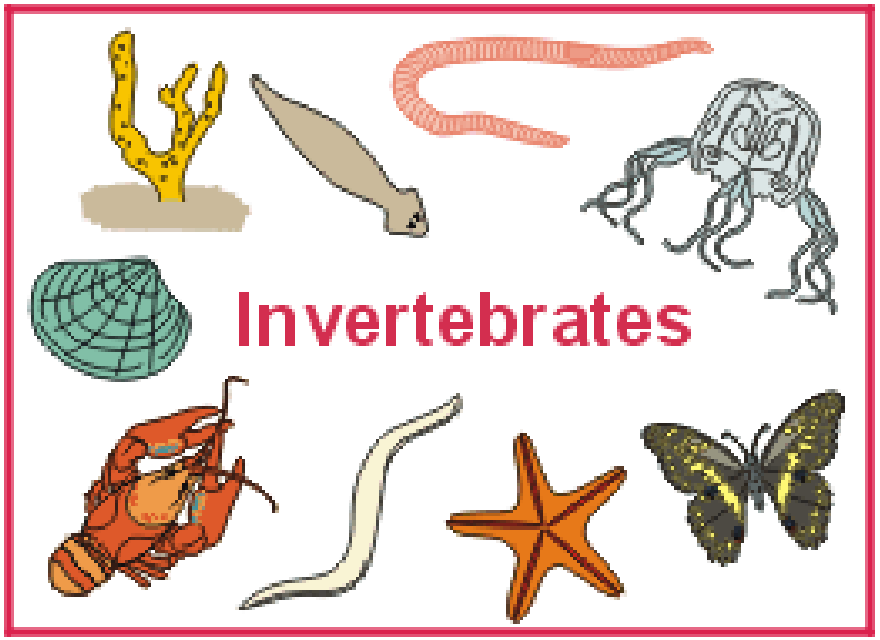
Invertebrates

Biology Department

Instructor: Dr. Soolaf A. Kathiar & Dr. Dr. Maysoon Hassan



Kingdoms

- Monera (the prokaryotes)
- Protista (the single-celled eukaryotes)
- Fungi
- Plantae
- Animalia

Animal Phylums There are around 30 to 40 different animal phylums (depending on the source you use), but we are only going to talk about 9 major groups:

1) **Phylum Porifera "The Sponges"**
2) **Phylum Cnidaria "Jellyfish/Coral"**
3) **Phylum Platyhelminthes "The Flatworms"**
4) **Phylum Nematoda "The Roundworms"**
5) **Phylum Annelida "The Segmented Worms"**
6) **Phylum Mollusca "Think Seafood - Clams, Oysters"**
7) **Phylum Arthropoda "Insects"**
8) **Phylum Echinodermata "Starfish"**

What is an Invertebrate?

- Invertebrates are animals without a **vertebral column**
- The Invertebrates are not a homogenous group of phyla
- Thy are a miscellany of animals, falling into a number of phyla, some of which are related whilst others are not
- They show greater range of forms and adaptations than do the vertebrates
- Invertebrates consist about 97% of all known animal species, the remaining 3% are the rest

The benefits of Invertebrates

- Crayfish, Clam, Shrimp...ect. Considered to be a great recourse of food for human.
- Used in scientific research, such as drosophila which used in genetics.
- Some species act as indicator for water pollution, such as *Daphinia.*
- Some insects produce wax, honey, and silk, and play an important role in plant fertilization.
- Used in biological control as a biological agents to control pests, such as lady beetles which used against aphids
- Invertebrates species play a significant role in food chain and serve as food for other animals

The harms of Invertebrate

- Some invertebrates are regarded as pests on agriculture products, such as grasshopper, beetles, nematodes, and mites.
- Some species with medical importance that transmit and cause diseases, such as Nematodes, Ticks, Plasmodium, Schistosoma, flies, fleas, mosquitoes....
- Several group of marine invertebrates, such as Cnidarians and Sponges are accumulated on emerged parts of ship and electric generates causing in reduction of their efficiency.

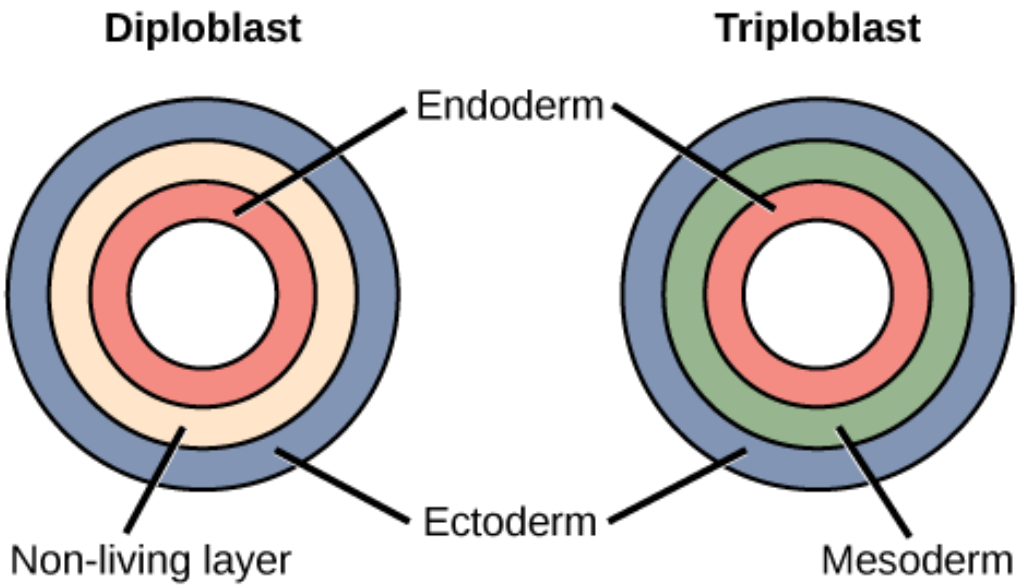
Animal Classification
cellular construction

1. **Protozoa**: one cell animals.
2. **Parazoa**: multicellular animal with loosely aggregated cells.
3. **Metazoa**: multicellular animal, cells are arranged in a germ layer.

Metazoa Classification

Metazoa are classified according to their germ layer into:

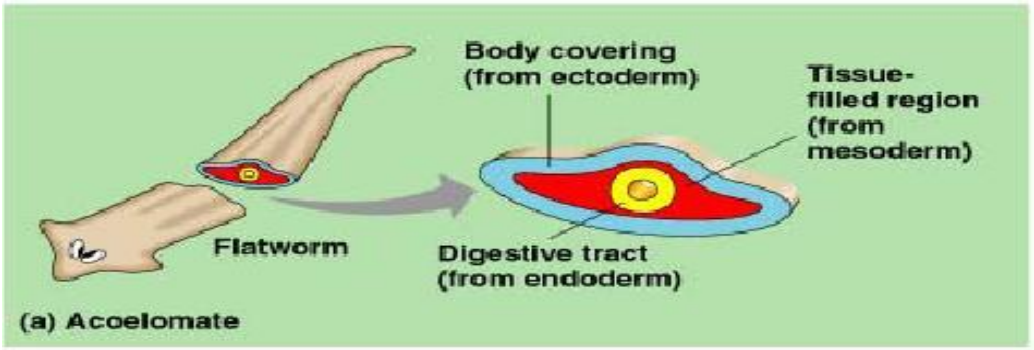
1. **Diploblastea**; with two germ layers, ectoderm & endoderm (Cnidaria & Ctenophora)
2. **Triploblastea**: with three germ layers, ectoderm, mesoderm & endoderm (other animals)



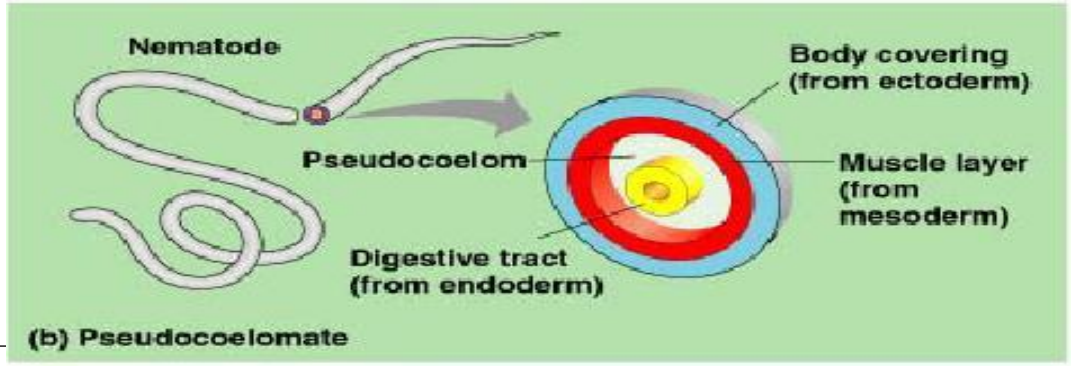
Animal Classification
Presence or absence of body cavity (Coelom)

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

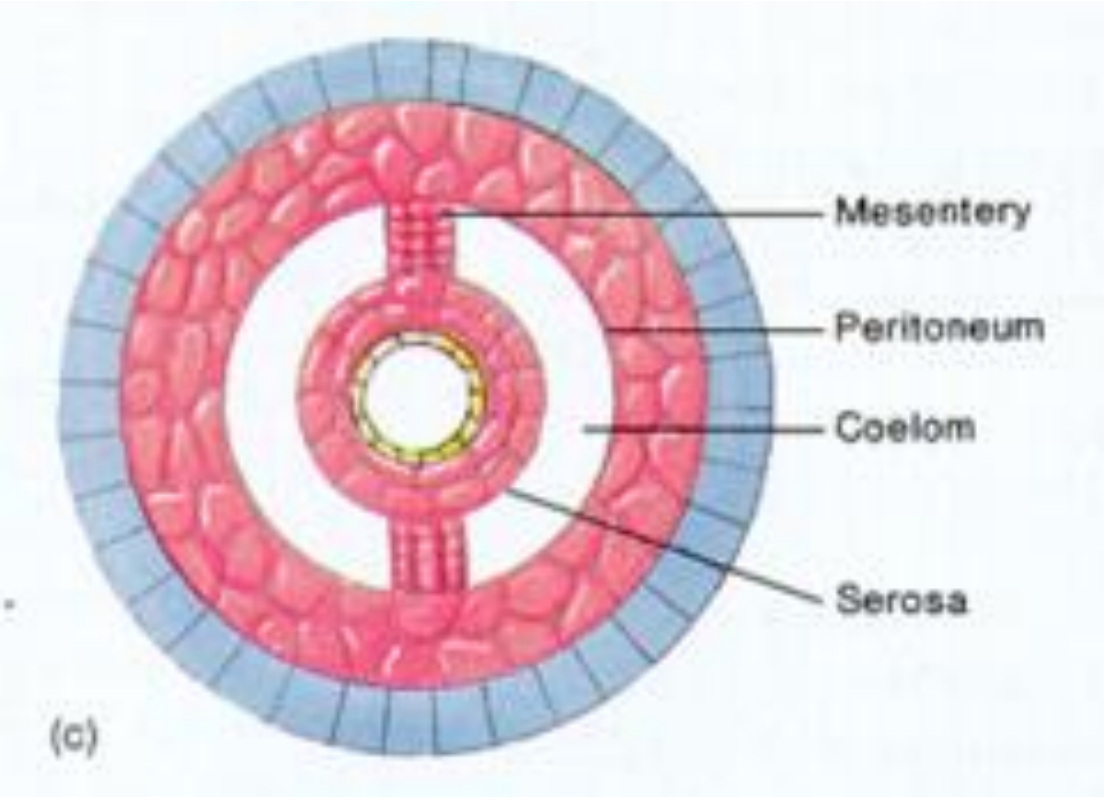
1. Acoelomate: animals that do not have a cavity, where the region between their internal organs and body wall. The body volume is filled with mesenchyme and other tissues.



1. **Pseudocoelomate:** animal that do have a body cavity but this cavity do not surrounding by the cells of the mesoderm and not lined by a cellular peritoneum.



3. **Eucoelomate:** With a body space which surrounded by the mesodermic cells and lined with peritoneum.



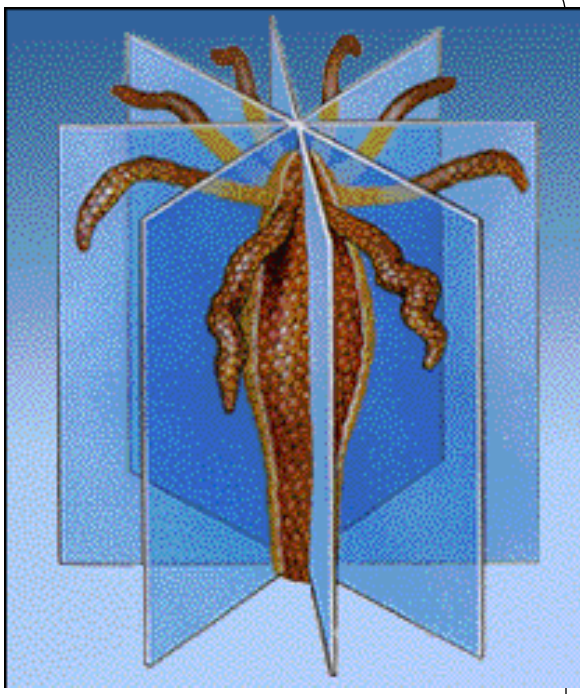
Animal Classification

symmetry: The concept of symmetry allow for division of a whole body into two or more equal portions by separation along lines or planes;

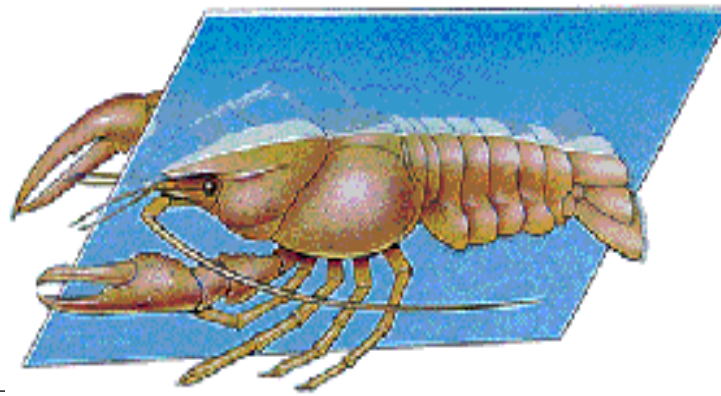
1. **Asymmetrical**: animal include those animal which no plane that can be used to divide their body into equivalent parts (Porifera).

2. **Spherical symmetry**: The body is divided into symmetrical halves in all direction and planes.

3. **Radial symmetry**: these animal can be divided into two equivalent parts by more than one plane



4. **Bilateral symmetry**: these animal can be divided by a single plane into two equivalent parts



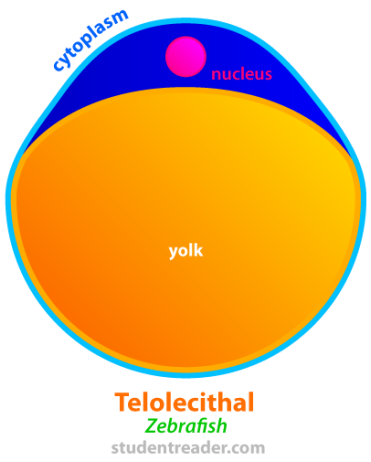
Animal Classification
Presence or absence of Segmentation

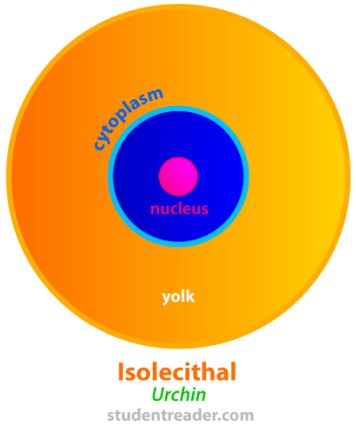
Metamerism is a segmentation of body and each segment contains one pair of some or all organs, such as nephridia, coelomoduct, gonads and ganglia.
Metamerism appear in Annelida; Arthropoda and chordate.

Animal Classification

egg types

1. **Isolicethal eggs**, small amount of yolk, with total holoblastic cleavage (total or entire cleavage) .
2. **Telolicethal eggs**, large amount of yolk, with meroblastic cleavage (partial cleavage).

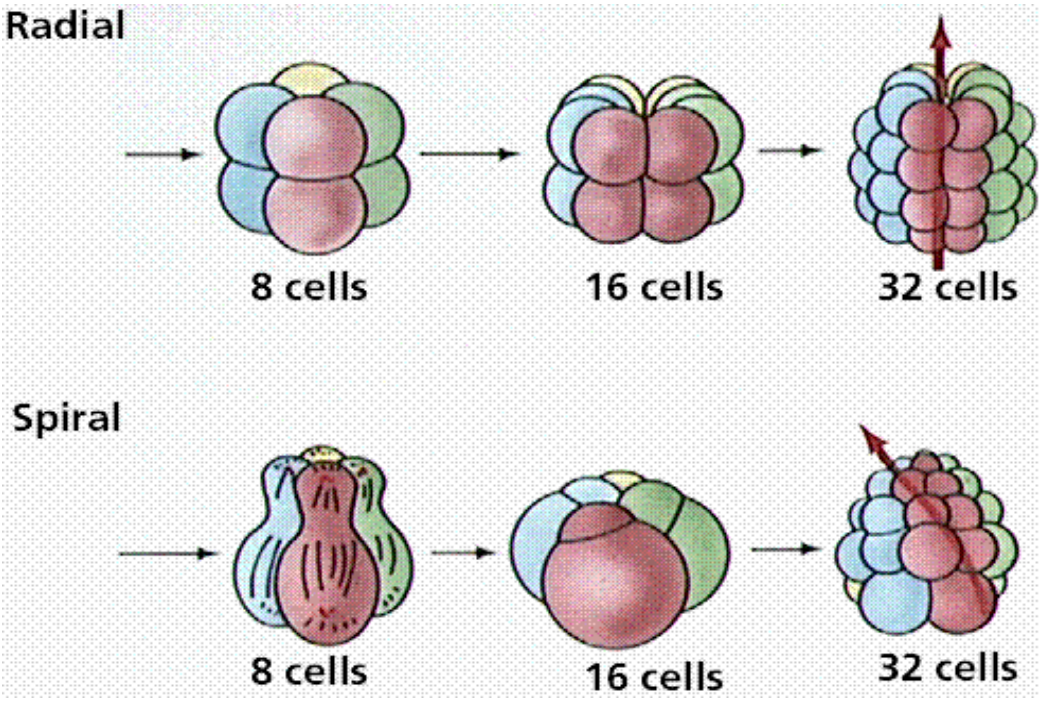




Animal Classification
Cleavage

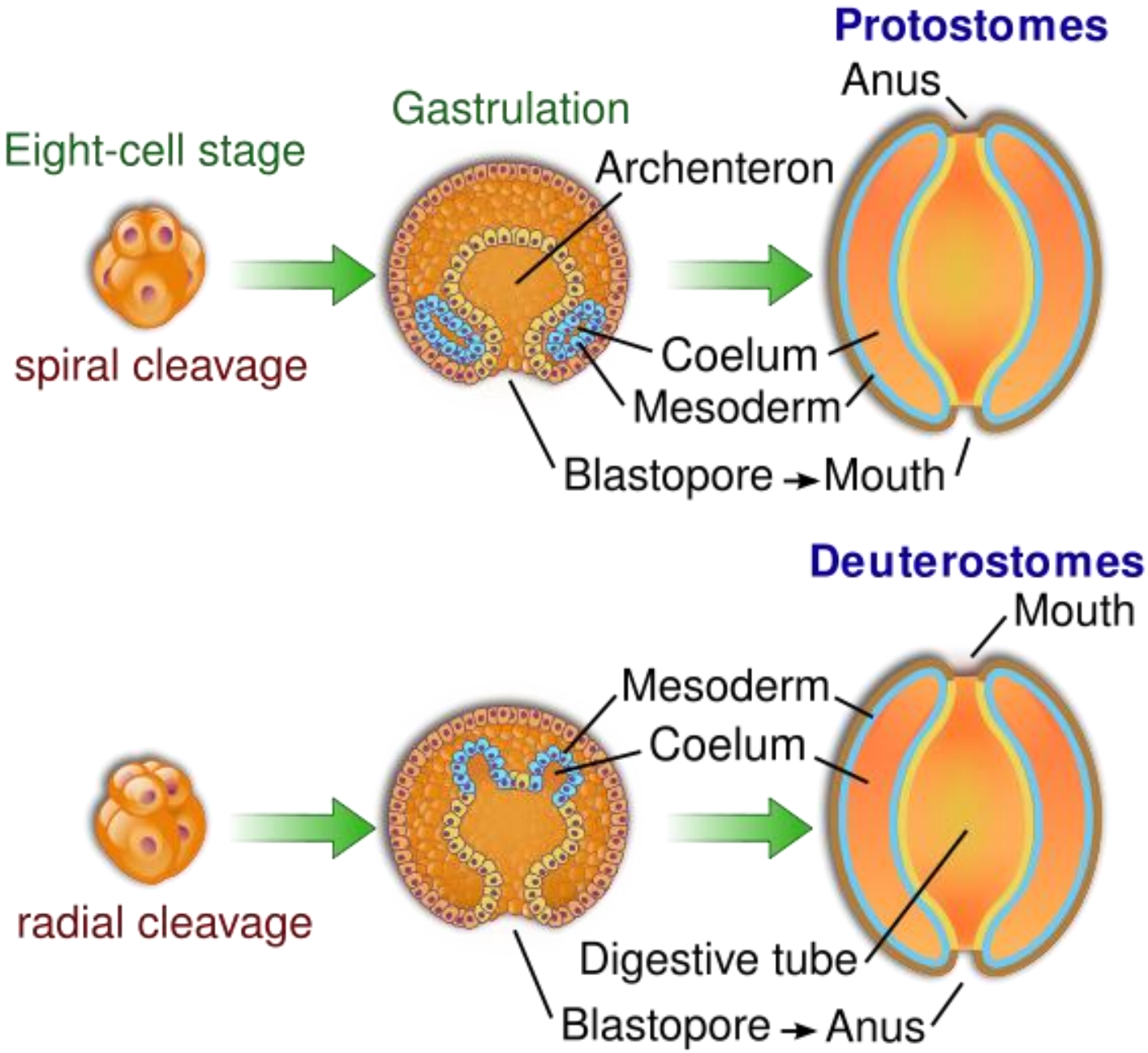
The division of fertilized egg follows two patterns amongst metazoan invertebrates. Both are holoblastic.

