body unpigmented being either white or with a yellowish tinge.
4) Caudal end of the body generally straight in female but coiled in males and the males are shorter than females.
5) Anterior cephalization is not prominent, therefore, the body is without any definite regions.
6) Mouth terminal surrounded by lips. In strongyloides the lips are modified into teeth known as leaf-crown.
7) Amphids and papillae are the main sensory organs and are of great taxonomic value in case of free-living forms.
8) Marine nematodes are annulated due to the presence of transverse striations or longitudinal striations which are of common occurrence.
9) Body is covered by rough resistant cuticle, having bristles, spines, warts and papillae etc. Sometimes cuticle modified as cephalic, cervical and lateral cuticle and in the form of vesicle.
10) Caudal end with a pouch of cuticular nature known as phasmids, very common in parasitic forms.
11) Cuticle in the strongyloides is modified into an umbrella-like form known as bursa which is generally supported by muscular rays.
12) The layers of body wall generally made up of cuticle, sub-cuticle or epidermis and muscle layer. The cuticle is generally of keratin which allows only glucose and urea etc.
13) Epidermis is syncytial where they are usually divided in four sections in the four longitudinal chords One dorsal, one ventral and 2 lateral in position.

14) Muscles consist of longitudinal muscle fibres with variable arrangements which is generally holomyarian, meromyarian and polymyarian etc. The muscles are of great taxonomic value.

15) The body cavity is pseudocoel.

16) Digestive tract well developed generally made up of mouth, buccal cavity, pharynx or oesophagus are of various types, intestine and anus.

17) Nervous system consists of a nerve-ring encircling the oesophagus. From it, nerves are given out anteriorly and posteriorly.

18) Protonephridia absent but the excretory system is made up of canals or gland-like organs.

19) Sexes are separate. Testis and ovaries are tubular and coiled. Usually there is a single testis. The ducts from the testis open into the cloaca and the cloaca is associated with accessory structures such as circular spicules. Ovaries, oviduct and uteri are double.

20) Aschelminthes are ovo-viviparous, oviparous or viviparous.

21) Life-cycle complicated, may be with or without intermediate host.

22) Larval stage four. Third stage of larva is infective.

Phylum Aschelminthes has been divided into five classes-

Class I- Nematoda

Class 2- Nematomorpha

Class 3- Rotifera

Class 4- Gastrotricha

Class 5- Kinorhyncha

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Class 1- Nematoda

1) They are aquatic, terrestrial or parasitic forms.

2) Body is slender, cylindrical, tapering towards both the ends. Body is covered with cuticle.

3) Intestine is well formed.

4) Body cavity is not lined with epithelium.

5) Cloaca is absent in female.

6) Male and female reproductive organs are well developed.

Examples- *Ascaris, Wuchereria, Trichinella*

Class 2- Nematomorpha

1) Body elongated thread like and unsegmented.

2) Well formed head absent.

3) Adults are free living, youngs are parasites in the body of insects and crustacean.

4) Presence of Cloaca.

5) Excretory organ absent.

6) Anterior and posterior part of the alimentary canal degenerate.

Examples- *Gordious, Paragoradium*

Class 3- Rotifera

1) Very transparent, microscopic, and aquatic.
2) Ciliary apparatus is present at the anterior end.
3) Body unsegmented and without any coeloms.
4) Pharynx with jaw apparatus known as mastax.
5) Flame cells in excretory organs.

Examples- ***Philodina, Brachionus***

Class 4- Gastrotricha

1) Microscopic, aquatic fresh water or marine.
2) Unsegmented body worm like, cilia in some parts of the body.
3) Cuticle with scales and bristles.
4) Paired protonephridia, each protonephridia is with a flame cell.

Examples- ***Chaetonotus, Turbanella***

Class 5- Kinorhyncha

1) Microscopic and live at the bottom.
2) Body slightly cylindrical with 13 indistinct segment, no cilia in the body.
3) Head with spine and is retractile.
4) Excretory duct paired with paired protonephridial duct, flame bulbs, multinucleate.

Examples- ***Echinoderes, Centroderes***

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Rotifer

Characteristics of Rotifera:-

1)Bilaterally symmetrical.

2)Body has more than two cell layers, tissues and organs.

3)Body cavity is a pseudocoelom.

4)Body possesses a through gut with an anus.

5)Body covered in an external layer of chitin called a lorica.

6)Has a nervous system with a brain and paired nerves.

7)Has no circulatory or respiratory organs.

8)Reproduction mostly parthenogenetic, otherwise sexual and gonochoristic.

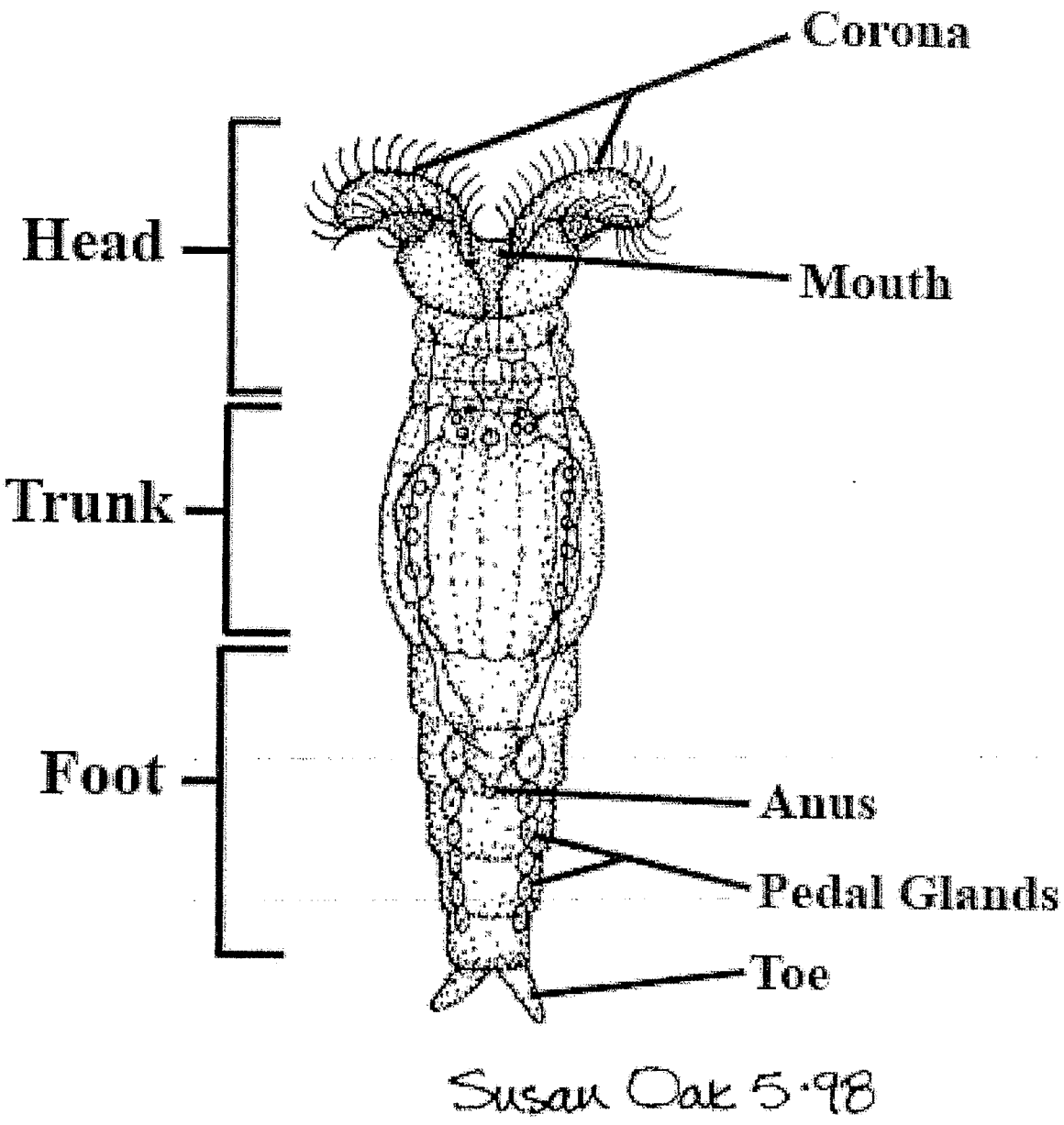
9)Feed on bacteria, and protista, or are parasitic.

10)All live in aquatic environments either free swimming or attached.

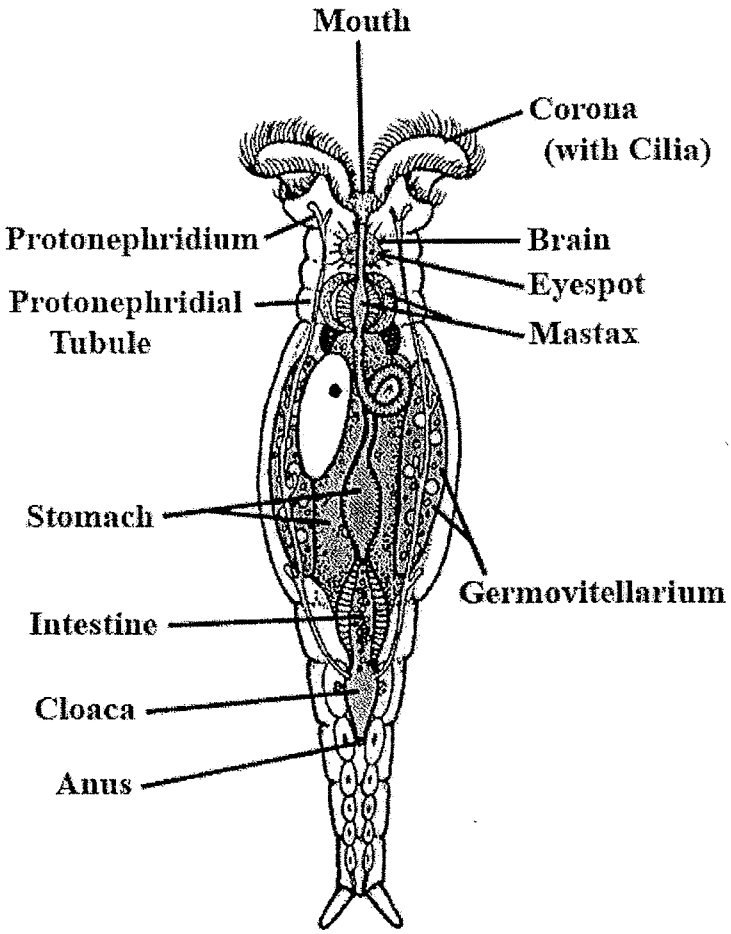
External Anatomy of Rotifers:

A rotifer's body consists of a distinct anterior *head* that bears the corona, a *trunk*, and a posterior *tail* or *foot*. Except for the corona, the body is not ciliated, and is often covered by a non-living *cuticle*. The corona (or *crown*) consists of either one or two rings of cilia. Beating of the coronal cilia creates water currents that help to draw food into a rotifer's mouth. In some species, the corona can create currents strong-enough to pull the animals through the water – in other words, some rotifers use their crowns not just for food-gathering, but for swimming.A rotifer's trunk contains most of the animal's internal organs, and may bear sensory antennae. Some

rotifers have a true cuticle that consists of an outer layer of non-living material secreted by the epidermis; all have protein fibers embedded in the epidermis that help to strengthen it. This tough epidermis and/or cuticle helps provide some protection from external dangers, but also helps the animal resist pressure generated from the *inside*. Rotifers are pseudocoelomates, and the tough epidermis and/or cuticle helps them resist the internal pressure of the pseudocoelom, which might otherwise cause the epidermis to split. The foot of a rotifer is narrowed and usually bears from one to four *toes*. The foot contains *pedal glands* that secrete a glue-like material that a rotifer can use to attach itself to surfaces.