1. **Radial**, the plane of cleavage is parallel to the polar axis.
2. **Spiral**, the plane of cleavage is lie an angle to the polar axis.

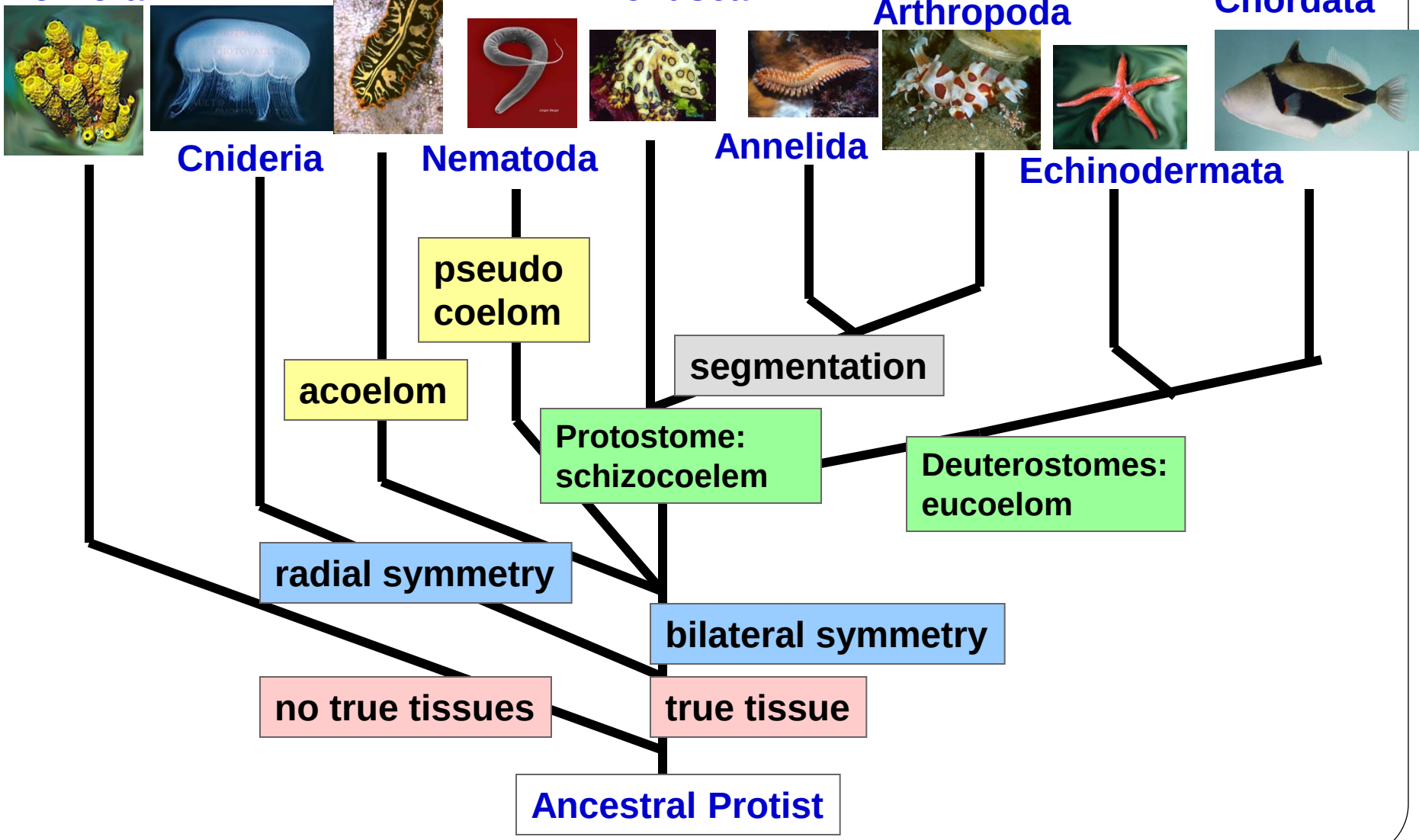


Animal Classification
Coelomate divided according to their mode of development

Deuterostomia	Protostomia
Radial cleavage	Spiral cleavage
Blastopore form anus	Blastopore form mouth
Entercoelic coelom	Schizocolic coelom
Central nervous system dorsal and superficial	Central nervous system ventral
Echinodermata; Chordate; Hemichordate	Annelida; Arthropoda; Mollusca

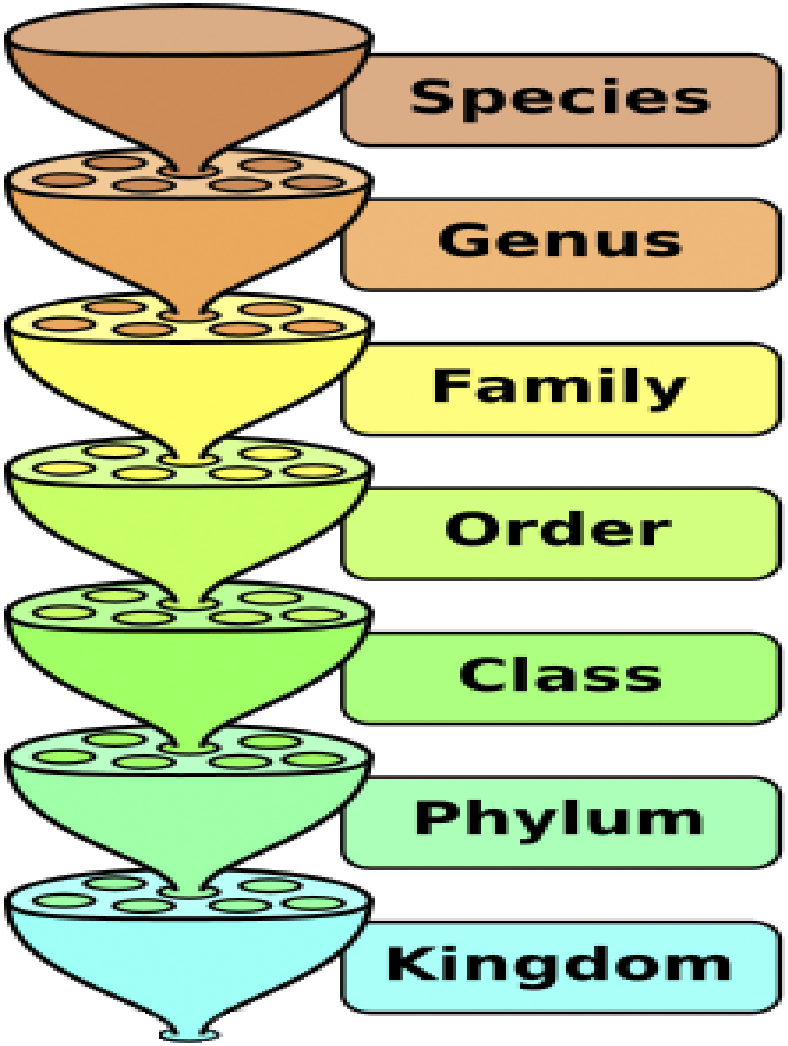

Protostomes
Anus
Gastrulation
Eight-cell stage
Archenteron
spiral cleavage
Coelum
Mesoderm
Blastopore → Mouth
Deuterostomes
Mouth
Mesoderm
Coelum
radial cleavage
Digestive tube
Blastopore → Anus

Phylogentic Relationships of Animals



Taxonomic Levels

Species: Interbreeding with one another produce offspring



Homo sapiens
Members of the genus Homo with a hightforehead and thin skull bones.

Homo
Hominids with upright posture and large brains.

Hominids
Primates with relatively flat faces and three-dimensional vision.

Primates
Mammals with collar bones and grasping fingers.

Mammals
Chordates with fur or hair and milk glands.

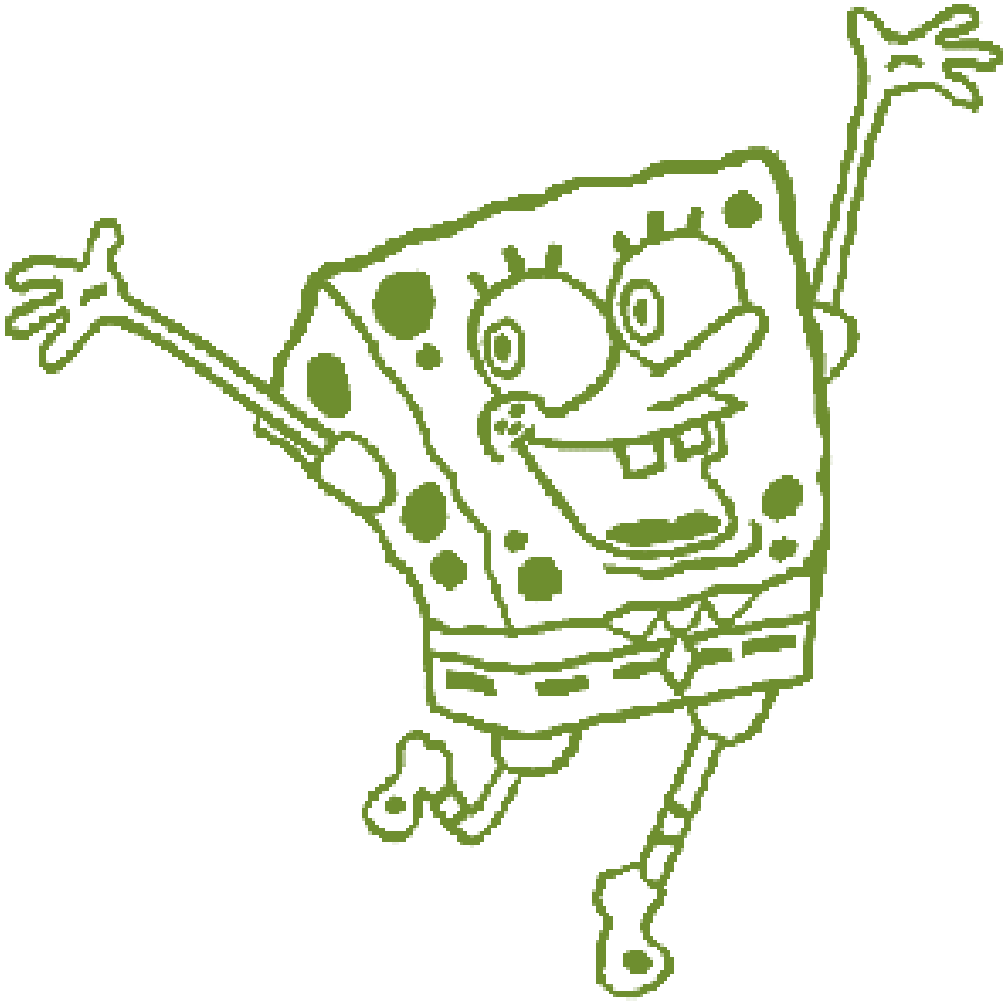
Chordates
Animals with a backbone.

Animals
Organisms able to move on their own.

Phylum Porifera

Sponges

" pore bearer "



Body structure

Sponges are Parazoa (multicellular animal with loosely aggregated cells).

- **Outer layer**: Perforated by small holes- dermal pores or ostia
- **Inner layer :** lined with flagellated cells = choanocytes
- **Mesophyl** (Mesoglea): an a cellular jell layer

General characters

1. Have cellular-level organization, No true tissues or organs.
2. No nerves, muscles, mouth or digestive system.
3. Most of the species are marine; few are freshwater (Spongillidae).
4. body - wall pierced by many tiny pores “(ostia)” (inhalent) and by one or more large oscula (exhalent).
5. Radial symmetrical or asymmetrical
6. Skeletons composed of $CaCO_3$ or SiO_2 spicules or spongin fibers
7. Depend on water currents created by the choanocytes to bring in food and oxygen and carry away wastes
8. Food items are taken into individual cells by phagocytosis
9. Reproduction by sexual and asexual
10. Adult sponges are generally sessile

The Cellular Structure

Sponges have two layers separated by an a cellular jell layer called mesohyl

1. Dermal layer

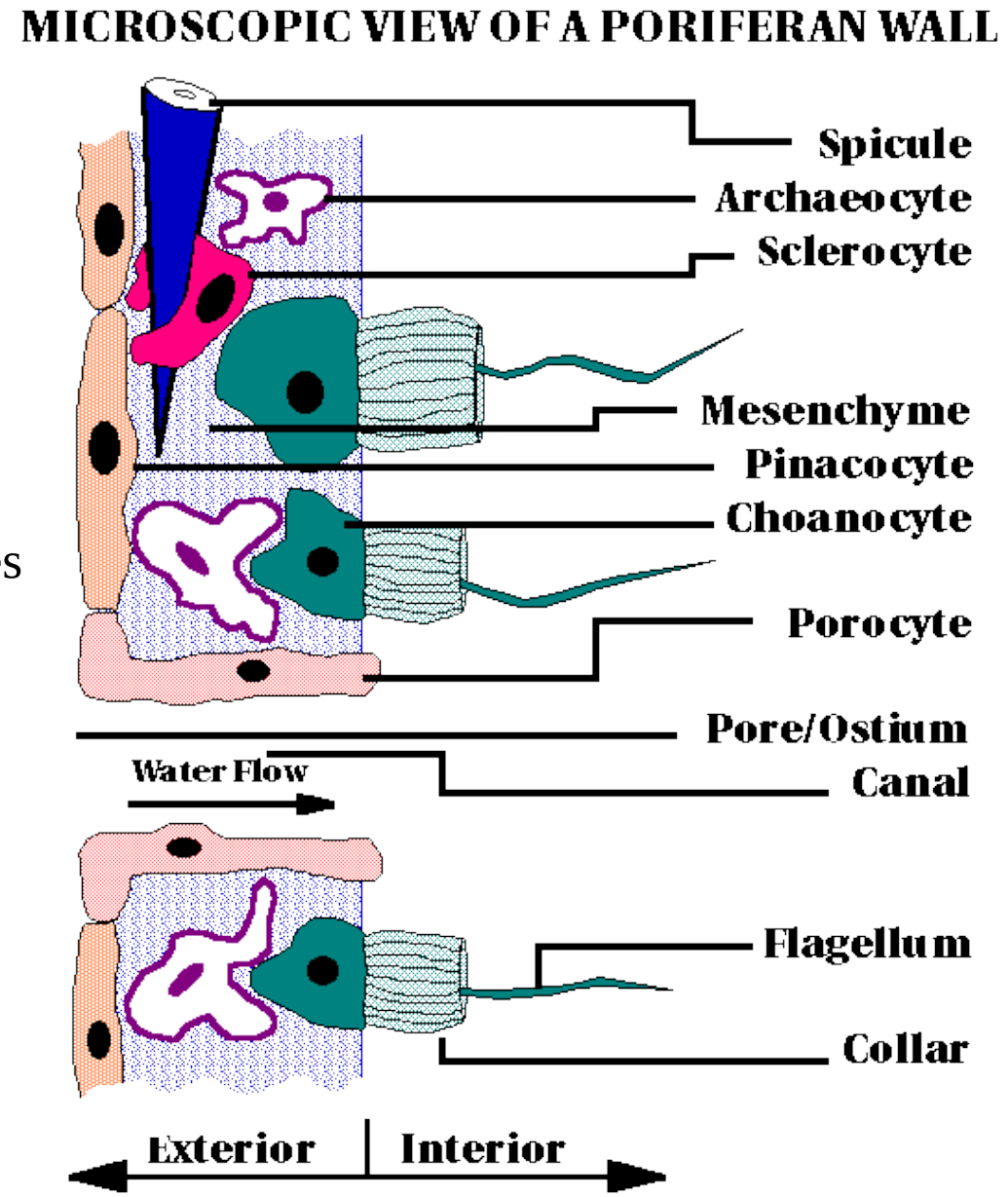
A- Pinacocytes

B- skeletogenous

1- Amoebocytes
- Archaeocytes
- Sclerocytes

C- Porocytes

2. Gastral layer (Choanocytes)

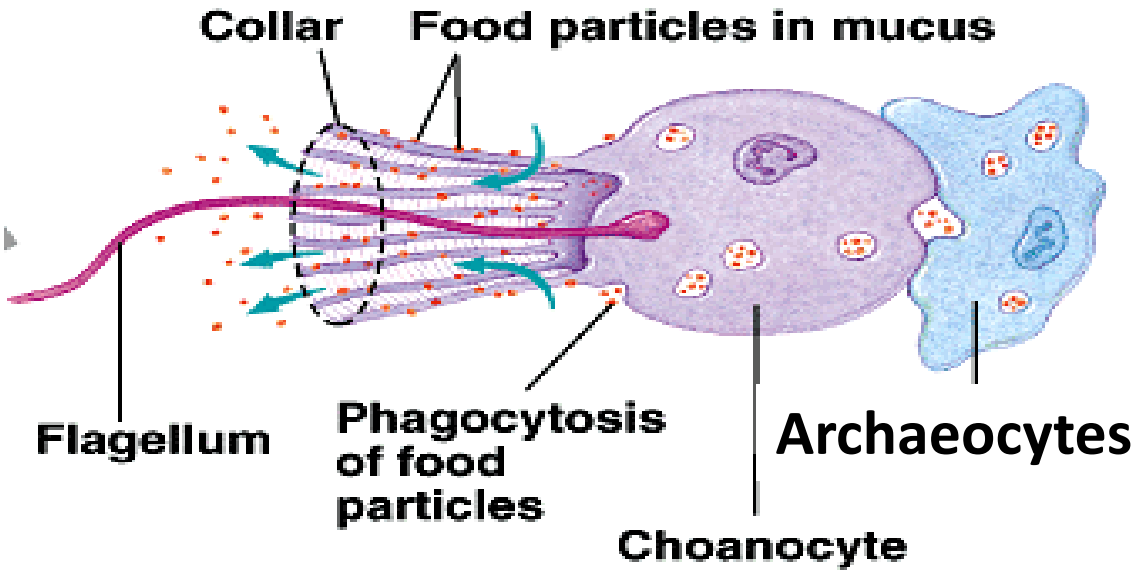


Sponge Cell Types

1. **Pinacocytes** "skin cells". They line the exterior of the sponge body wall. They are thin, leathery and tightly packed together.
2. **Archaeocytes**. These cells have pseudopodia. They ingest and digest food caught by the choanocyte collars. In some sponges, they develop into gametes.
3. **Sclerocytes**. Secrete the spongin skeletal fibers.
4. **Porocytes** which surround canal openings and pores can contract to regulate flow through the sponge.
5. **Choanocytes**. These cells have a central flagellum that is surrounded by a collar of microvilli. The beating of the choanocytes' flagella creates the sponge's water current, while the collars of the choanocytes are the primary areas that nutrients are absorbed into the sponge. In some sponges they develop into gametes.