The external anatomy of a typical rotifer.



Digestive system

The coronal cilia create a current that sweeps food into the mouth. The mouth opens into a characteristic chewing pharynx (called the *mastax*), sometimes via a ciliated tube, and sometimes directly. The pharynx has a powerful muscular wall and contains tiny, calcified, jaw-like structures called *trophi*, which are the only fossilizable parts of a rotifer. The shape of the trophi varies between different species, depending partly on the nature of their diet. In suspension feeders, the trophi are covered in grinding ridges, while in more actively carnivorous species, they may be shaped like forceps to help bite into prey. In some ectoparasitic rotifers, the mastax is adapted to grip onto the host, although, in others, the foot performs this function instead. Behind the mastax lies an oesophagus, which opens into a stomach where most of the digestion and absorption occurs. The stomach opens into a short intestine that terminates in a cloaca on the posterior dorsal surface of the animal. Up to seven salivary

glands are present in some species, emptying to the mouth in front of the oesophagus, while the stomach is associated with two gastric glands that produce digestive enzymes. A pair of protonephridia open into a bladder that drains into the cloaca. These organs expel water from the body, helping to maintain osmotic balance.

Nervous system

Rotifers have a small brain, located just above the mastax, from which a number of nerves extend throughout the body. The number of nerves varies between species, although the nervous system usually has a simple layout. Close to the brain lies a *retrocerebral organ*, consisting of two glands either side of a medial sac. The sac drains into a duct that divides into two before opening through pores on the uppermost part of the head. Its function is unclear. Rotifers typically possess one or two pairs of short antennae and up to five eyes. The eyes are simple in structure, sometimes with just a single photoreceptor cell. In addition, the bristles of the corona are sensitive to touch, and there are also a pair of tiny sensory pits lined by cilia in the head region.

Biology

The coronal cilia pull the animal, when unattached, through the water. Like many other microscopic animals, adult rotifers frequently exhibit eutely—they have a fixed number of cells within a species, usually on the order of 1,000. Bdelloid rotifer genomes contain two or more divergent copies of each gene, suggesting a long-term asexual evolutionary history. For example, four copies of hsp82 are found. Each is different and found on a different chromosome excluding the possibility of homozygous sexual reproduction. Its thin lamellae resemble cabbage leaves, and are composed from their creases of the receptor membrane.

Feeding

Rotifers eat particulate organic detritus, dead bacteria, algae, and protozoans. They eat particles up to 10 micrometres in size. Like crustaceans, rotifers contribute to nutrient recycling. For this reason, they are used in fish tanks to help clean the water, to prevent clouds of waste matter. Rotifers affect the species composition of algae in ecosystems through their choice in grazing. Rotifers may be in competition with cladocera and copepods for slowvagplanktonic food sources.

د. بشرى فالح

Reproduction and life cycle

Rotifers are dioecious and reproduce sexually or parthenogenetically. They are sexually dimorphic, with the females always being larger than the males. In some species, this is relatively mild, but in others the female may be up to ten times the size of the male. In parthenogenetic species, males may be present only at certain times of the year, or absent altogether. The female reproductive system consists of one or two ovaries, each with a *vitellarium* gland that supplies the eggs with yolk. Together, each ovary and vitellarium form a single syncitial structure in the anterior part of the animal, opening through an oviduct into the cloaca. Males do not usually have a functional digestive system, and are therefore short-lived, often being sexually fertile at birth. They have a single testicle and sperm duct, associated with a pair of glandular structures referred to as *prostates* (unrelated to the vertebrate prostate). The sperm duct opens into a gonopore at the posterior end of the animal, which is usually modified to form a penis. The gonopore is homologous to the cloaca of females, but in most species has no connection to the vestigial digestive system, which lacks an anus.

Fertilization is internal. The male either inserts his penis into the female's cloaca or uses it to penetrate her skin, injecting the sperm into the body cavity. The egg secretes a shell, and is attached either to the substratum, nearby plants, or the female's own body. A few species, such as *Rotaria*, are ovoviviparous, retaining the eggs inside their body until they hatch. Most species hatch as miniature versions of the adult. Sessile species, however, are born as free-swimming larvae, which closely resemble the adults of related free-swimming species. Females grow rapidly, reaching their adult size within a few days, while males typically do not grow in size at all. The life span of monogonont females varies from two days to about three weeks.

Loss of sexual reproduction

'Ancient asexuals': Bdelloid rotifers are assumed to have reproduced without sex for many millions of years. Males are absent within the species, and females reproduce only by parthenogenesis.

Recent transitions: Loss of sexual reproduction can be inherited in a simple Mendelian fashion in the monogonont rotifer *Brachionus calyciflorus*: This species can normally switch between sexual and

asexual reproduction (cyclical parthenogenesis), but occasionally gives rise to purely asexual lineages (obligate parthenogens). These lineages are unable to reproduce sexually due to being homozygous for a recessive allele.

Resting eggs

Males in the class Monogononta may be either present or absent depending on the species and environmental conditions. In the absence of males, reproduction is by parthenogenesis and results in offspring that are genetically identical to the parent. Individuals of some species form two distinct types of parthenogenetic eggs; one type develops into a normal parthenogenetic female, while the other occurs in response to a changed environment and develops into a degenerate male without a digestive system, but with a complete male reproductive system used to inseminate females thereby producing fertilized 'resting eggs' (also termed diapausing eggs). Resting eggs develop into zygotes that can survive extreme environmental conditions such as may happen during winter or when the pond dries up. These eggs resume development and produce a new female generation when conditions improve again.

Anhydrobiosis

Bdelloid rotifer females cannot produce resting eggs, but many can survive prolonged periods of adverse conditions after desiccation. This facility is termed anhydrobiosis, and organisms with these capabilities are termed anhydrobionts. Under drought conditions, bdelloid rotifers contract into an inert form and lose almost all body water; when rehydrated they resume activity within a few hours. Bdelloids can survive the dry state for long periods, with the longest well-documented dormancy being nine years. While in other anhydrobionts, such as the brine shrimp, this desiccation tolerance is thought to be linked to the production of trehalose, a non-reducing disaccharide (sugar), bdelloids apparently cannot synthesise trehalose. In bdelloids, a major cause of the resistance to desiccation, as well as resistance to ionizing radiation, is a highly efficient mechanism for repairing the DNA double-strand breaks induced by these agents. This repair mechanism likely involves mitotic recombination between homologous DNA regions.

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Annelida

The phylum's name is derived from the Latin word *annelus*, meaning "little ring".

General characters of Annelida

1. Habitat:- mostly aquatic, marine or freshwater, burrowing or free living.
2. Body is elongated and vermiform.
3. Triploblastic, segmented body.
4. Cuticle (secreted by epidermis) covers the whole body; outer covering.
5. Locomotory organ:-setae or chetae (hair) and parapoda.
6. Respiration through body surface , in some by gills.
7. Blood vascular system:- close type(blood is red due to presence of haemoglobin.
8. Excretion by nephredia (paired and segmented).
9. nervous system:- consist of brain and segmental ganglia.
10. Direct development (when sexes are separate), indirect (when sexes are united).

Segmentation

Prostomium

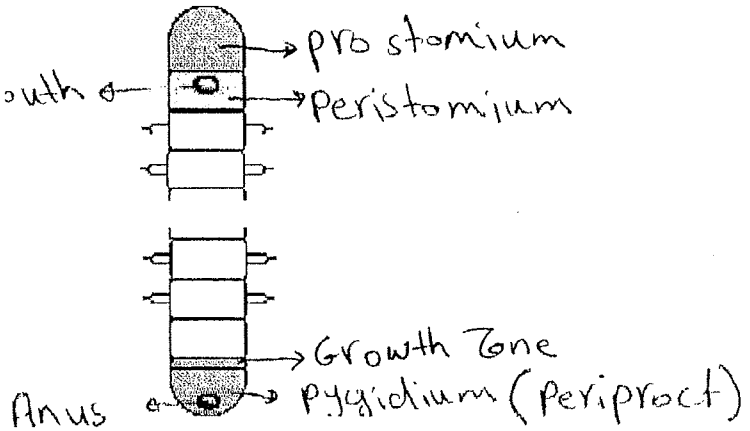
Peristomium

O Mouth

Growth zone

Pygidium

O Anus



Segments of an annelid

The frontmost section, called the prostomium (Greek προ- meaning "in front of" and στομα meaning "mouth") contains the brain and sense organs, while the rearmost, called the pygidium (Greek πυγιδιον, meaning "little tail") or periproct contains the anus, generally on the underside. The first section behind the prostomium, called the peristomium (Greek περι- meaning "around" and στομα meaning "mouth"), is regarded by some zoologists as not a true segment, but in some polychaetes the peristomium has chetae and appendages like those of other segments.

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Classification of Annelida

Class Polychaeta :----- *Neris*

1- (Poly = many, Chaeta = bristle) .
2- are the most diverse and most speciose group of the Annelida containing over 5,500 species.
3- Most polychaetes are gonochoristic (meaning they are either male or female).

Class Clitellata contains three distinct groups:

Subclass Oligochaeta:

1- **Oligochaeta** (Oligo = few, Chaeta = bristle) are the second most numerous group of annelids with around 3,100 species.
2- Oligochaeta live in marine, freshwater and terrestrial habitats.
3- They are normally hermaphrodites, and possess a clitellum as adults, an organ which looks like a bandage of skin wrapped around the animal. This clitellum, from which the whole group takes its name has an important function in sexual reproduction, otherwise reproduction may asexual by fission.
4- A few species are parasitic but most species are free living.

-**Order** : Plesiopora ------ *Tubifex*

- **Order :** Prosopora ------ *Lumbriculus.*

- **Order :** Opisthopora ---- *Lumbricus.*

① plesiopora : تتفتح القنوات المنوية الرئيسية اي خارج في الحلقة التي تقع خلف الحلقة الكاذبة على الجزء المتبقي .

② Prosopora : تفتح القنوات المنوية الرئيسية في نفس الحلقة الكاذبة على الجزء .

③ Opisthopora : توجد بين الحلقة الكاذبة والجزء والحلقة التي تفتح منها القنوات المنوية حلقة واحدة أو اكثر

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Subclass Branchiobdella:----- *Branchiobdella parasita*

- **They are parasite animals.**

Subclass Hirundinea :------- ***Hirudo***

1- contains the 500 or so species of animals commonly known as leeches.

2- Leaches are well known for their blood sucking habits and their head to tail looping mode of locomotion. (somersualting) like hydra.

3- they have two suckers which in most cases are located one at the anterior (head) end of the body composed of segments 1-4 and the other at the posterior (tail) end composed of segments 25-33.

4- Fresh water, marine and terrestrial environments.