Porifera feeding

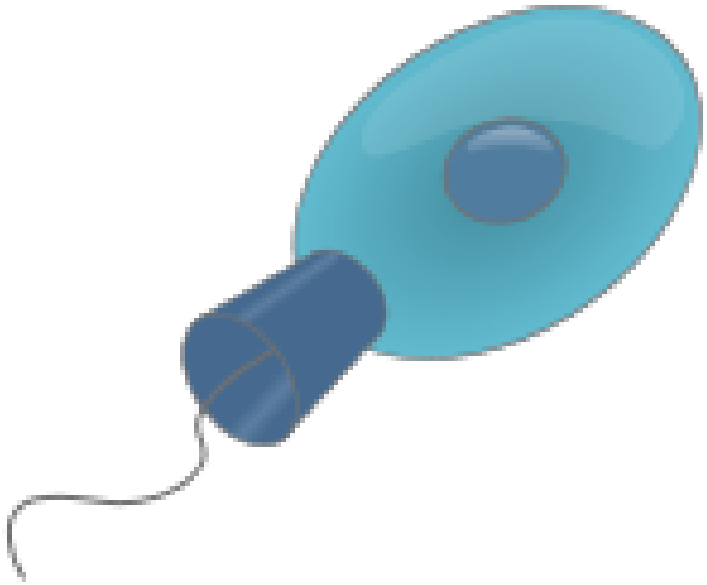
Filter feeder: Openings are connected by a series of canals, which are lined by choanocytes (the flagellated collar cells). The flagellae beat regularly, creating a water flow across the microvilli which can then filter nutrients from the water taken from the collar of the sponge. Food particles are then phagocytosed by choanocytes and archaeocytes.



Choanoflagellates are the sister to the animals

Spong's similarity to choanoflagellates make many scientists believe that choanoflagellates are the sister group to the animals.

choanoflagellates are the closest related single cell unicellular animals to the multicellular animals

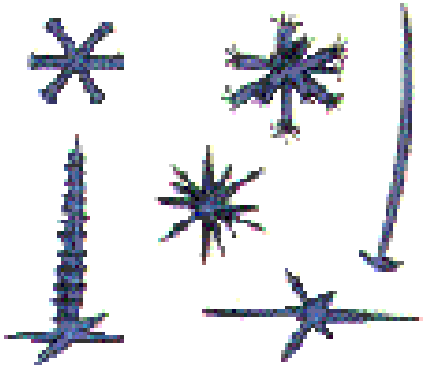


Excretion

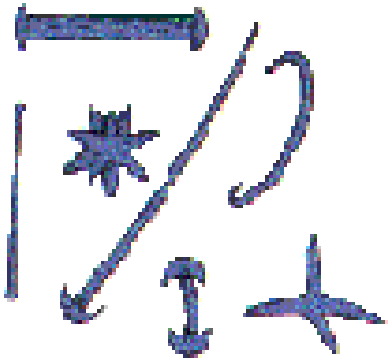
- Excretion (undigested materials) and gas exchange (O_2 and Co_2) by water current

Skeletons

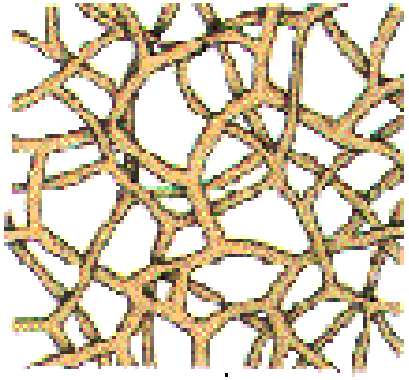
- the skeleton gives sponges their bodies shapes.
- spicules are often categorized by size, the larger being megascleres and the smaller microscleres.
- some spicules are formed of the mineralized substances calcium carbonate and silica, while others are made of an organic substance called spongin.



siliceous spicules (Hexactinellida)



siliceous spicules (Demospongiae)



spongin

calcareous

Reproduction

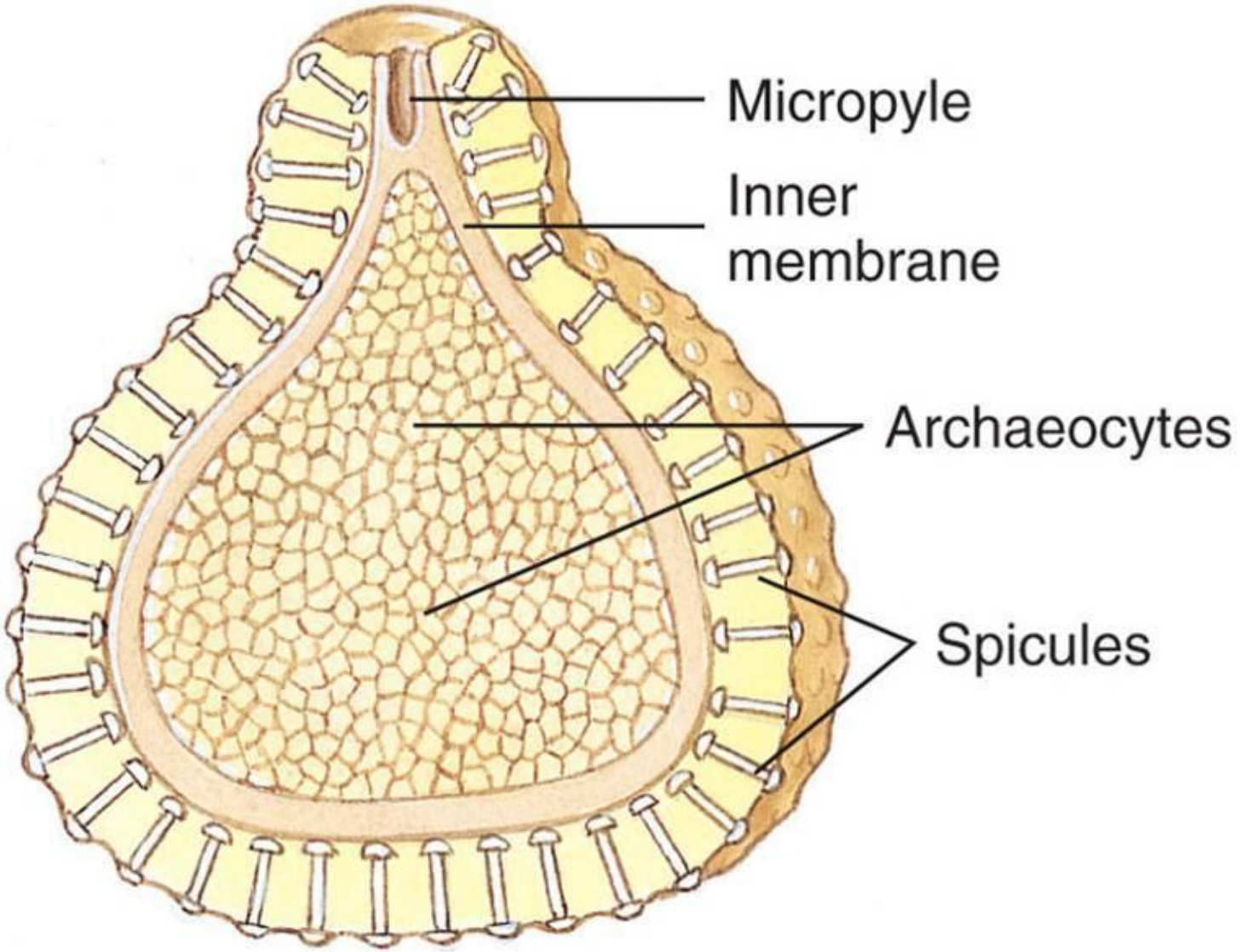
Asexual:

- **Budding**
  - **External** (production of external buds that detach or remain to form colonies)
  - **Internal** (internal buds called gemmules that form during unfavorable periods)

Gemmules are aggregates of sponge tissue and food, covered by a hard coating containing spicules or spongin fibers.

- **fragmentation** (regeneration): can regenerate from broken pieces

Gemmules of Spongilla

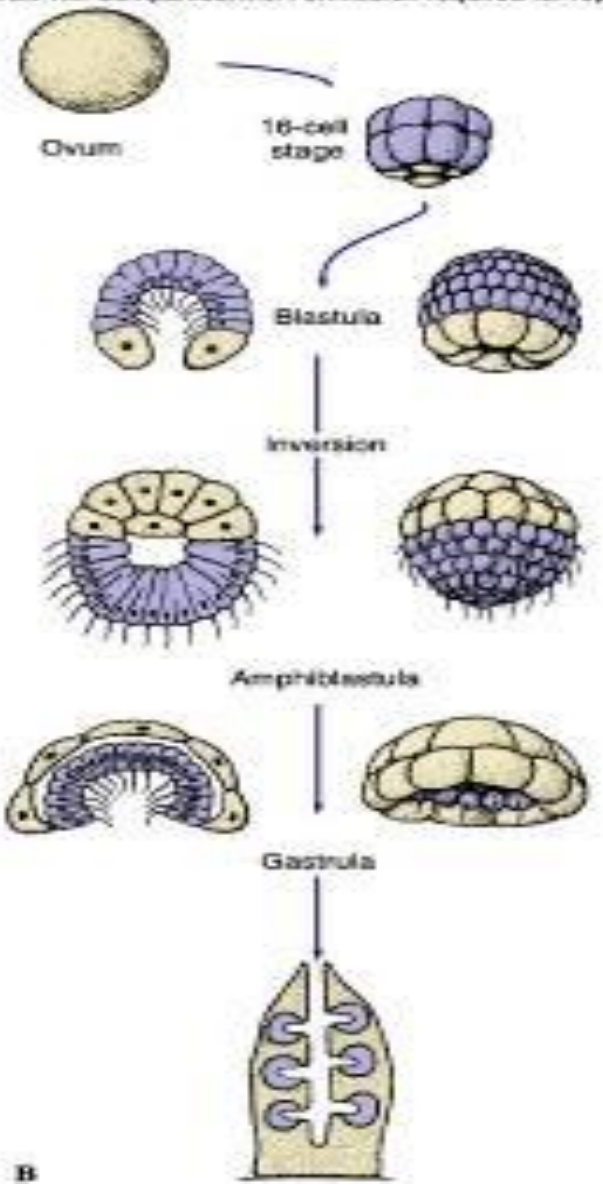


Reproduction

Sexual

Majority are hermaphroditic; produce sperms and eggs at different times

- Sperms and eggs from choanocytes; and amoebocytes
- Fertlized egg develop into mesoglea form blastula
- Develop to amphiblastula
- Escape from the osculum
- Swim hours or days, and then settling on an object



Types of Canal Systems in Sponges

- **Most sponges can be separated based on their type of canal system.**

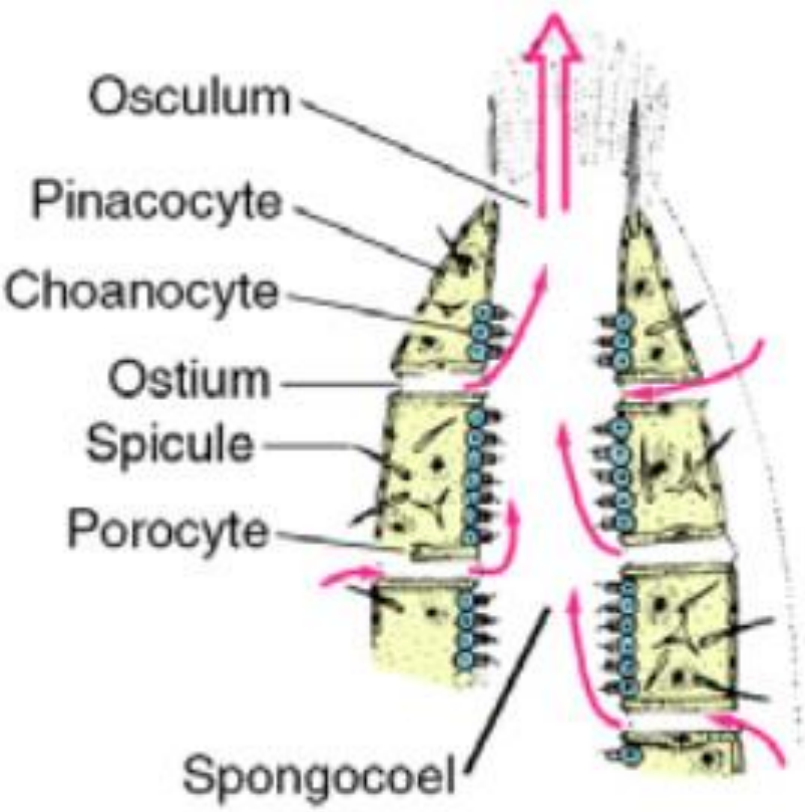
  1. Asconoid

  2. Syconoid

  3. Leuconoid

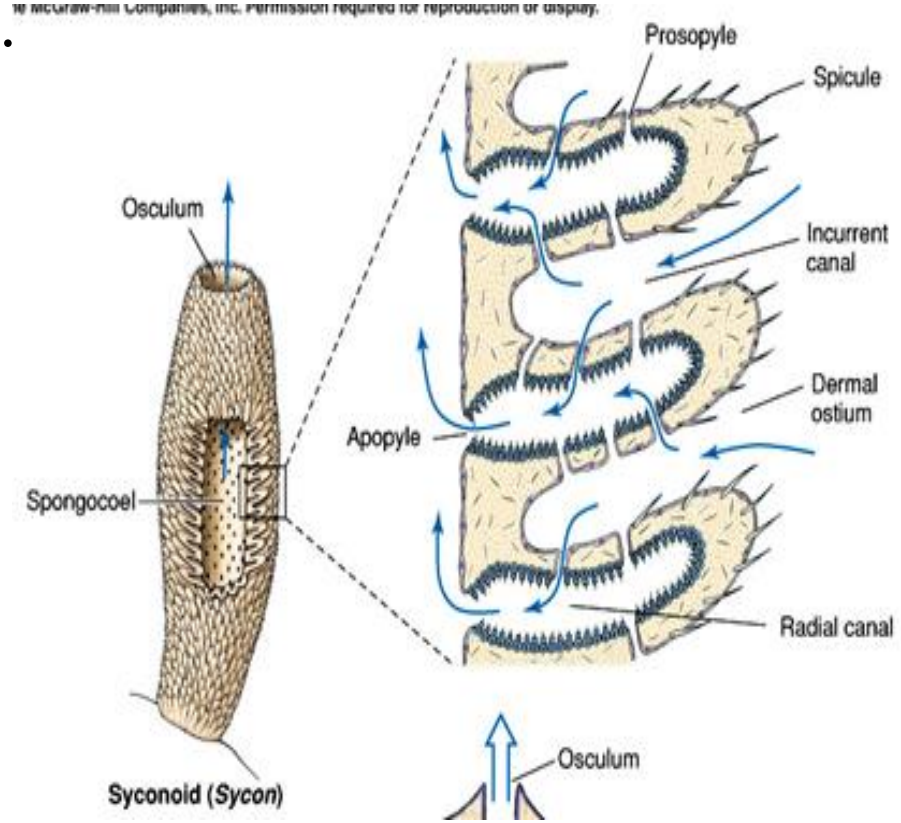
1- Asconoid sponges

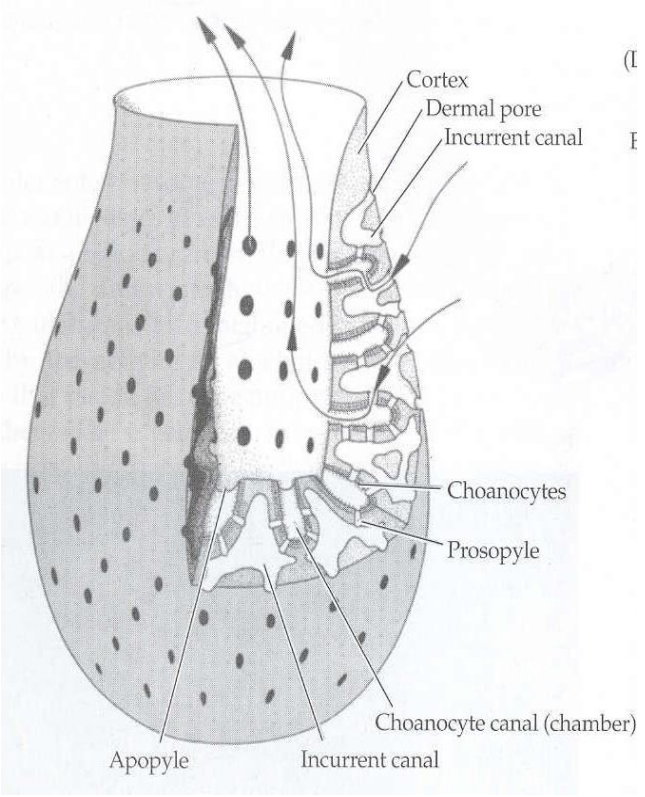
- Small, simple forms with a tube-shaped body.
- The open internal part of the tube is called spongocoel; spongocoel surrounded by a single layer of choanocytes.
- There is a single opening to the outside the osculum.



2- Syconoid sponges

- larger than asconids, body wall is thicker and more complex with incurrent canals rather than simple pores.
- There is a single opening to the outside the osculum.