Earthworm

is a tube-shaped, segmented worm commonly found living in soil, that feeds on live and dead organic matter.

Body – Wall

The outermost layer of the earthworm body wall is the cuticle - a delicate membrane of fibrils that, along with the mucus that covers the skin of the worm, helps retain water. Earthworms generally require moist habitats and are in a sense only partially adapted to life on land as they rapidly desiccate if caught in sunlight. However, there usual habitat of burrowing in soil and possibly crawling about leaf litter at night retains plenty of moisture

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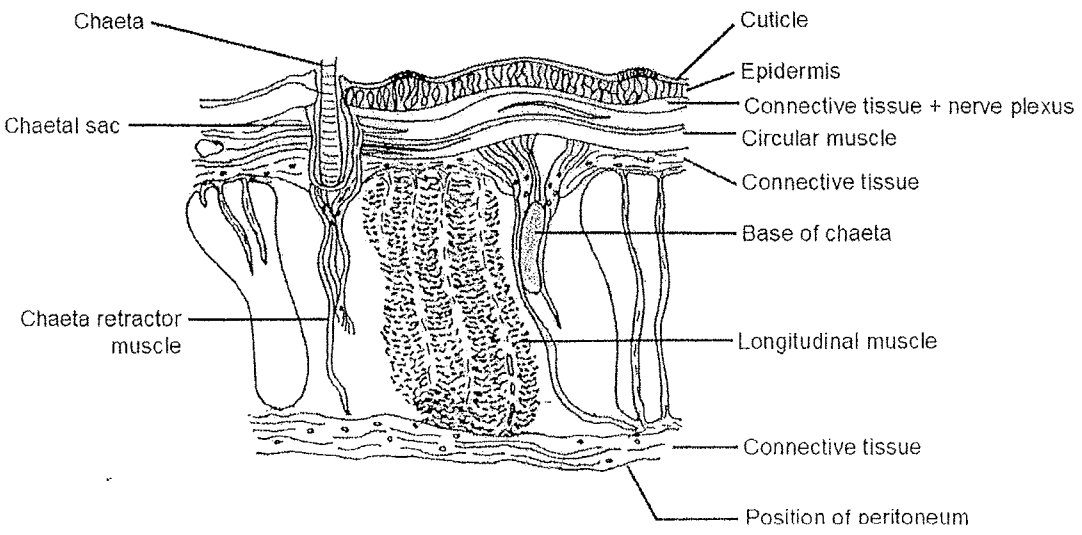
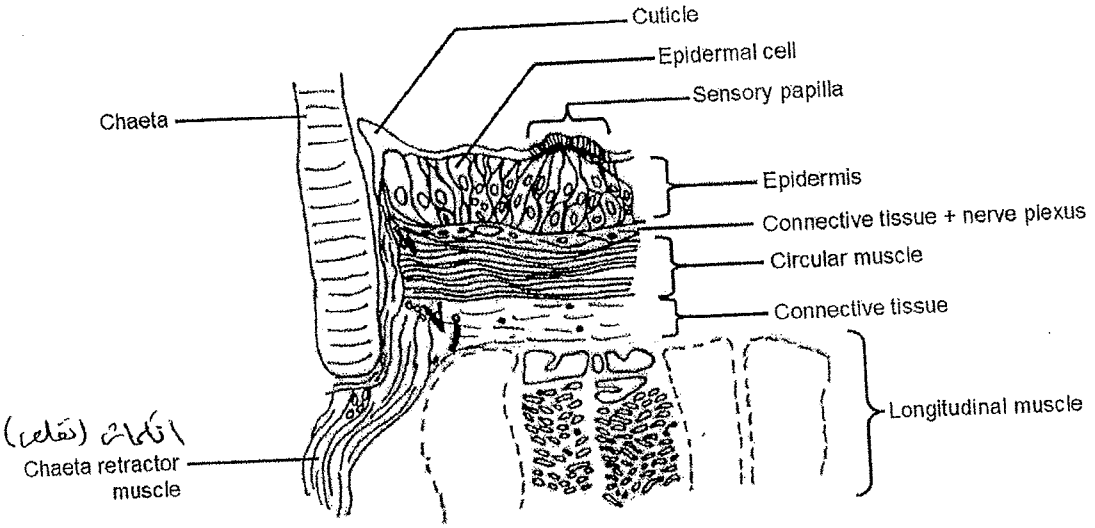
and earthworms are superbly adapted to this environment. The cuticle is secreted by the epidermis - a covering layer of cells, or epithelium. The epidermis consists of tall columnar cells. Beneath the epidermis is a basement layer of connective tissue, permeated by nerve cell processes, forming a sub-epidermal nerve network or plexus. Inside this layer is a cylinder of circular muscle - muscle whose fibres run in circular courses around the worm, investing it in a sheath that can contract to make the worm thinner. Beneath this is another layer of connective tissue and then a cylinder of longitudinal muscle - muscle whose fibres run lengthwise from anterior to posterior parallel to the long axis of the worm and whose contractions make the worm shorter.

Medium-power view of a section of the body wall of *Lumbricus terrestris*



High-power view of a section of the body wall of *Lumbricus terrestris*



The earthworm body wall is richly supplied by blood. Capillaries (tiny blood vessels) form loops inside the body wall, extending to just beneath the epidermis. These capillaries help give the worm its red-brown colour and have a respiratory function - oxygen diffuses across the cuticle and epidermis into the body wall where it is rapidly absorbed by pigments in the blood and carried away to create a diffusion gradient along which oxygen diffuses into the wall more rapidly. In this way the skin of the worm is behaving rather like the lining of the lungs of mammals. Carbon dioxide waste gas is also carried in the blood and this diffuses out across the epidermis .