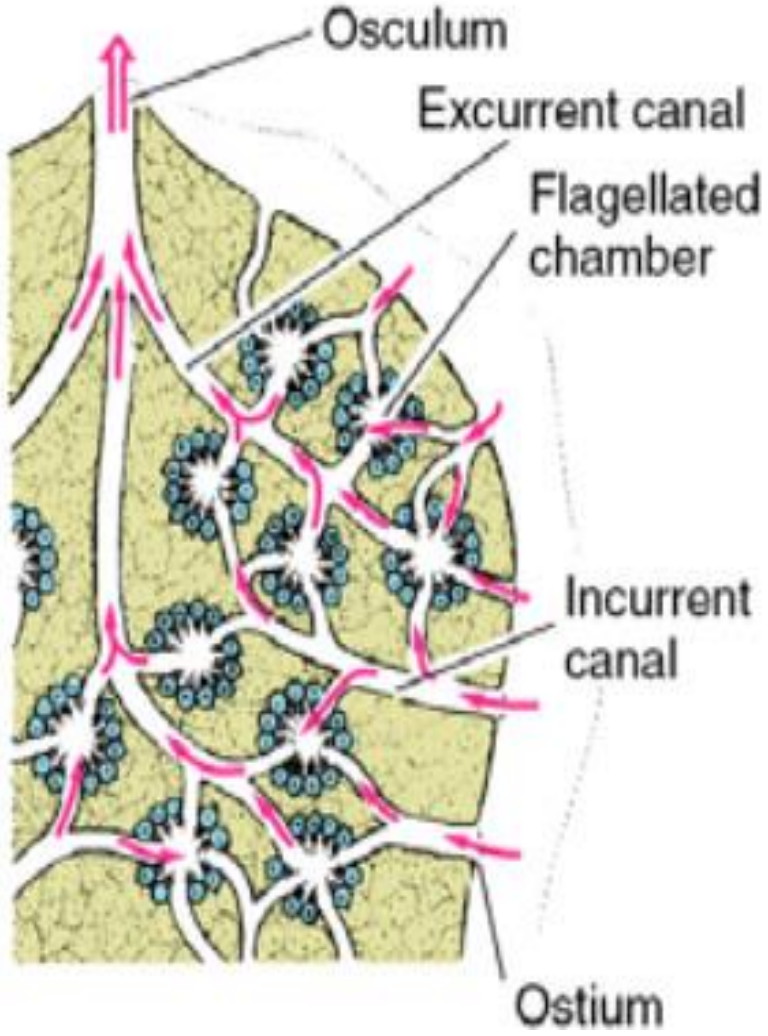


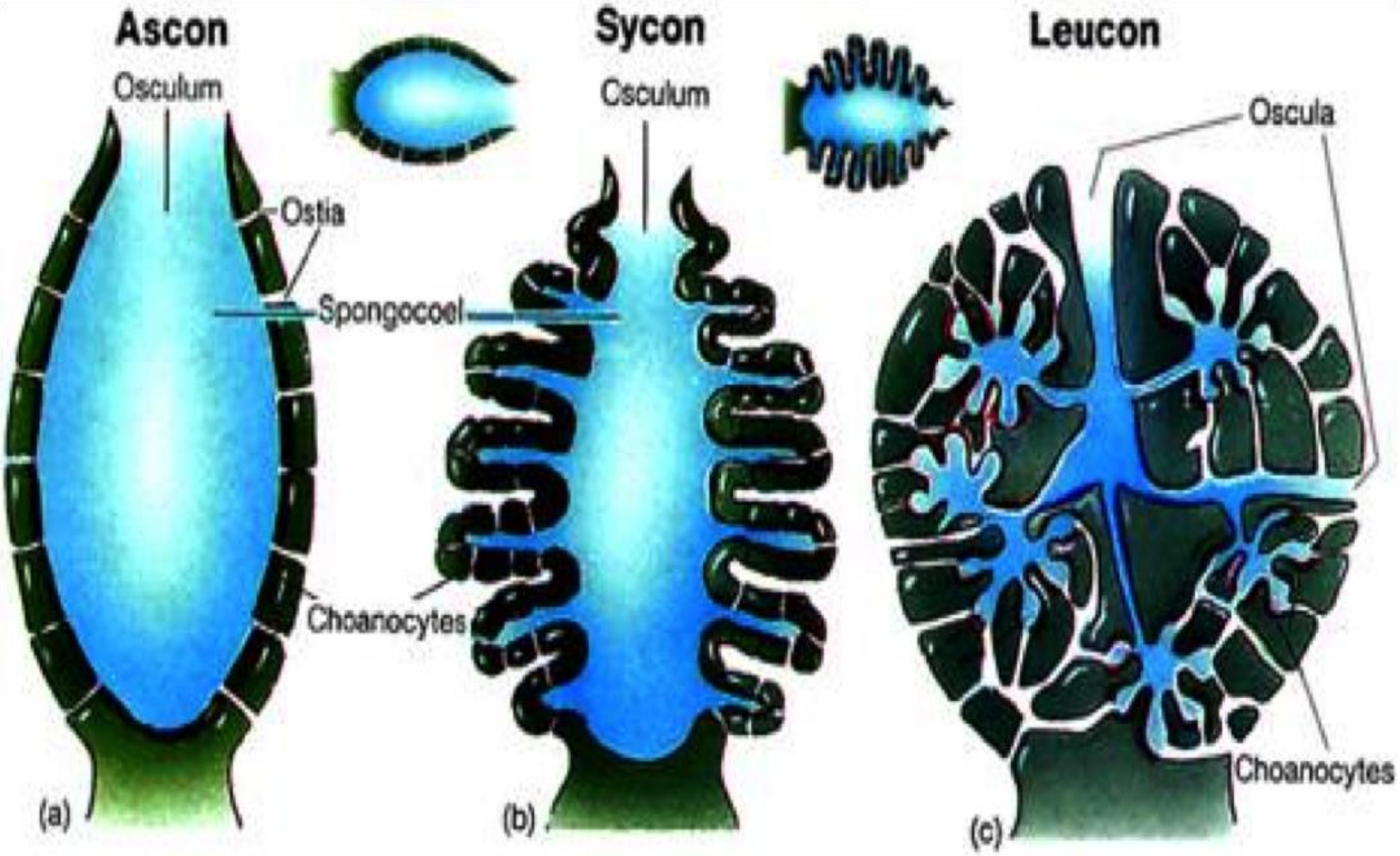


3- Leuconoid sponges

- Most complex.
- Sponges are made up of masses of tissue penetrated by canals.
- Canales lead to small chambers lined with choanocytes

cells.




Ascon
Osculum
Ostia
Spongocoel
Choanocytes
(a)
Sycon
Csculum
(b)
Leucon
Oscula
Choanocytes
(c)

Importance

- ✓ many species contain toxic substance to discourage predators
- ✓ this chemical substance play role in competition among sponges and other organisms
- ✓ this chemical substance have been found to have beneficial pharmaceutical effects for humans
- ✓ sponges provide a home for a number of small marine plants
- ✓ symbiotic relationships with bacteria and algae

Clssification of Sponges

- **P: Porifera**
  - **Class: Calcarea**
  - **Class: Hexactinellida**
  - **Class: Demospongiae**
  - **Class: Seclerospongia**

1- Class Calcarea (Calcareous Sponges)

- Calcareous ($CaCO_3$) spicules
- contains all morphological types, asconoid, syconoid, and leuconoid
- small and brightly colored
- simplest sponges
- marine and shallow water dweller
- This class include two orders namely :
- a. Order Homocoela (ex . *Leucosolenia sp.*).
- b. Order Heterocoela (ex. *Grantia sp . and Sycon sp.*)

2- Class Hexactinellida (Glass Sponges)

- SiO_2 spicules and lack an epidermal covering
- between syconoid and leuconoid.
- large and pale in color and are cup- or basket-shaped.
- mostly deep sea forms
- six pointed spicules . Hexactinellida, commonly known as glass sponges

3- Class Demospongiae

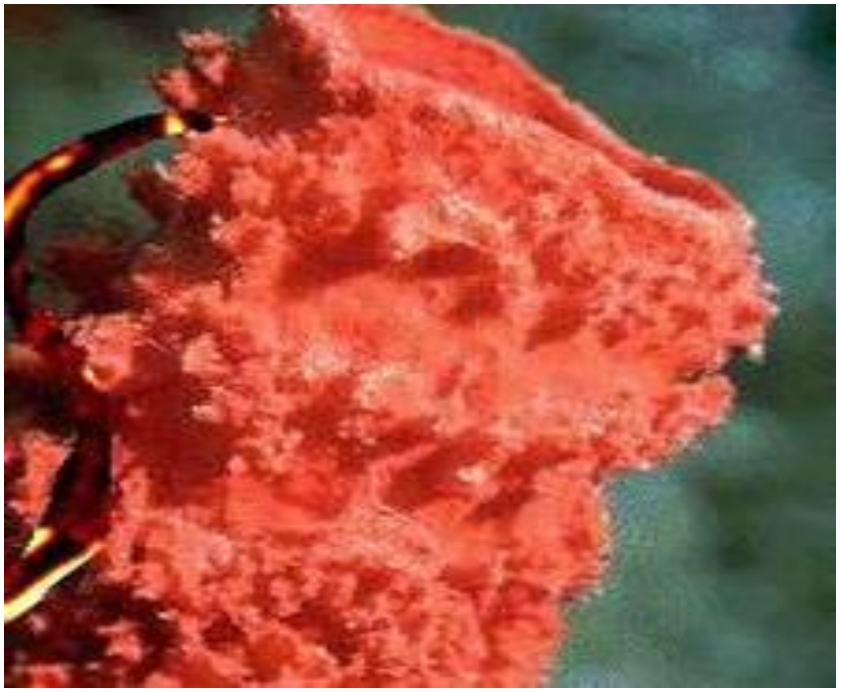
- Most sponges belong in this class about 95%
- Spongin and SiO_2 spicules
- all are leuconoid
- vary in size from small to very large, irregular masses and brightly colored
- family Spongillidae belong to this class; green because of symbiotic algae that live in the amoebocytes
- *Hippospongia communis* and *Spongia officinalis*, and most of the other sponges used commercially
- family Clionidae are extremely interesting because of their ability to bore into calcareous rocks and mollusk shells
- This class consist of for orders namely :
- a .Order Monaxinida with monaxon spicules eg. Spongella (freshwater sponge)
- b. Order Keratosa (horn sponges) with sponging skeleton .eg. *Euspongia* (path sponges)
- c. Order Myxospongiae without skeleton eg. *Oscarella*.
- d. Order Tetractinellida with tetraxonspicules eg. *Plakina* .

Orders of Demospongiae

1. **Order Monaxonida**: with monaxon spicules, eg. *Spongilla* (freshwater sponges)
2. **Order Keratosa** (horn sponges): with sponging skeleton, eg. *Euspongia* (path sponges)
3. **Order Myxospongiae**: without skeleton, eg. *Oscarella*
4. **Order Tetraxonida:** with tetraxonspicules, eg. *Plakina*

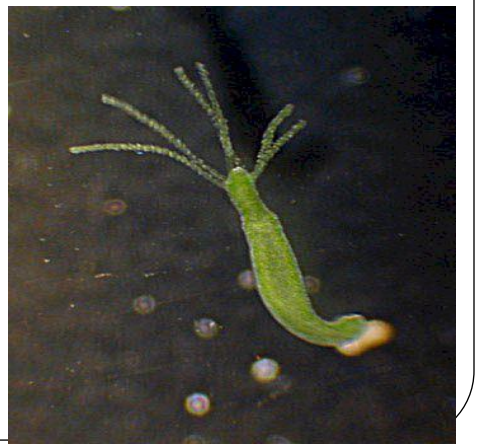
4- Class Seclerospongia

- Have Silicious spicules and spongin
- Also have an outer covering composed of calcium carbonate
- Are leuconoid sponges



Phylum Cnidaria

corals, sea anemones, jellyfish, sea fans, and hydras



General characters

- Phylum name comes from specialized cells called cnidocytes (nettle)
- Cnidocytes contain stinging structure, nematocysts, that are used to immobilize prey.
- Radially symmetrical, sometimes with biradial symmetry.
- Diploblastic, having ectoderm and endoderm with a mesoglea or mesenchyme (jellylike, not tissue layer) in between.
- Digestive cavity (gastrovasculur cavity) with only one opening.
- No specialized circulatory, respiratory, or excretory systems.
- A diffuse nervous system as a simple nerve net.
- Have one of two forms: a polyp or medusa, but many forms have reduced or lost one or the other of these two forms.
- Usually have a ciliated planula larvae.

Body Forms

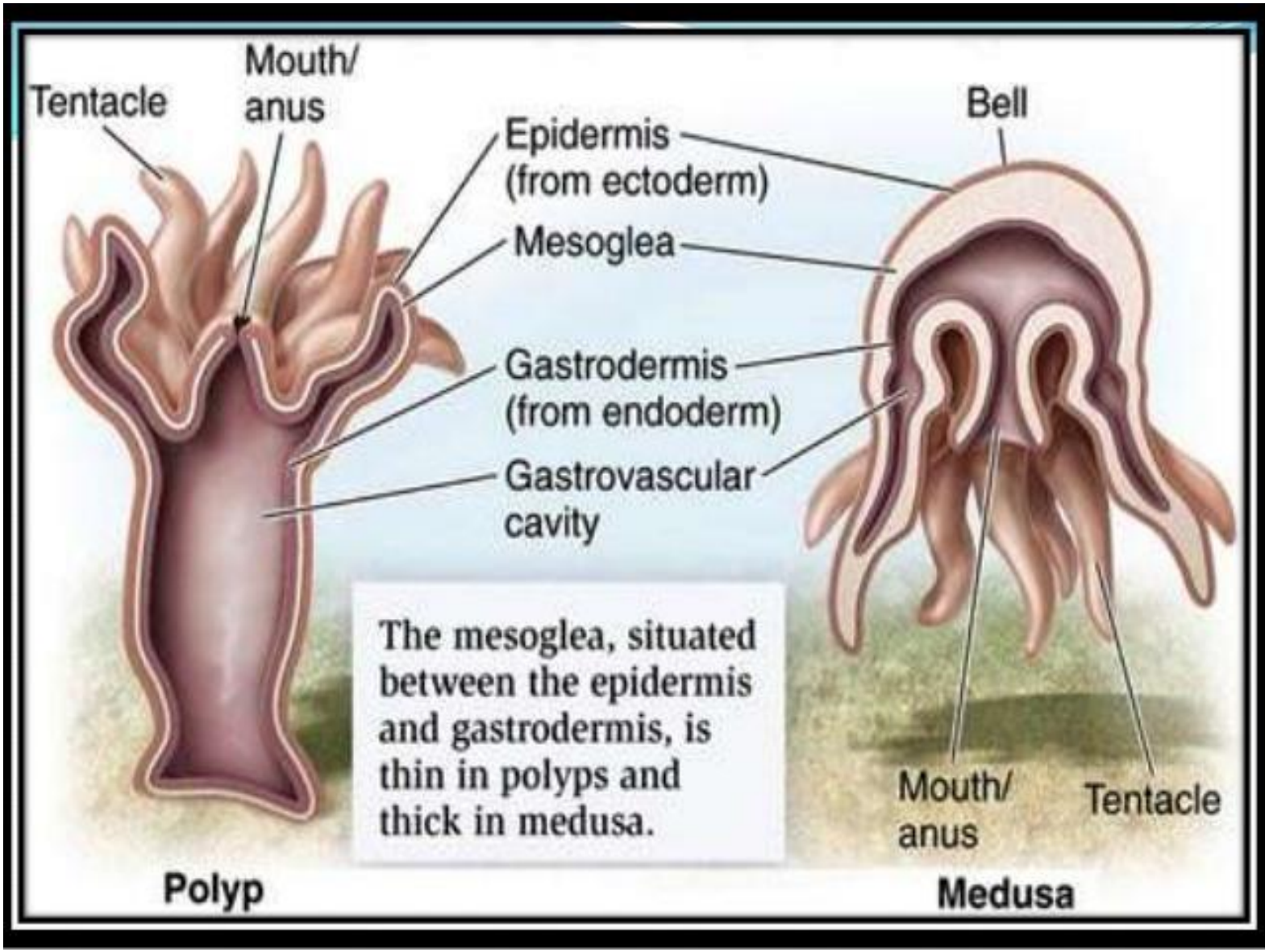
1- Polyp

- It is asexually reproductive stage.
- It is a tubular organism.
- The polyp is a sessile form which attaches to the sea floor.
- A mouth opening located on the top of the polyp, and numerous of tentacle around the edge of the mouth opening.
- Has a thin body wall consisting of two single layer of ectoderm and endoderm separated by narrow mesogloea.

2- Medusa

- It is the sexually reproductive stage.
- Is an umbrella-shaped, jelly like.
- Free swimming.
- A mouth at the end of a central projection called a manubrium (the portion that bears the mouth at its tip).
- Medusa has tentacle dangling from its oral surface
- It has wide mesoglea.

Body Forms


Tentacle
Mouth/
anus
Epidermis
(from ectoderm)
Mesoglea
Gastrodermis
(from endoderm)
Gastrovascular
cavity
Bell
The mesoglea, situated between the epidermis and gastrodermis, is thin in polyps and thick in medusa.
Mouth/
anus
Tentacle
Polyp
Medusa

The cells in both layers

1- **Epitheliomuscular cells**: found in ectoderm, are columnar in shape and provided by contractile fibers. contractions of these fibers shorten the tentacles or body

2- **Nutritive muscular cells:** found in endoderm, tall columnar in shape that have laterally extended bases containing myofibrils. Water is brought into the cavity through the mouth by the beating of the cilia on the nutritive-muscular cells

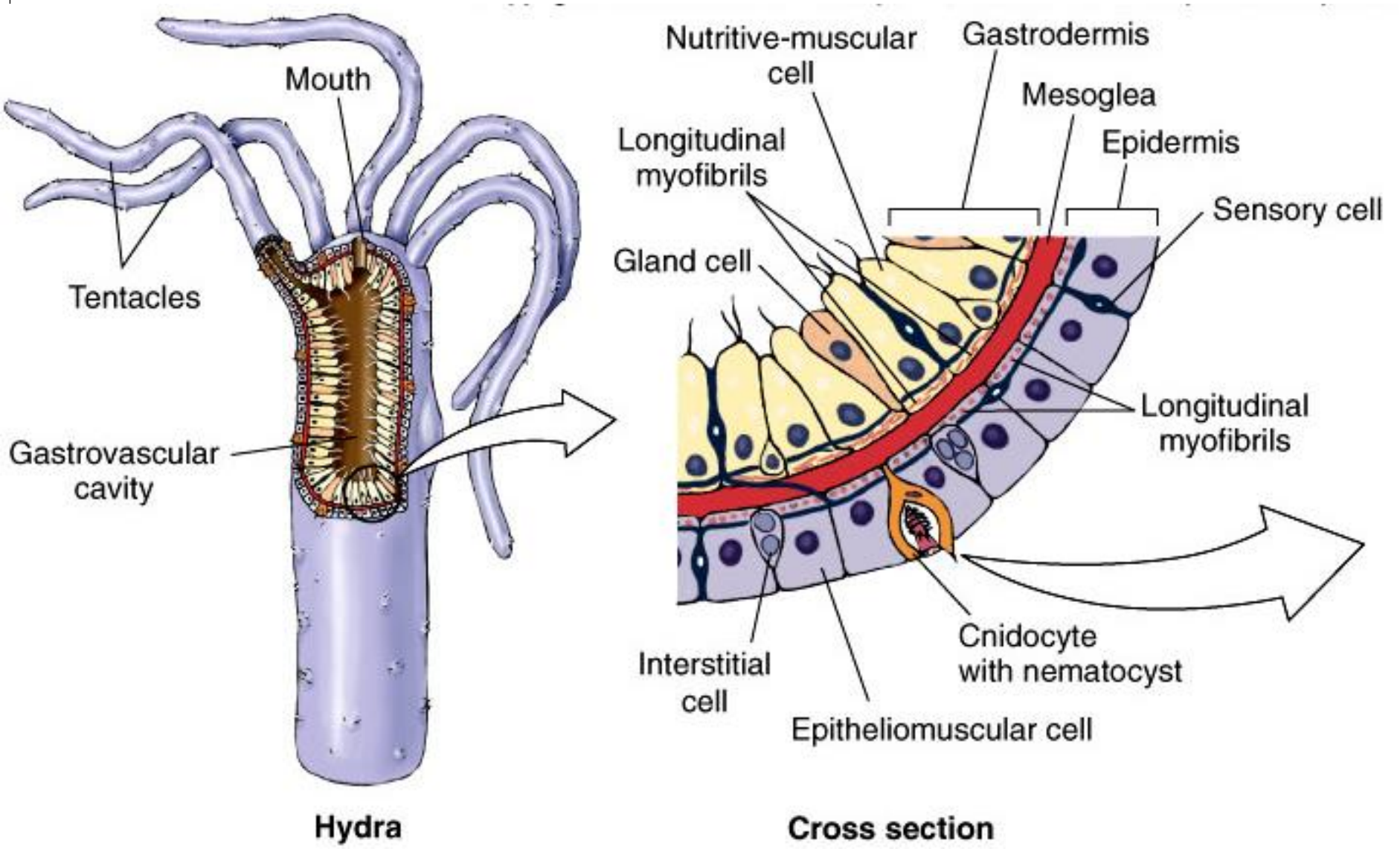
3- **Gland cells**: found in both ectoderm and endoderm, larger oval cell. An endodermal gland cells secrete a digestive secretion. An ectodermal gland cells secrete mucus or adhesive material.