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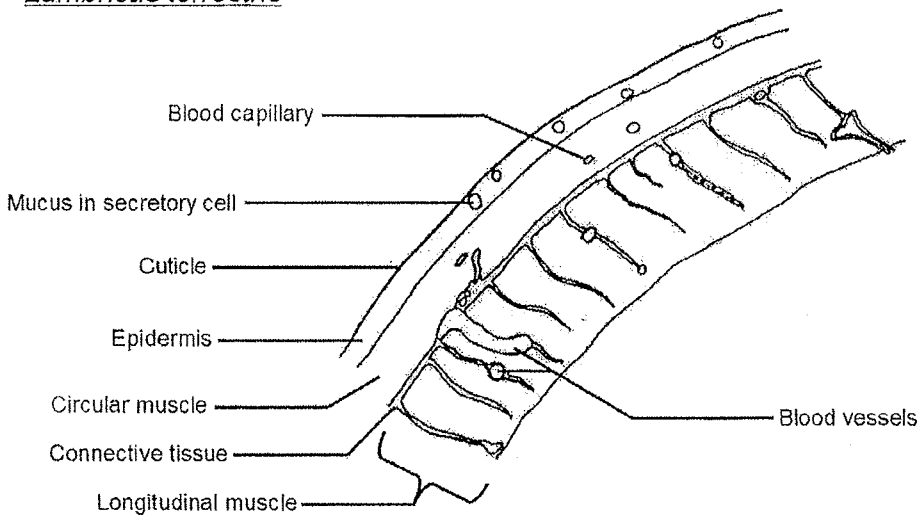
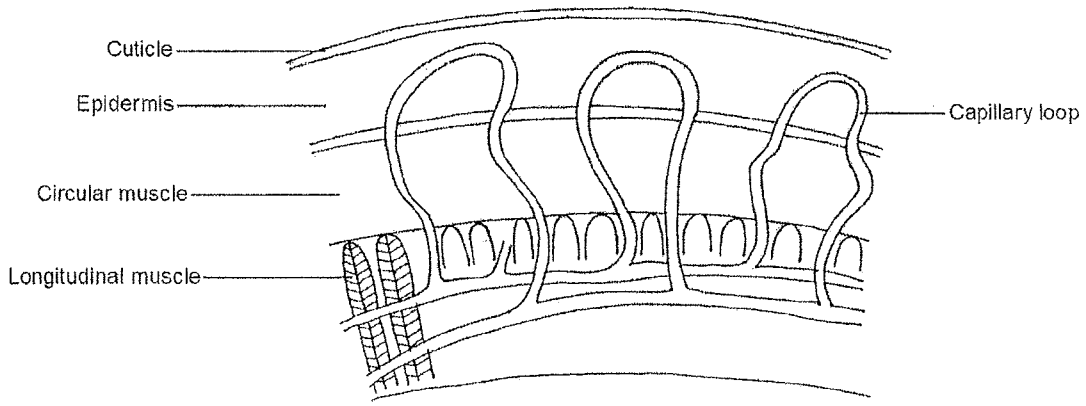
Low-power view of T.S. of the body wall of *Lumbricus terrestris*





The blood supply to the body wall of *Lumbricus*

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Digestive system

1- The gut of the earthworm is a straight tube which extends from the worm's mouth to its anus.

2- Buccal cavity (generally running through the first one or two segments of the earthworm), pharynx (running generally about four segments in length), esophagus, crop, gizzard (usually) and intestine.

3- gizzard, strong muscular contractions grind the food with the help of mineral particles ingested along with the food. Once through the gizzard, food continues through the intestine for digestion. pharynx, the pharyngeal glands secrete mucus.

4- The intestine secretes pepsin to digest proteins, amylase to digest polysaccharides, cellulase to digest cellulose, and lipase to digest fats. Instead of being coiled like a mammalian intestine, an earthworm's intestine increases surface area to increase nutrient absorption by having many folds running along its length.