4- **Sense cells**: found in ectoderm especially near mouth and tentacles. The free end of each sensory cell bear a flagellum which is the sensory receptor for chemical and tactile stimuli.

5- **Interstitial cells**: found in both ectoderm and endoderm, which preserve an embryonic characters and may develop into germ cells, and others.

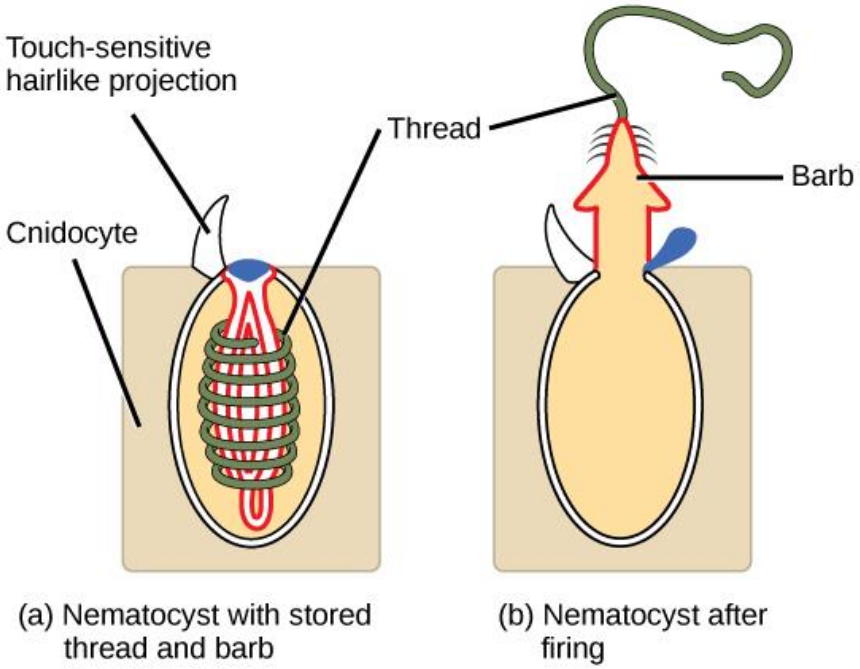
6- **Cnidocytes**: stinging cells, found in ectoderm contain nematocyst.

7- **Nerve cells:** found in ectoderm, most multipolar, form synapses with sensory cells and other nerve cells connect to epitheliomuscular cells and cnidocytes


Mouth
Tentacles
Gastrovascular cavity
Hydra
Nutritive-muscular cell
Gastrodermis
Mesoglea
Epidermis
Longitudinal myofibrils
Sensory cell
Gland cell
Longitudinal myofibrils
Cnidocyte with nematocyst
Interstitial cell
Epitheliomuscular cell
Cross section

Discharge mechanism of Cnidocytes

Cnidocytes contain coiled threads that bear barbs. The outer wall of the cell has hairlike projections called cnidocils, which are sensitive to touch. When touched. Cnidocytes 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. The resulting osmotic pressure causes a rapid influx of water into the cell. This increase in water volume in the cytoplasm forces the coiled nematocyst (hollow tube that exists inside the cell) to eject rapidly and penetrate prey or predators of cnidarians. These coiled threads release toxins into the target and can immobilize prey.



Feeding

- Incomplete digestive system.
- gastrovascular cavity is sac shaped with one opening acting as both mouth and anus.
- Predation. Predatory species use their cnidocytes to poison prey, and those with venomous nematocysts may start digestion by injecting digestive enzymes.
- absorbing dissolved organic chemicals.
- filtering food particles out of the water.
- obtaining nutrients from symbiotic algae within their cells, such as the corals *Hetroxenia* and *Leptogorgia*.

Respiration

There are no respiratory organs, and both cell layers absorb oxygen from and expel carbon dioxide into the surrounding water.

Regeneration

All cnidarians can regenerate, allowing them to recover from injury and to reproduce asexually. Medusae have limited ability to regenerate, but polyps can do so from small pieces or even collections of separated cells. This enables corals to recover even after apparently being destroyed by predators.

Nervous system and senses

- Cnidaria have no brains or even central nervous systems (simple nervous system).
- Instead they have decentralized nerve nets
- In the center of nerve net is the nerve ring which controls swimming and where to go.
- Nerve net consist of sensory neuron and motor neuron which are connected by the intermediate neuron.
- The communication of nerve cells are via chemical synapses

Reproduction

➢asexual:

1. **Budding** if buds remain connected = colonial
2. **Fission** in sea anemones only

➢sexual:

- most are dioecious
- many shed gametes into water
- gonads are epidermal in hydrozoa
- gonads are gastrodermal in other groups
- in many members of the group there is an alternation of generations between polyp which reproduces asexually and the medusae which reproduces sexually

Classification of Cnidaria

- **P: Cnidaria**

1. **Class Hydroza (hydras)**
2. **Class Scyphozoa (jellyfish)**
3. **Class Cubozoa (cube jellies and Sea wasp)**
4. **Class Anthozoa (corals and sea anemones)**

1- Class Hydroza

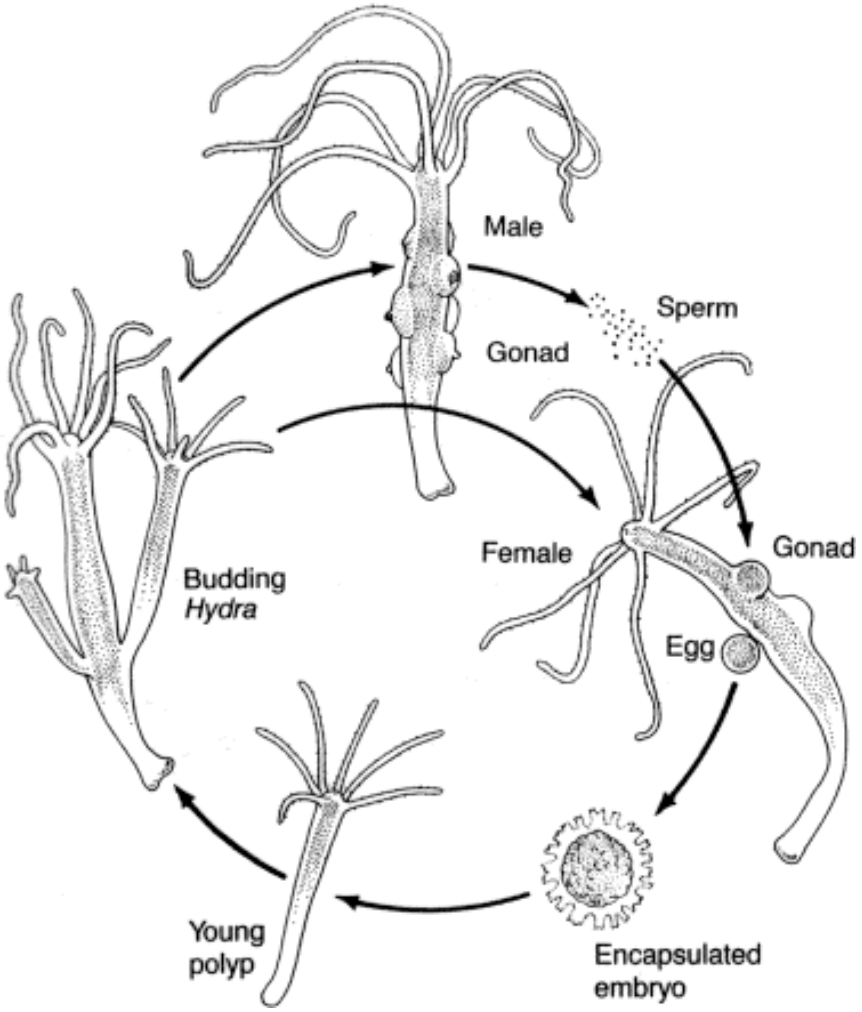
1. The polyp typically alternate with the medusa
2. The medusa possesses a velum and nerve ring
3. The gastrovascular cavity is not divided by vertical septa
4. The gonad are ectodermal in origin
5. There may or may not be a skeleton
6. The tentacles of the polyp are generally soild
7. The members almost form colonies
8. mesoglea gelatineous

1- Class Hydroza

Examples

1. Hydra (Hydrida)
2. Obelia (Calyptoblastea)
3. Tubularia (Gymnoblastea)
4. Physalia (Physalia)
5. Millipra (Hydrocorallina)
6. Genionemus (Trachylina)

1- Hydra (Hydrida)

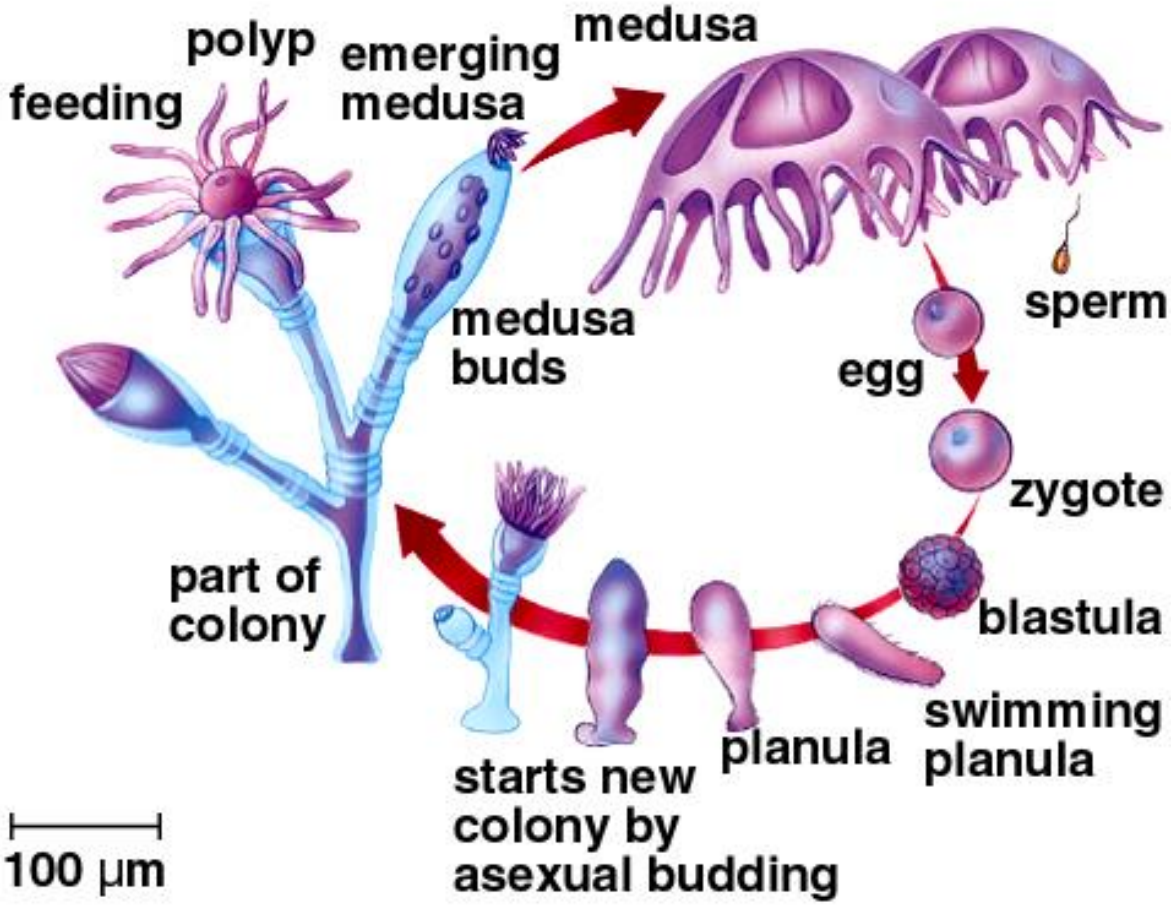


2- Obelia (Calyptoblastea)

Obelia structure and life cycle

© Runk/Schoenberger/
Grant Heilman Photography

100 µm



2- Class Scyphozoa (true Jellyfish)

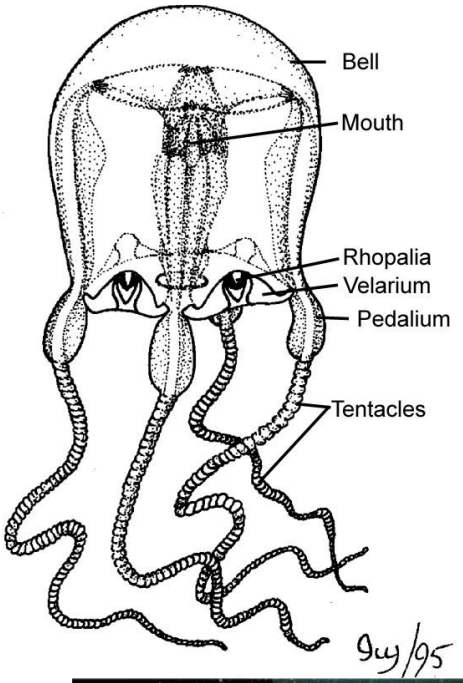
1. The medusa is dominant and the polyp form generally reduced or absent.
2. They possess four gastric pouches lined with nematocysts. Pouches are connected with the mouth as part of the gastrovascular system
3. The medusa possesses neither a velum nor a nerve ring
4. The gastrovascular cavity either in the adult or in the larva is subdivided by vertical septa.
5. They have many rhopalia for sensory function (vision & gravity)
6. The gonads are endodermal in origin
7. The members are solitary
8. Example ***Aurelia***

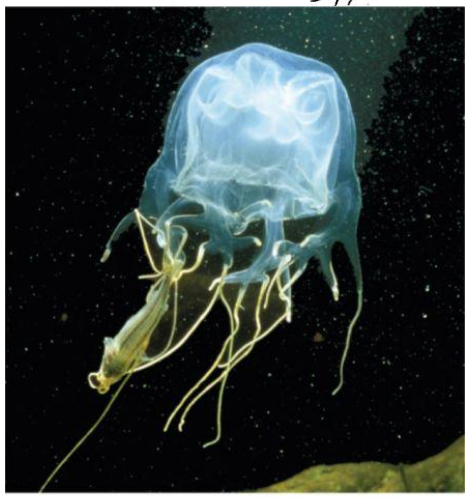
3- Class Cubozoa (cube jellies and Sea wasp

1- Medusoid cnideria with bells having four flattened side

2- Bell margin simple and bearing a velum and four tentacles

The cubozoa was formerly considered an order of scyphozoa, however, the presence of a velum, the possession of a type of nematocyst found only in hydrozoa, the lack of rhopalia are considered evidence that they are not closely related to the other scyphozoas and should be placed within a separate class.





Sea wasp (class Cubozoa)

4- Class Anthozoa (sea anemones, sea fans and corals)

1. Exclusively marine; there is no medusa stage.
2. At the end of the mouth is a ciliated groove called the siphonoglyph, which generates a water current and brings food to the gastrovascular cavity
3. There are mesenteries or septa which project from the body wall into the coelenteron
4. Anthozoans are divided into two subclasses; Alcyonaria (Octocorallia) and Zoantharia (Hexacorallia)

1- Subclass Alcyonaria (Octocorallia)

1. The tentacles are pinnate and 8 in number
2. The mesenteries are 8 in number and are not arranged in pairs.
3. The stomodaeum possesses typically a single siphonoglyphs (ciliated groove).
4. The longitudinal muscles of the mesenteries are on the surface facing the siphonoglyph.
5. The members are exclusively colonial.
6. Eg. *Corallium rubrum* (red coral)

2- Sub class Zoantharia (Hexacorallia)

1. the tentacles are simple and numerous.
2. the mesenteries are usually arranged in multiples of six and are frequently in pairs .
3. The stomodaeum possesses typically two siphonoglyphs.
4. The longitudinal muscle of the mesenteries are arranged in many different ways.
5. Both solitary and colonial form occur.

Phylum Platyhelminthes (Flatworms)

(Greek platy = flat, and helmins = worms)

General characters

1. Bilaterally symmetrical.
2. Cephalization-head (concentration of nervous tissue)
3. Triploblastic- 3 cell layers (Ectoderm, Mesoderm, Endoderm)
4. Acoelomate, no internal cavity.
5. Possesses a blind gut (i.e. it has a mouth but no anus)
6. Excretion and osmoregulation by flatworms is controlled by "flame cells" located in protonephridia (these are absent in some forms).
7. Has normally a nervous system of longitudinal fibers rather than a nervous net.
8. Generally dorsoventrally flattened.

General characters

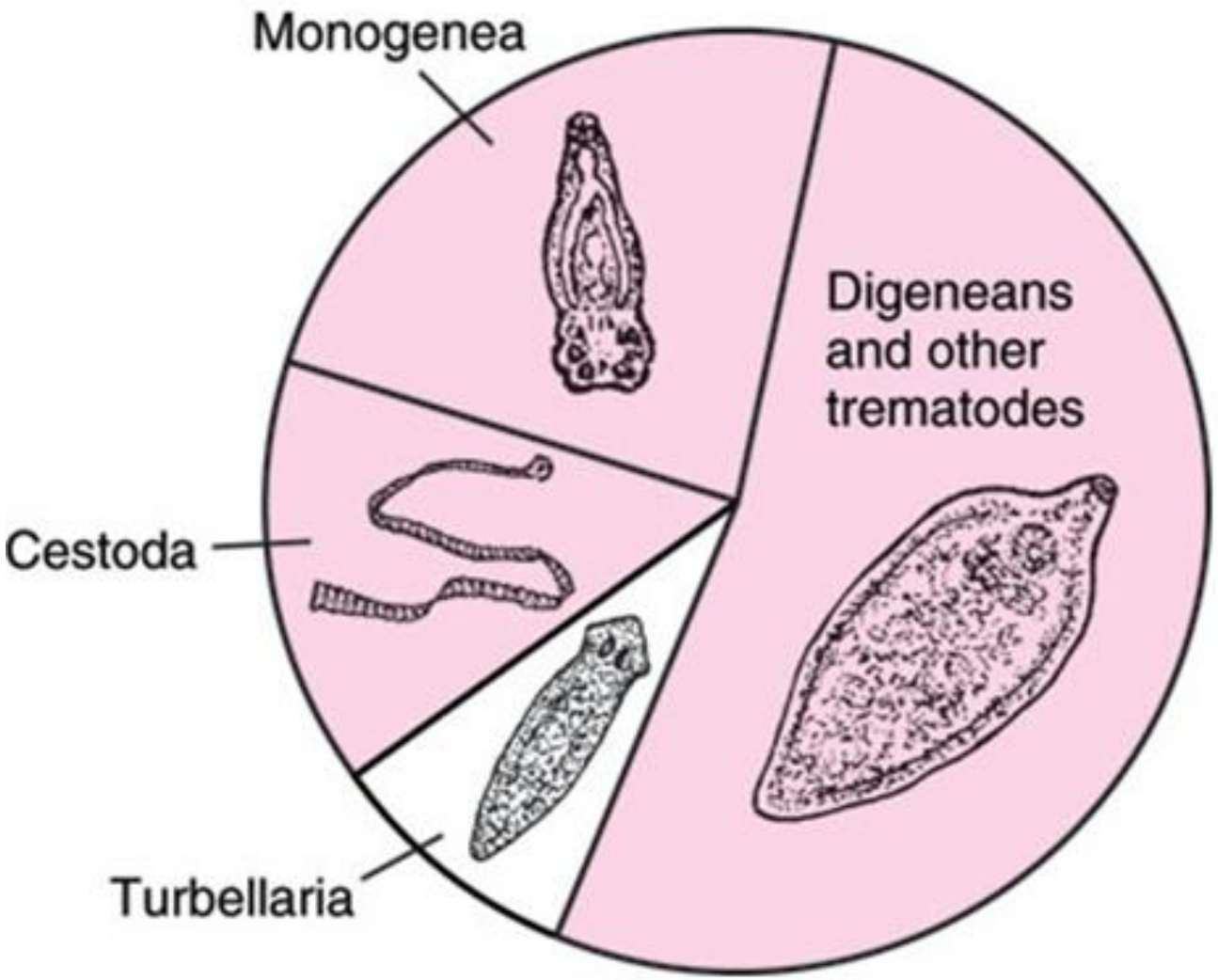
8. all are hermaphrodites. Parasitic species (flukes and tapeworms) have complex lifecycles, with various hosts and several different larval stages.
9. Incredible powers of regeneration.
10. many as parasites of other animals. Some are free living.
11. Flatworms lack a respiratory or circulatory system; these functions take place by absorption through the body wall.
12. In some flatworms, the process of cephalization has included the development in the head region of light-sensitive organs called ocelli. Other sense organs found in at least some members of this group include chemoreceptors, balance receptors (statocysts), and receptors that sense water movement (rheoreceptors).