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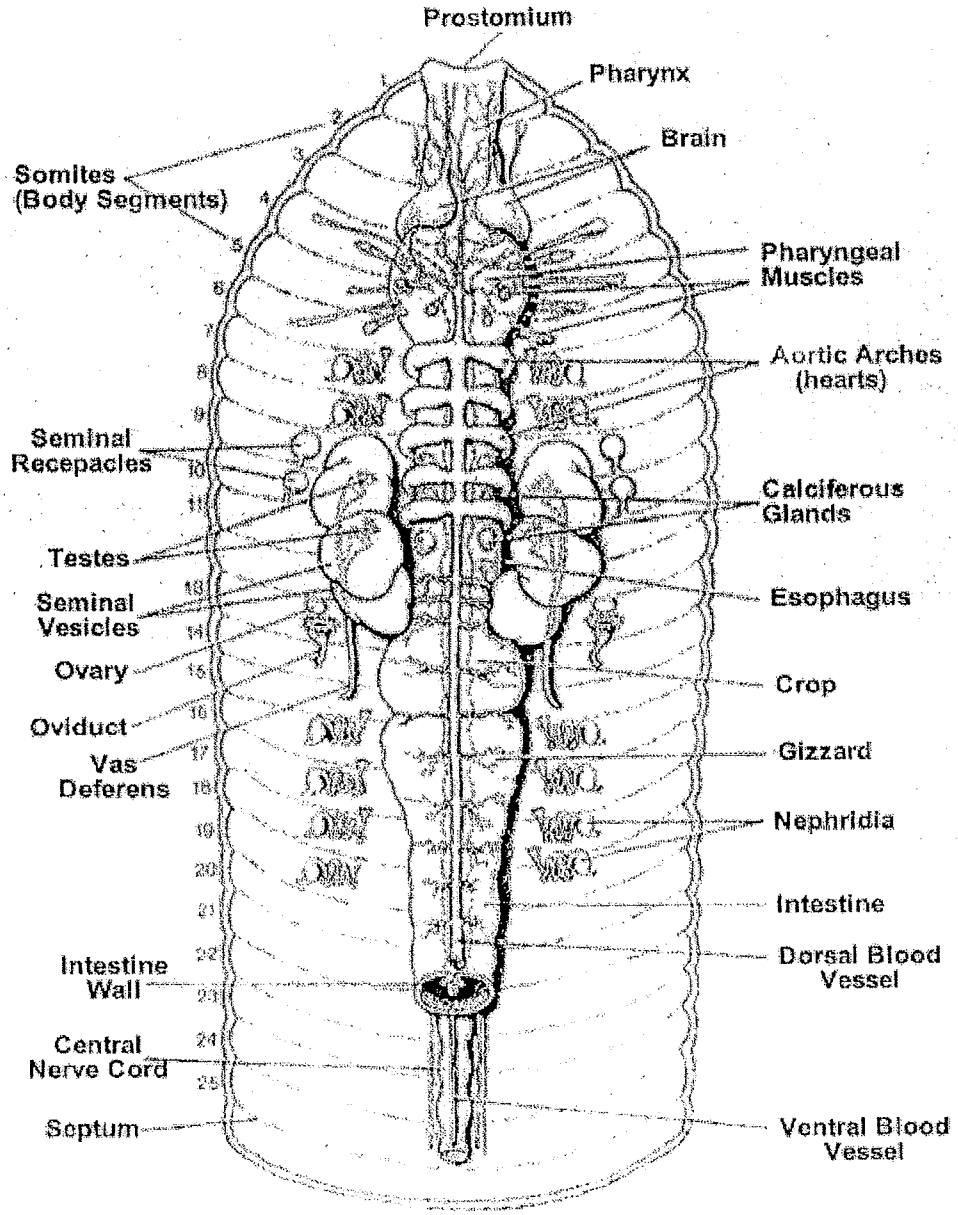

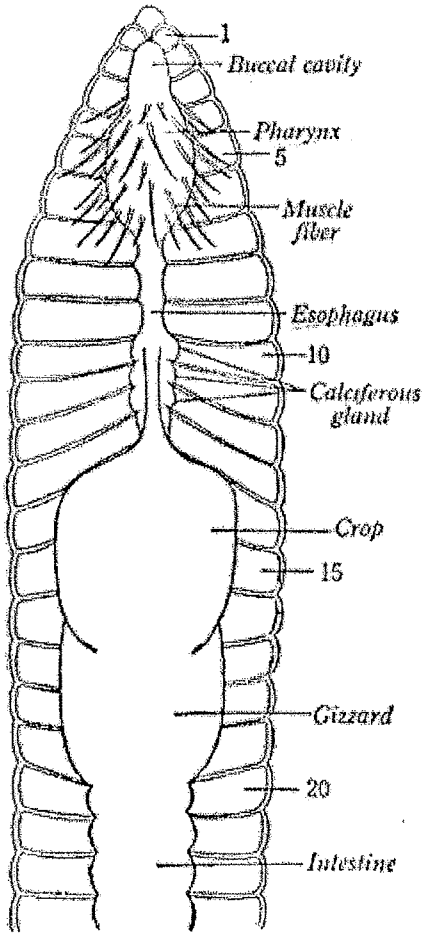

FIG. 156. *Digestive System of Earthworm,* Lumbricus terrestris[1]

This is a diagrammatic drawing of the worm dissected from the dorsal side. Each fifth segment is numbered, and the intestine continues with little change to the anal opening, at the posterior end of the body

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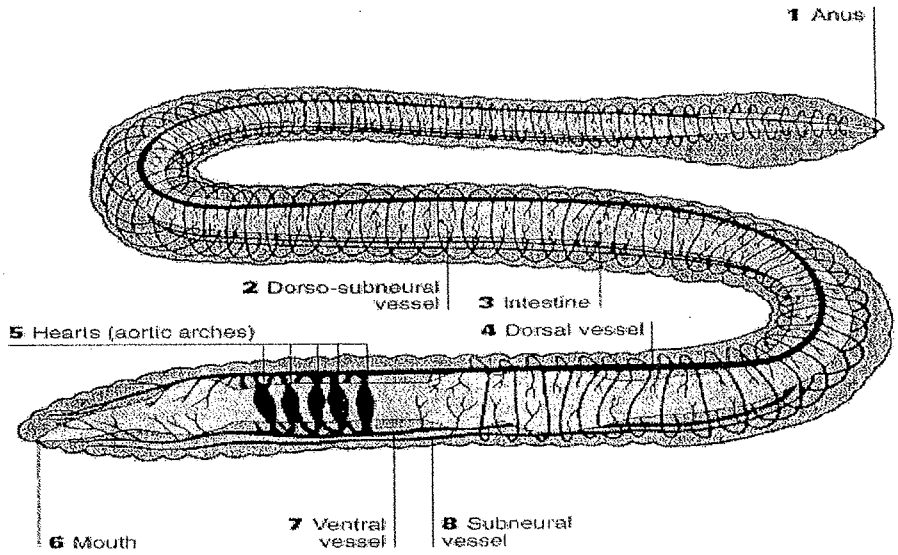
Circulatory System

The earthworm has a closed circulatory system. An earthworm circulates blood exclusively through vessels. There are three main vessels that supply the blood to organs within the earthworm. These vessels are the aortic arches, dorsal blood vessels, and ventral blood vessels. The aortic arches function like a human heart. There are five pairs of aortic arches, which have the responsibility of pumping blood into the dorsal and ventral blood vessels. The dorsal blood vessels are responsible for carrying blood to the front of the earthworm's body. The ventral blood vessels are responsible for carrying blood to the back of the earthworm's body.