Classification of Platyhelminthes

Class

- Turbellaria - mostly free living
- Monogenia - all parasitic, mainly ectoparasites
- Trematoda - all parasitic, mainly in digestive tract
  - Digenea - 2 hosts, one almost always a mollusc
  - Aspidogastrea - 1 host, mainly molluscs
  - Didymozoidea - tissue dwelling parasites of fish
- Cestoidea - all parasitic
  - Cestodaria - } found in vertebrates, most
  - Cestoda - } species require at least 2 hosts

Classification of Platyhelminthes

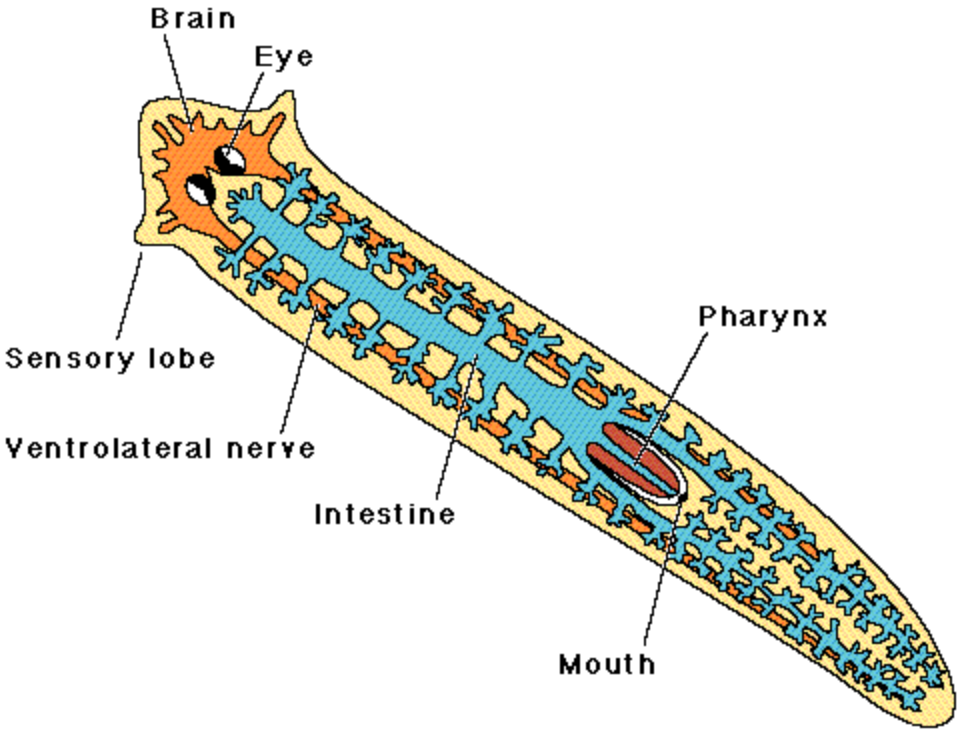


1- Class Turbellaria (planarians)

1. Most are free–living, marine and benthic, but some are fresh water.
2. They are dorsoventrally compressed, with high surface area to volume ratios.
3. Marine species can be quite colorful, but the terrestrial turbellarians tend to be drab.
4. They move by coordinated waves of cilia on a secreted mucus trail, some species can swim by rhythmic muscle contractions.
5. Their ciliated epidermis, the presence of sub-epidermal rhabdites, and their free-living condition distinguish turbellarians from members of the other classes of Platyhelminthes.

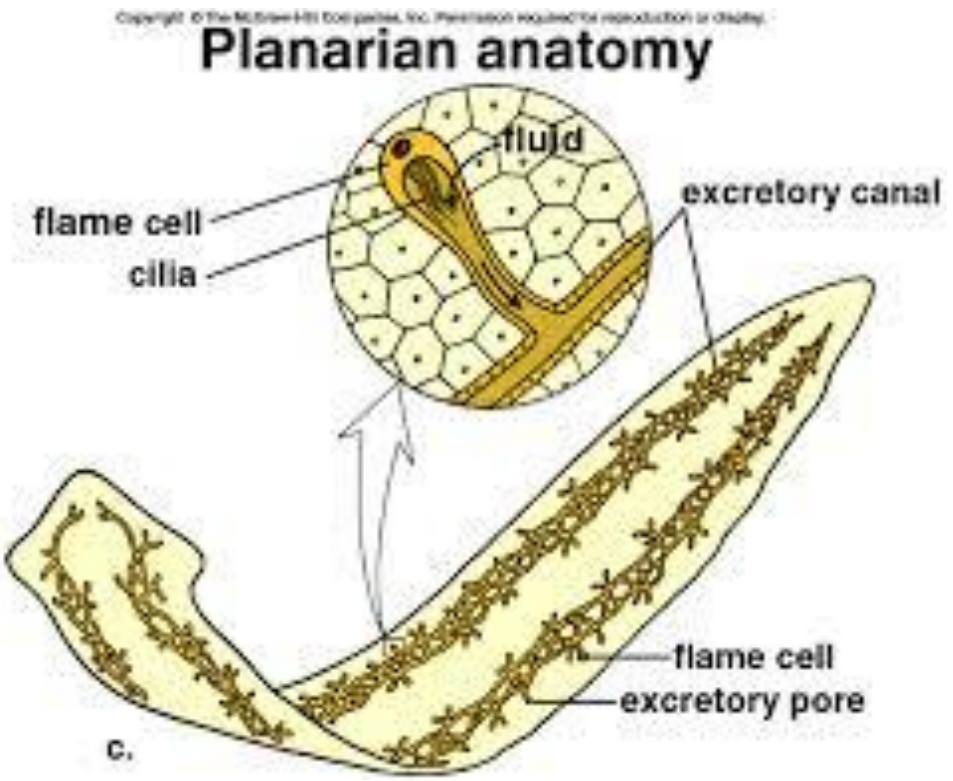
Digestive System of Turbellaria

In planarians, the pharynx can extend through the mouth that is mid-ventrally located. The intestine has three branches, one anterior and two posterior. This gastrovascular cavity is lined with columnar epithelium.



Excretory System (osmoregulation) of Turbellaria

A network of water collecting tubules adjacent to flame cells or a protonephridia . When cilia beat they move water into the tubules and out the body through pores called nephridiopores



Nervous System of Turbellaria

Includes: brain, longitudinal nerve cords, and transverse nerves

Most free living planarians and parasitic larval forms possess a variety of sensory organs, such as eyespots (light), statocysts (balance), rheoreceptors (sense direction of water current)

They do not have image-forming eyes, but many species have pigment cells and photoreceptors concentrated into eyespots

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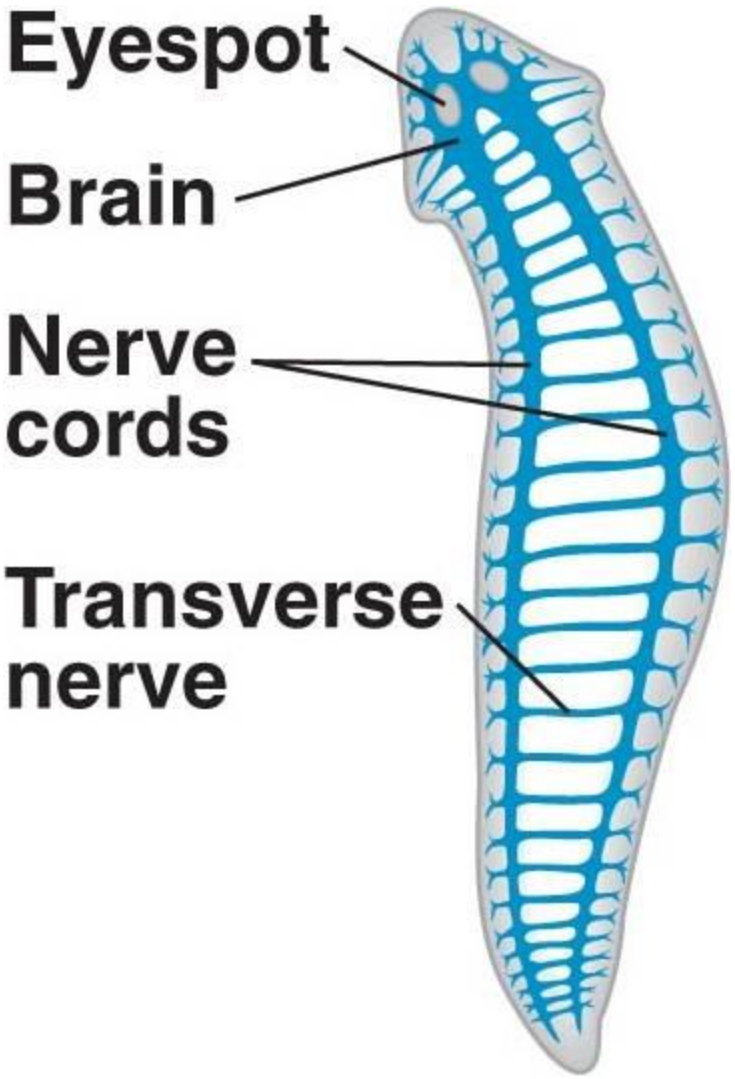
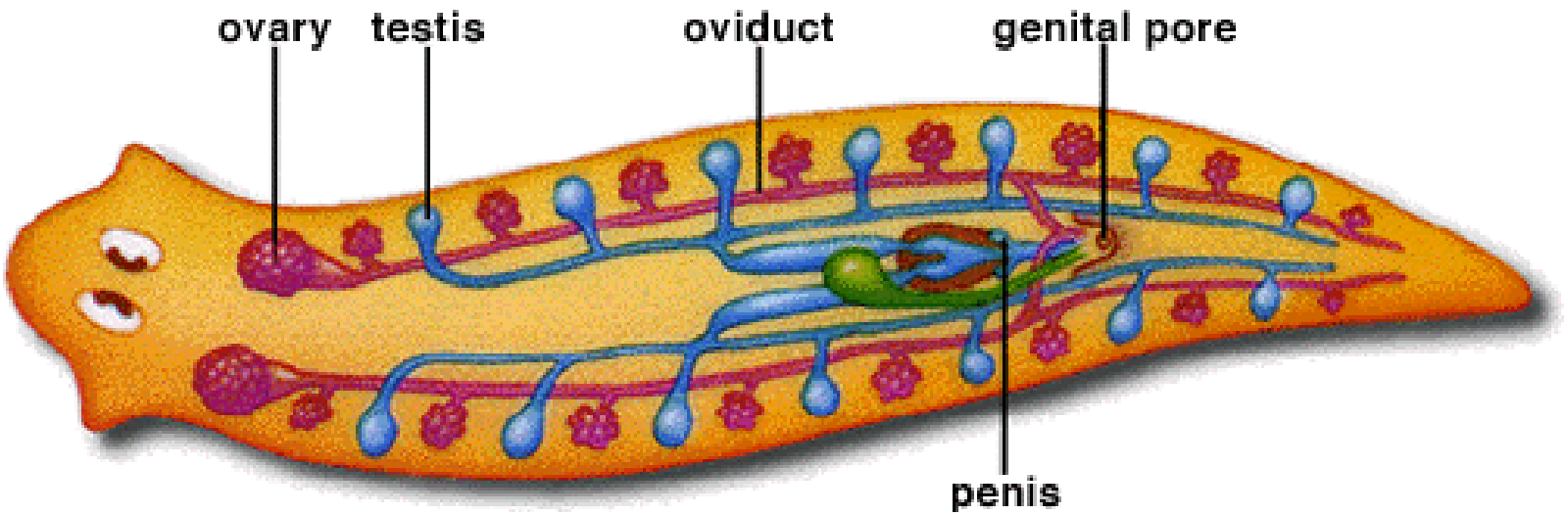


Reproductive System of Turbellaria

Most are capable of some form of asexual reproduction (e.g., many turbellarians reproduce by fission)

Most flatworms are hermaphroditic; however, they often pair with other individuals to exchange gametes



Classification of Turbellaria

orders of Turbellaria are defined by the type of pharynx, organization of the reproductive system, and branching pattern of the gut.

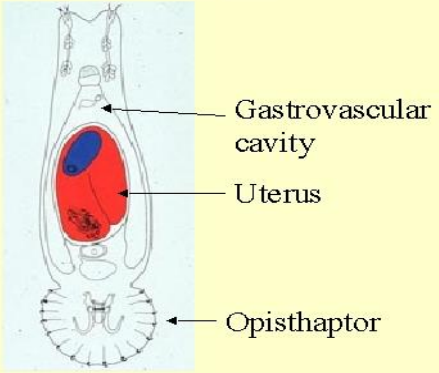
Orders of the class Turbellaria are:

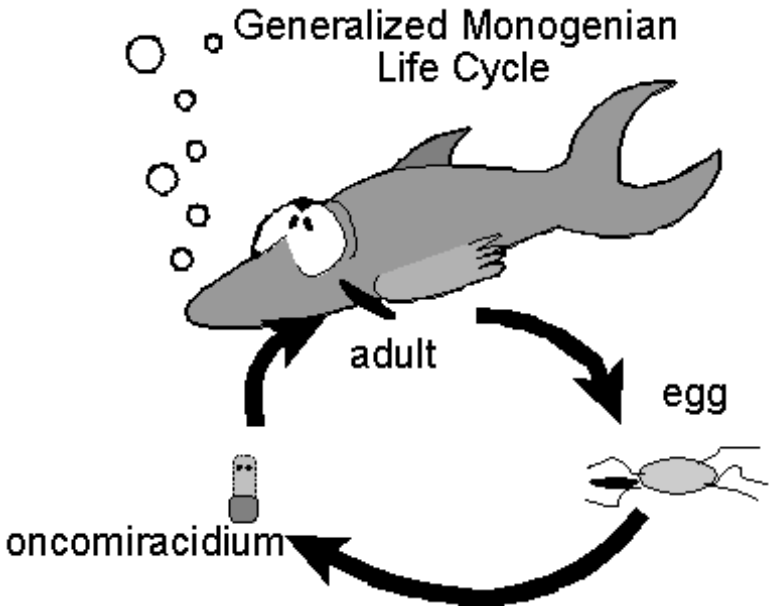
1. Nemertodermatida
2. Acoela
3. Catenulida
4. Haplopharyngida
5. Macrostomida
6. Polycladida
7. Lecithoepitheliata
8. Prolecithophora
9. Proseriata
10. Temnocephalida
11. Rhabdocoela
12. Tricaldida.

2- Class Monogenea

Monogenetic flukes are small flukes without a well-developed sucker. At their posterior end, they have a bulbous structure covered with hooks called an opisthaptor. Most monogeneans are ectoparasites on fish or other aquatic animals, a few live in the urinary bladders of turtles and frogs. Their life cycle involves a single host. Eggs hatch into ciliated larvae, which may attach directly to a host or swim freely for a time before attaching. Adults lack cilia..

Gyrodactylus sp. is a parasite of freshwater fish.





3- Class Trematoda (Flukes)

1- subclass Digenea

- The Digeneans are a large and successful group of parasites.

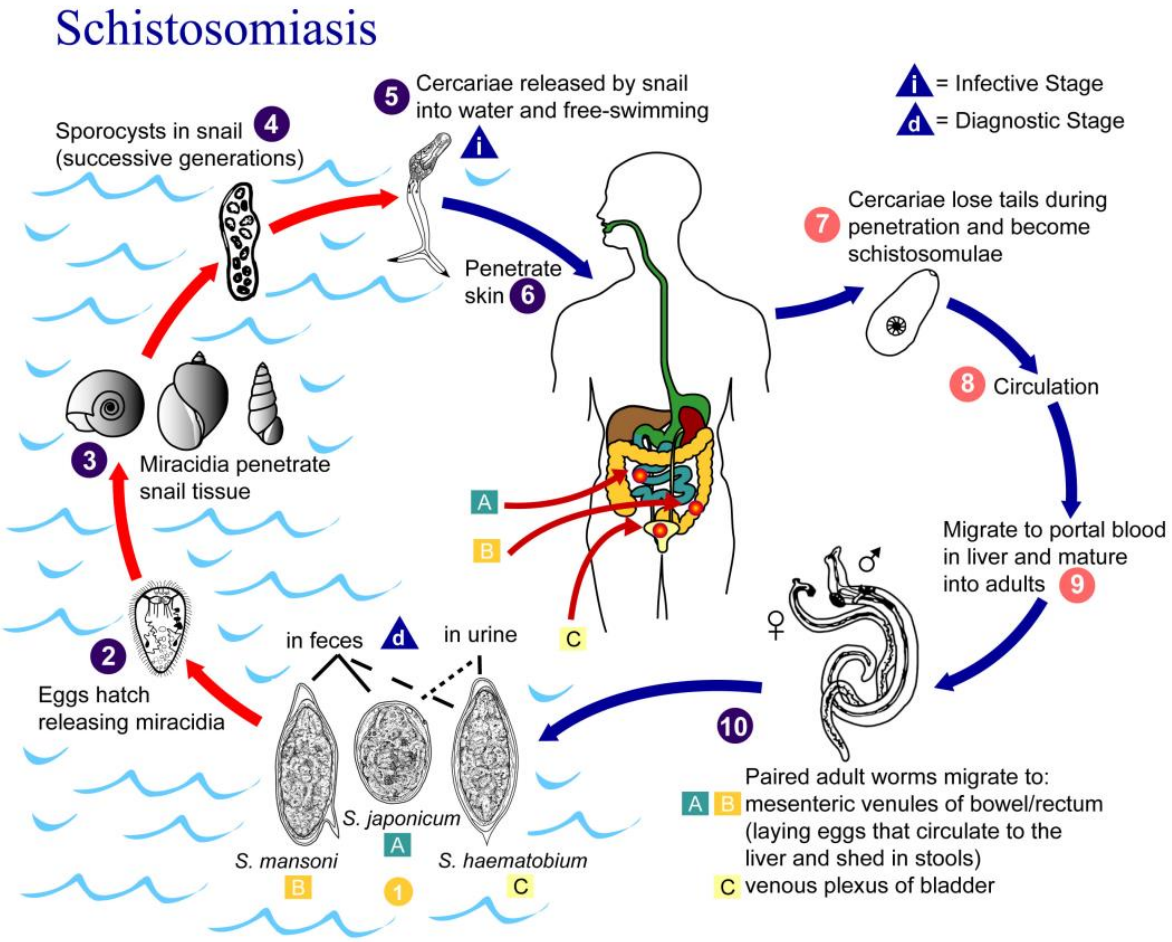
- They all have complicated life cycles involving at least one intermediate host, which is normally an aquatic snail as well as the primary host which is normally a vertebrate.

- The adults are flat worm shaped, they have two sucker. The first is the oral sucker, around the mouth, it has two functions, a) to hold the animal to its host and b) to assist in feeding. The second sucker is found a little way further down the animals body and for attachment.

- They have an “alternation of generations”. This means the egg hatches into a larval form which reproduces asexually to produce numerous copies of itself, these copies change into another larval form which in time grows into a sexually reproducing adult. This possession of an asexual generation means that a single egg can produce not just one infections agent, but many, this is called Polyemberyony.

3- Class Trematoda (Flukes)
1- subclass Digenea

The species that infect humans can be divided into groups, the Schistosomiasis (meaning they live and feed inside the blood vessels)

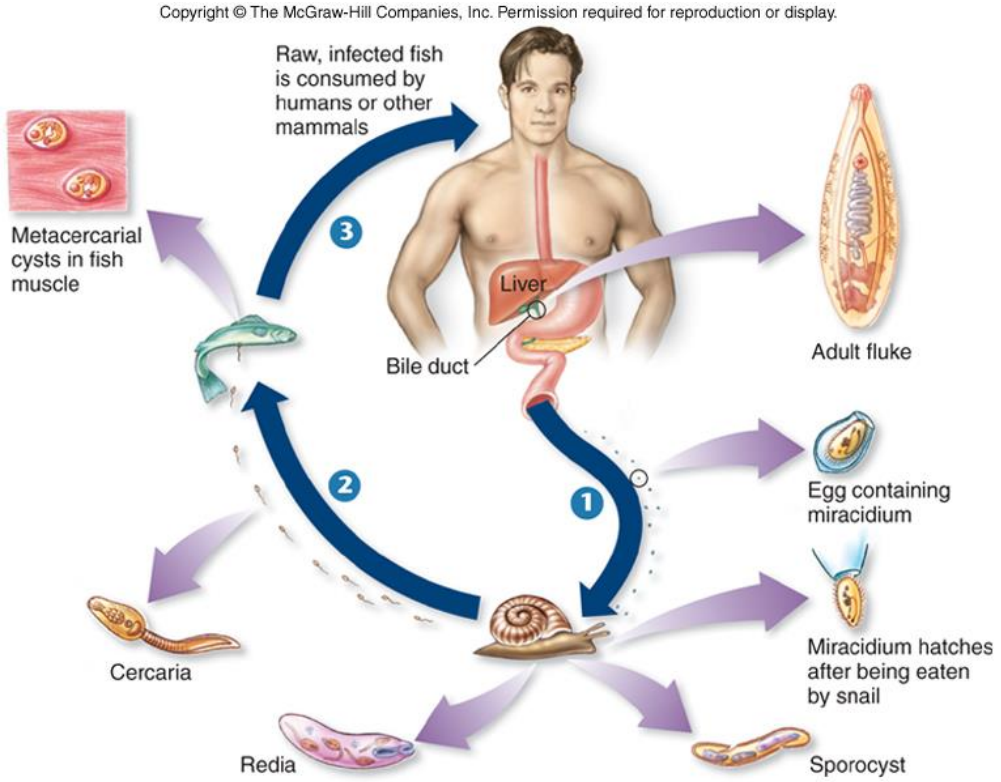


the difference between the non-Schistosomiasomes and the Schistosomiasomes is that in the non-Schistosomiasomes the cercaria larvae never leave the intermediate host and actively seek out the primary host. Instead they form cysts on vegetation or in the snails body, or in the body of an animal which has eaten the snail. Thus the primary host always becomes infected as a result of eating material contaminated with encysted cercaria or metacercaria.

Examples

Distomum (= Fasciola)

Chlonorchis



3- Class Trematoda
2- Subclass Aspidogastrea

1- Small group of absolutely no economic importance.

2- They are parasites of freshwater and marine mollusc and vertebrates.

3- have a nervous system of extraordinary complexity, greater than that of related free-living forms, they have a very great number of sensory receptors of many different types.

4- Their life cycle is much simpler (no multiplicative larval) than that of digenean trematodes, including a mollusc and a facultative or compulsory vertebrate host.

All this has led to the suggestions that aspidogastreans are archaic trematodes, not yet well adapted to specific hosts, and that the complex life cycles of digenean trematodes have evolved from the simple ones of aspidogastreans

Characteristics of Aspidogastrea

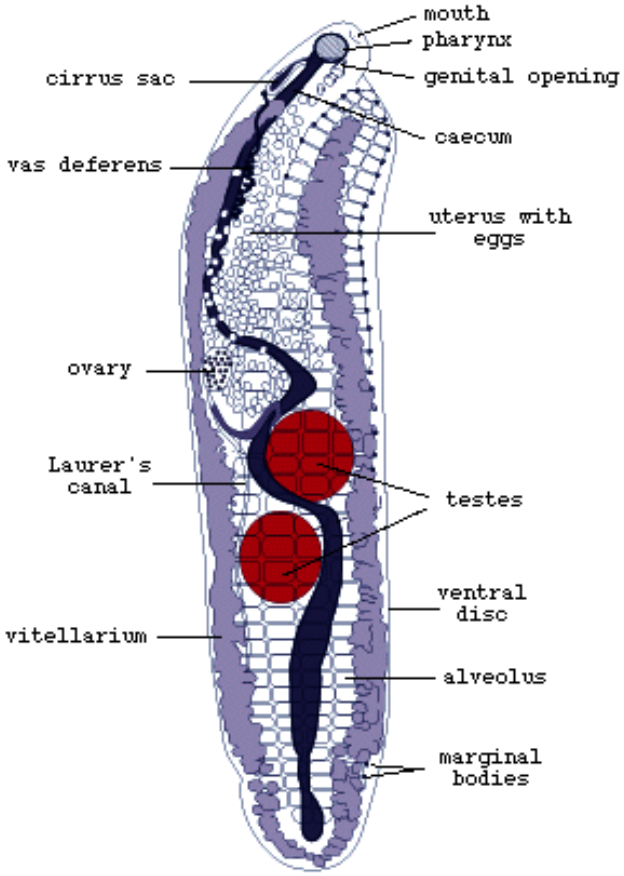
1- a large ventral disc with a large number of small alveoli (suckerlets) or a row of suckers

2- a tegument with short protrusions, so-called microtubercles.

3- Larvae have a posterior sucker

they either possess a number of ciliated patches, or they are non-ciliated

Eg. *Aspidogaster* *Multicotyle*



Class Cestoda (tapeworms)

1- Their bodies are long and flat, made up of many segments called proglottids. Each proglottid is a reproductive unit,

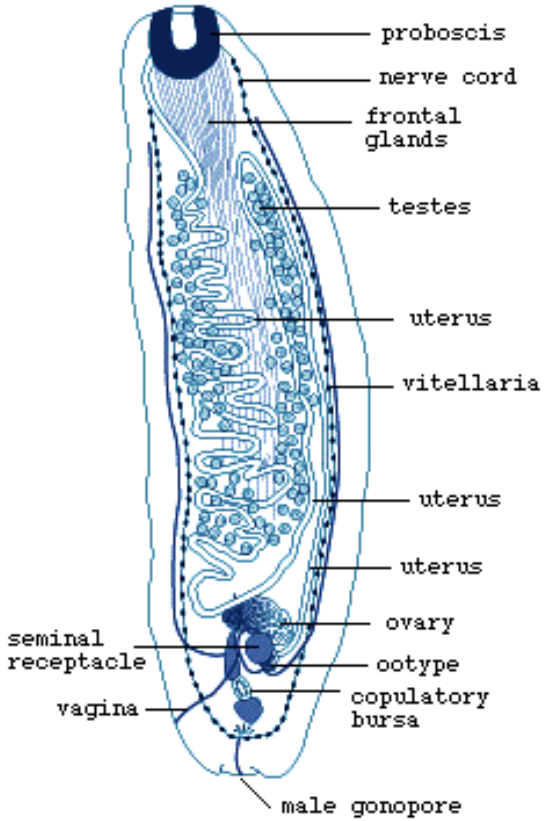
2- Adults lack cilia and their surface is a tegument (as in monogeneans and trematodes), but in cestodes the tegument is covered with microvilli, which increase its surface area and thereby its ability to absorb nutrients from a host.

3- Digestive tracts are absent completely. At the tapeworm's anterior end is a specialized segment called a scolex, which is usually covered with hooks or suckers and serves to anchor it to the host.

4- Most require at least two hosts, with the host of the adult tapeworm a vertebrate. Intermediate hosts are often invertebrates. A number of tapeworm species inhabit humans.

Class Cestoda
1- subclass Cestodaria

contains only a few species of unusual worms, their bodies are unsegmented and roughly oval in shape, they have only a single set of male and female reproductive organs and the larvae have 10 hooks for attachment.



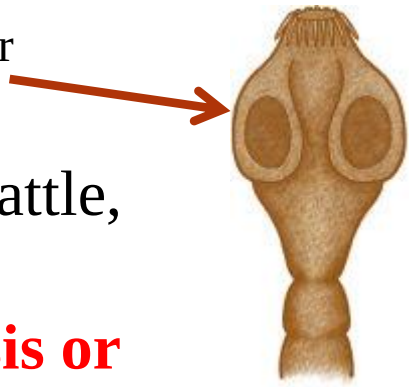
Class Cestoda
2- subclass Eucestoda

- The larvae have 6 attachment hooks
- The adult body consists of a head, called a 'Scolex' which is distinguished by the presence of suckers and hooks, the hooks may be absent as in *Taenia saginatus*.
- they live in darkness there are no eyes
- they do not feed in the usual manner there is no mouth.
- Behind the scolex is a band of rapidly growing material that produces an endless series of reproductive segments called 'Proglottids'. The proglottids contain both male and female reproductive organs, making the tapeworms hermaphrodites. The male organs mature before the female ones. In some species such as the Fish Tapeworm (*Diphyllobothrium latum*) can reach 20 meters in length, contain 3,000 proglottids and produce millions of eggs every day.

Class Cestoda -subclass Eucestoda two orders, Pseudophyllidea and Cyclophyllidea

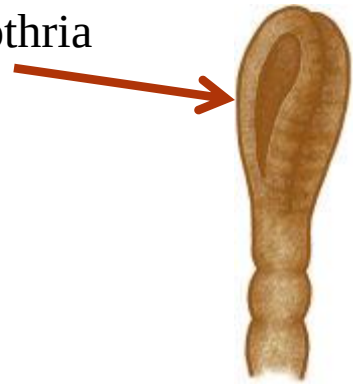
Cyclophyllidean

- cestodes have terrestrial host life-cycles
- scolex with 4 suckers and sometimes hooks
- The larvae of *Taenia* spp. cause **cysticercosis** in cattle, pigs and humans,
- while those of *Echinococcus* cause **Echinococcosis or hydatid disease** in humans, domestic and wild animals.

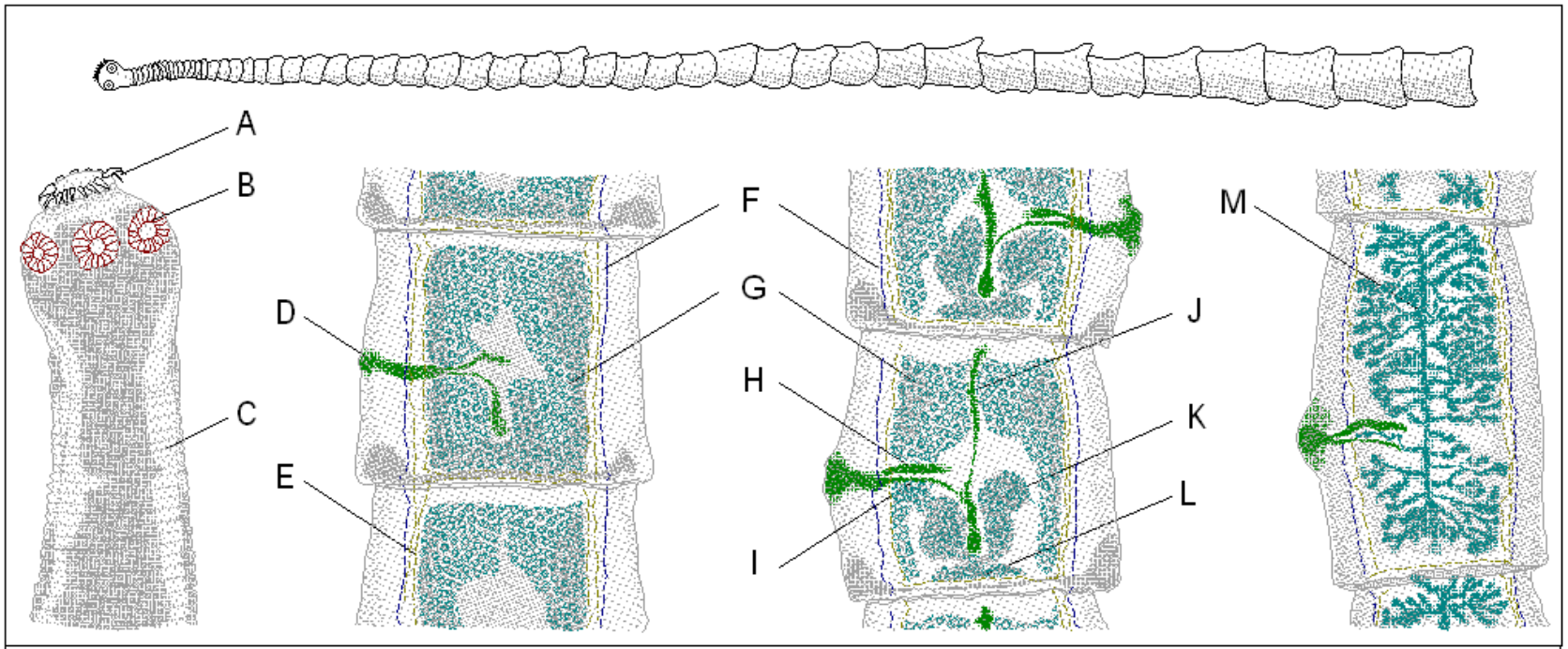


Pseudophyllidean

- cestodes have aquatic host life-cycles
- scolex with 2 longitudinal bothria
- Cause **Sparganosis** in humans.



Cyclophyllidean



A) HOOKS ON SCOLEX
B) SUCKERS
C) YOUNG PROGLOTTIDS
D) GENITAL PORE
E) EXCRETORY CANAL
F) NERVE CORD
G) TESTES
H) SPERM DUCT
I) VAGINA
J) UTERUS
K) OVARY
L) YOLK GLAND
M) UTERUS WITH EGGS

Phylum : Rotifera

شعبة الدولابيات

General characters of Rotifera

1. **Rotifera are microscopic , they are mainly freshwater ,and some species found in marine and humid terrestrial habitats.**
2. **Bilateral symmetry .**
3. **The general body plan consist of : head , neck , trunk(body) and the foot with two or three toes, contains adhesive glands permitting temporary attachment to objects.**
4. **The head has ciliated lobes or corona (crown) that draw food into the mouth and help the swim. The characteristic movement of these cilia suggests a spinning wheel, hence the group name rotifer (wheel bearer)**
5. **The rotifers are pseudocoelomates .**
6. **The digestive system consists of a mouth ,** , and a specialized pharynx called the **mastax**, with its cuticular lining differentiated **into trophi, a series of pieces that act as jaws .and have esophagus , stomach , digestive glands , intestine and anus . They are feed on bacteria and algae, protozoa and detritus .**
7. **The excretory system consists of ciliated cells (flame cells).**
8. **Nerve cells cluster in the head region .**
9. **Reproductive system is simple , consisting in the female of ovary , yolk gland , and oviduct .in male of testis and sperm duct .**
10. **The reproductive duct , inestine and excretory system (bladder) unite to form cloaca.**

Classification of Rotifera

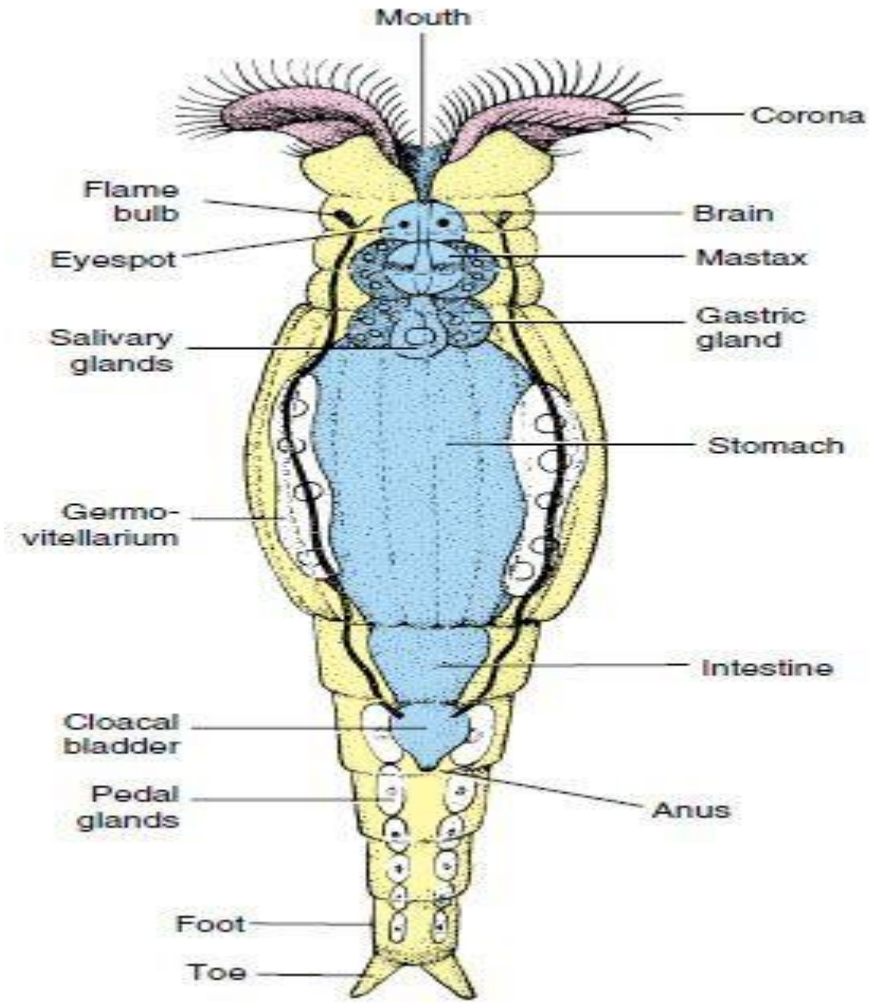
1. **Class Bdelloidea** : Does not have cuticular covering (lorica)**with 2 ovaries , male have never been observed , and the females appear to be obligatery parthenogenic (asexual) produce diploid eggs that hatch into diploid females** . Ex. *Philodina .*
2. **Class Monogononta** :have cuticular covering (lorica), **with 1 ovary , sexual reproduction has been observed, although males are few. EX *Brachionus***

Females produce two kinds of eggs :

- **Amictic eggs -Diploid eggs that have not undergone reduction division , cannot be fertilized & develop only into females.**
- **Mictic eggs -Haploid eggs – undergone meiosis and if ;**
  - **Unfertilized – develop quickly into males.**
  - **Fertilized –they secrete a thick shell and become dormant for several months before developing into females .**