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Respiratory System

Earthworms do not have lungs. They breathe through their skin. Oxygen and carbon dioxide pass through the earthworm's skin by diffusion. For diffusion to occur, the earthworm's skin must be kept moist. Body fluid and mucous is released to keep its skin moist. Earthworms therefore, need to be in damp or moist soil. This is one reason why they usually surface at night when it is possibly cooler and the "evaporating potential of the air is low. Earthworms have developed the ability to detect light even though they cannot see. They have tissue located at the earthworm's head that is sensitive to light. These tissues enable an earthworm to detect light and not surface during the daytime where they could be affected by the sun.

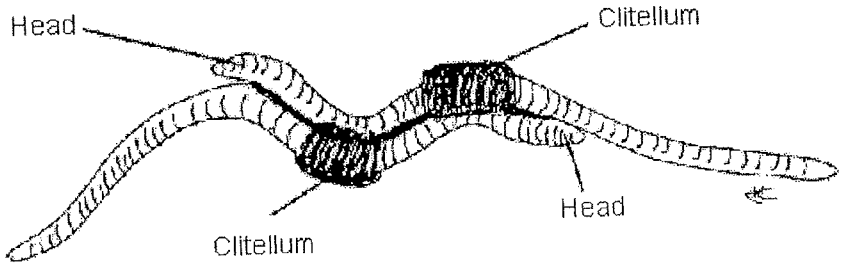
Excretion system

Nitrogen containing waste (from protein breakdown) is removed by Nephridia . These are long coiled tubes which remove nitrogen wastes from blood capillaries and excrete it through tiny pores on the skin surface , there are two nephridia in each segment .

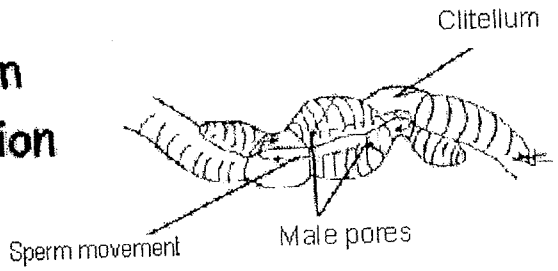
Earthworm Reproduction

Earthworms are hermaphrodites where each earthworm contains both male and female sex organs. The male and female sex organs can produce sperm and egg respectively in each earthworm. Although earthworms are hermaphrodites, most need a mate to reproduce. During mating, two worms line up inverted

from each other so sperm can be exchanged. The earthworms each have two male openings and two sperm receptacles, which take in the sperm from another mate. The earthworms have a pair of ovaries that produce eggs. The clitellum will form a slime tube around it, which will fill with an albuminous fluid. The earthworm will move forward out of the slime tube. As the earthworm passes through the slime tube, the tube will pass over the female pore picking up eggs. The tube will continue to move down the earthworm and pass over the male pore called the spermatheca which has the stored sperm called the spermatozoa. The eggs will fertilize and the slime tube will close off as the worm moves completely out of the tube. The slime tube will form an "egg cocoon" and be put into the soil. The fertilized eggs will develop and become young worms.



Earthworm Reproduction



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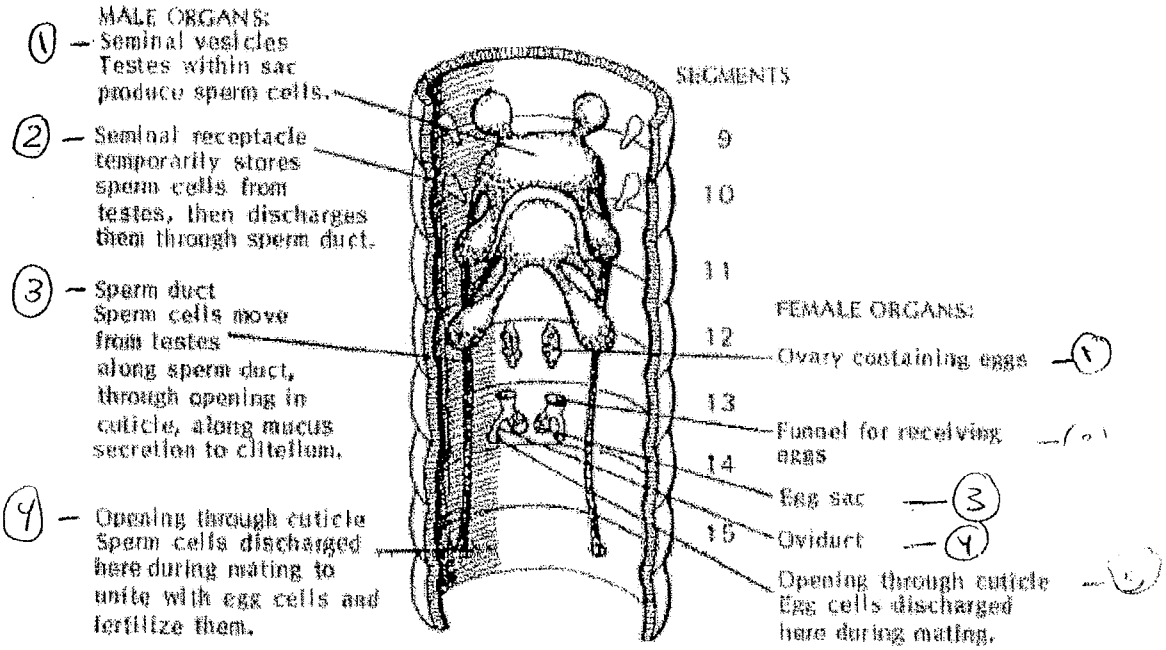

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