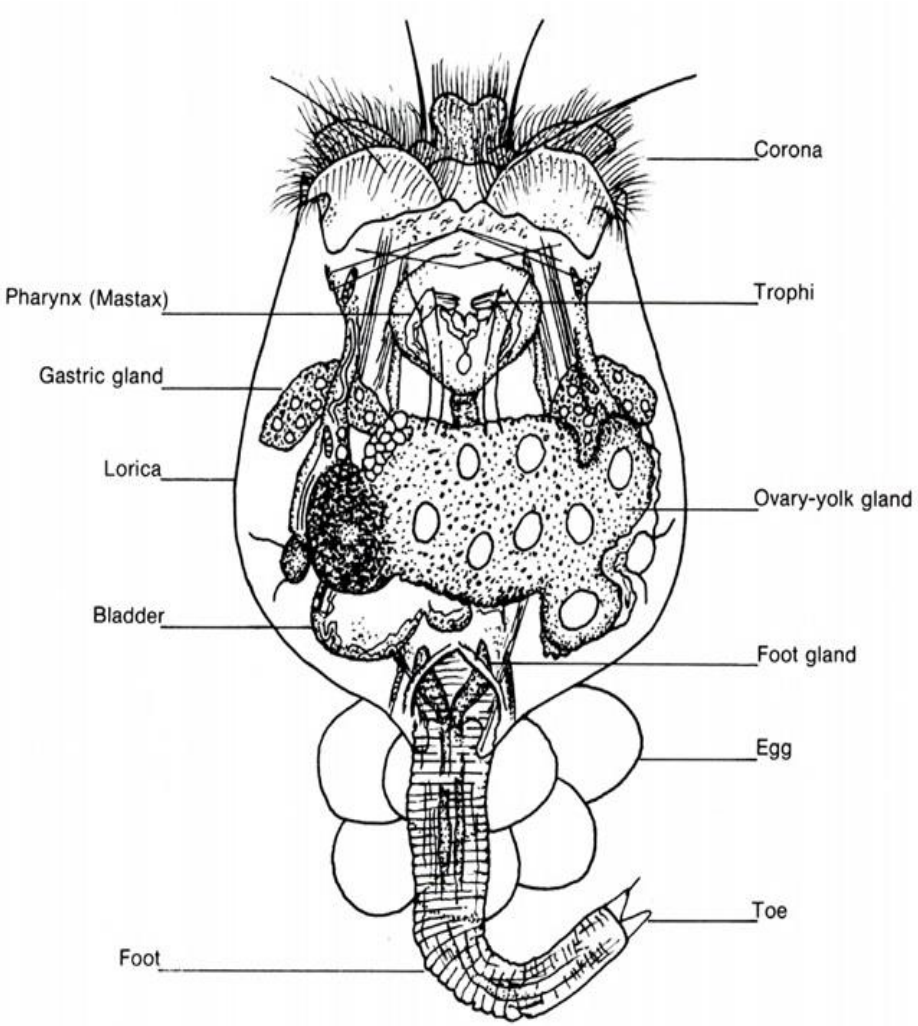
3. Class Seisonidea is the marine class , they are large and live in the gills of crustaceans. single genus :*Seison*

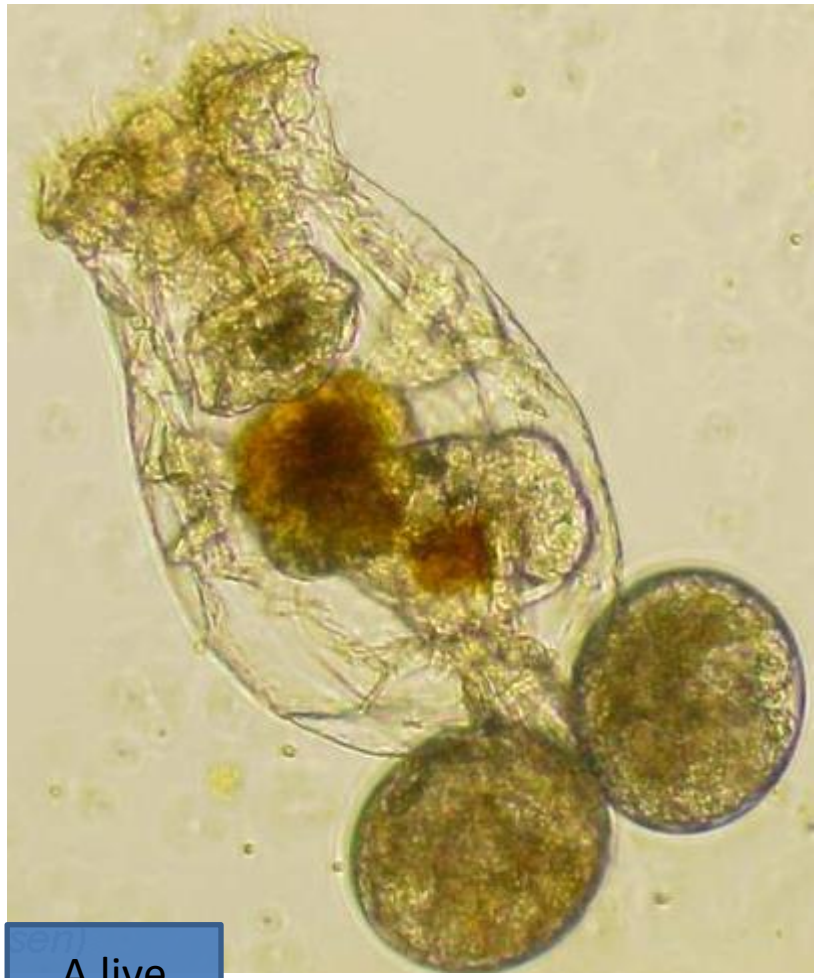
Class Bdelloidea ; *Philodina*



a live

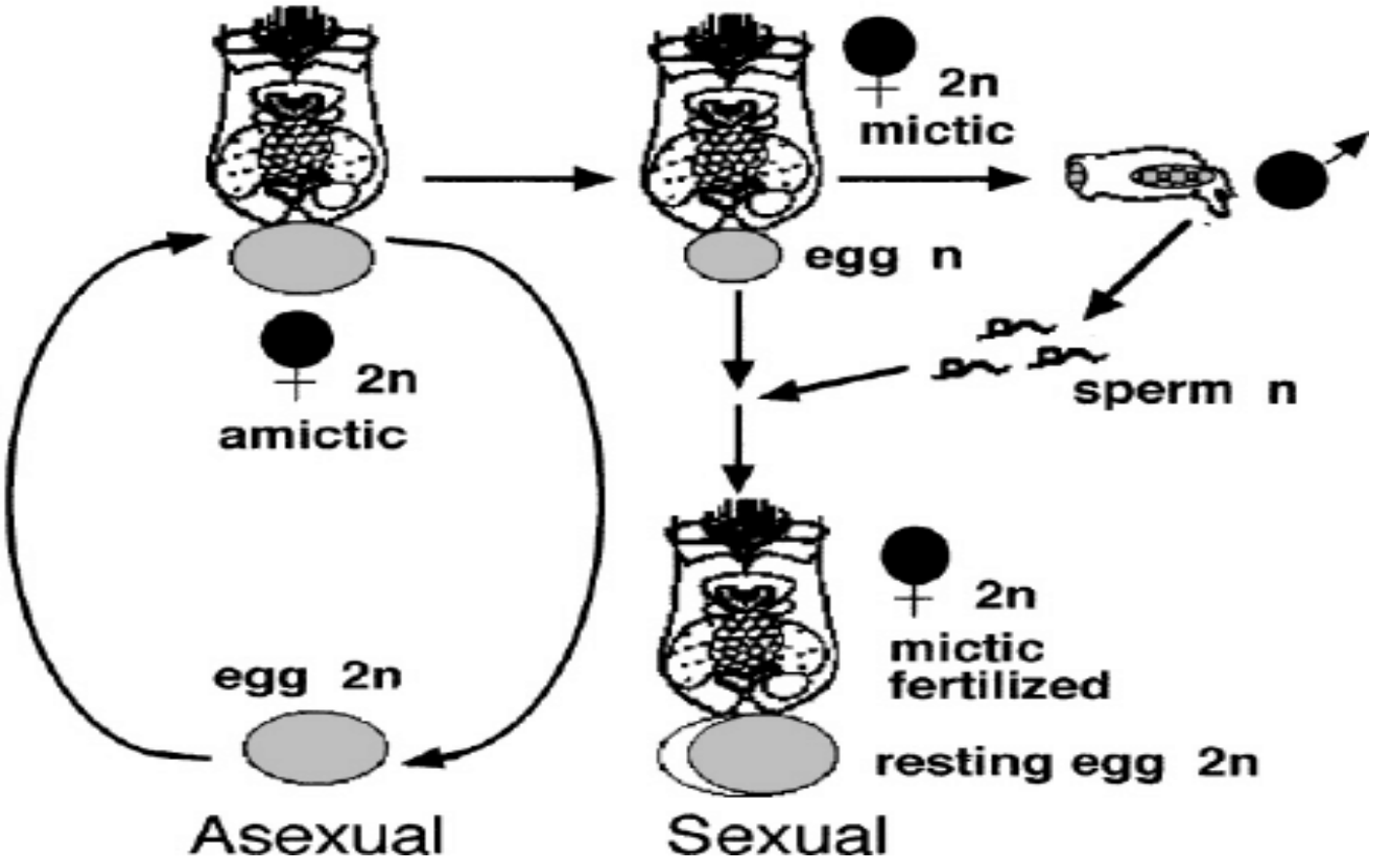
Class Monogononta : *Brachionus*



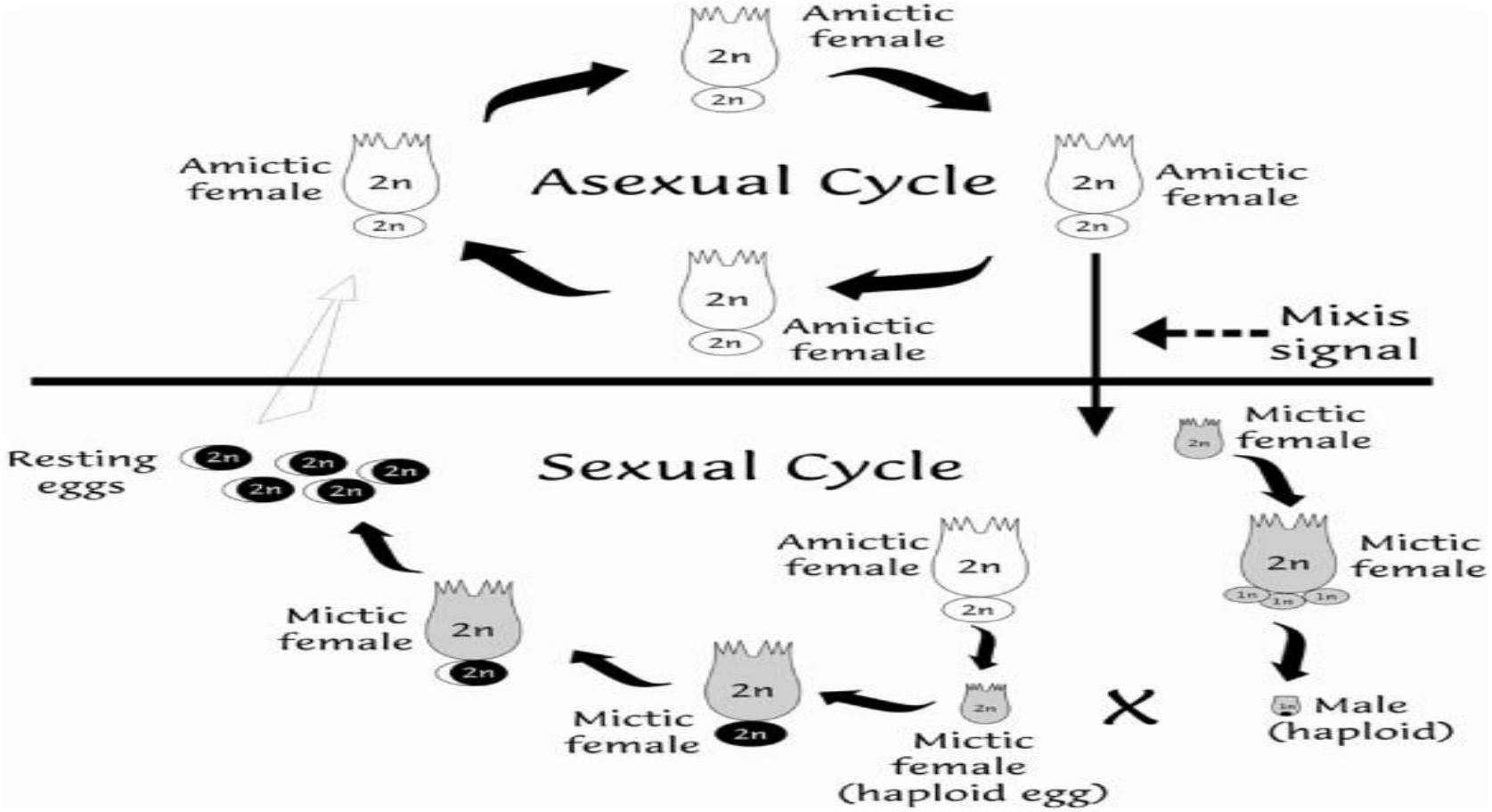


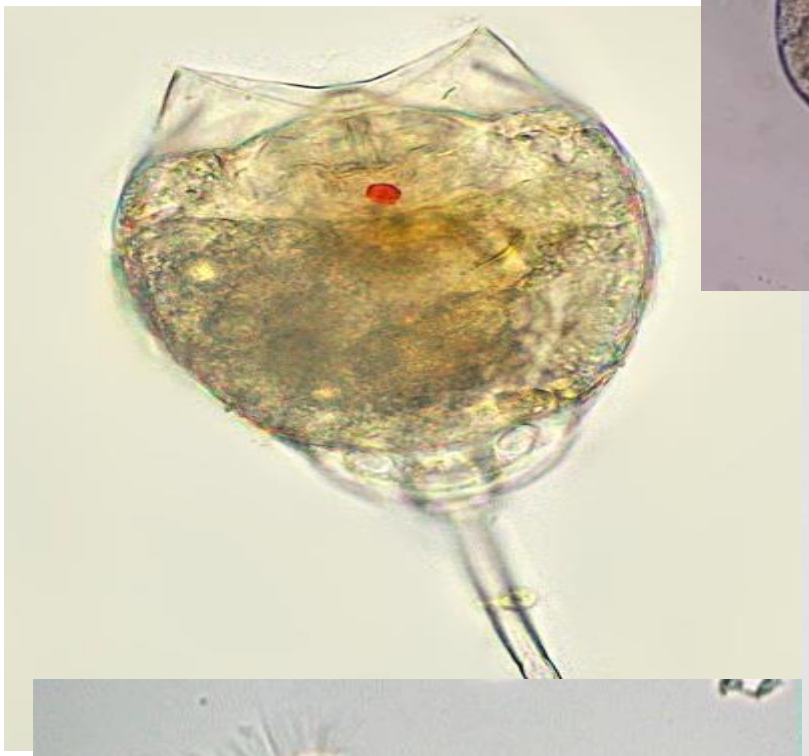
A live

Class Monogononta : *Brachionus* *Reproduction*



Class Monogononta : *Brachionus*
Reproduction



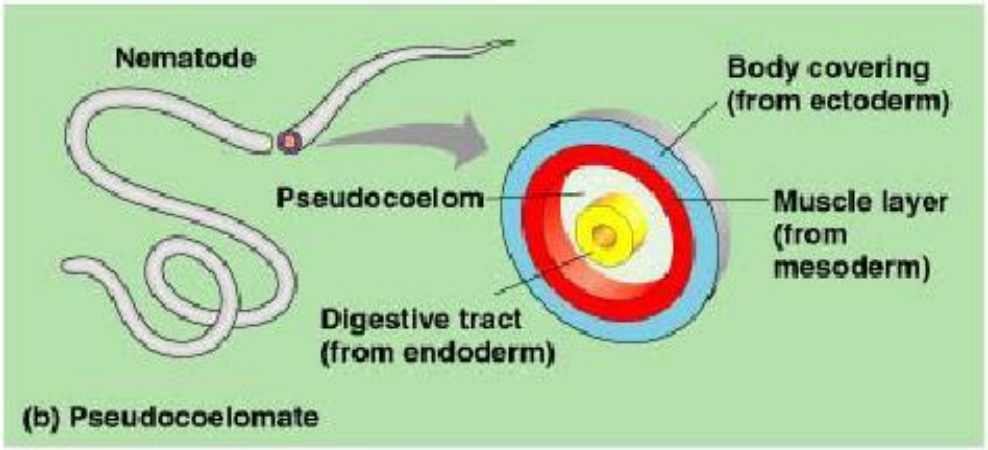


Phylum Nematoda

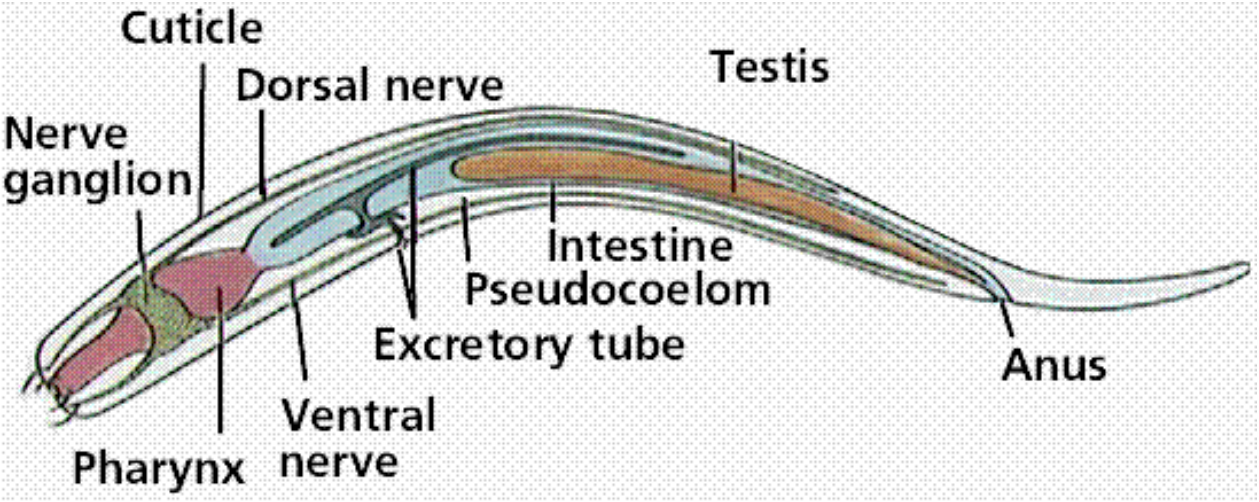
"Greek nema a thread"

Characteristic of Nematoda

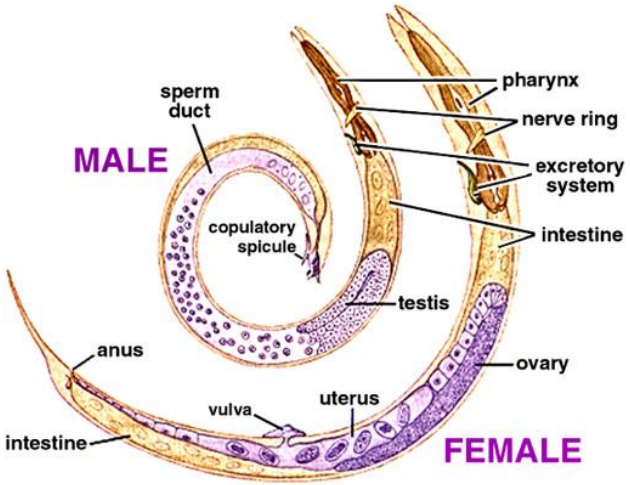
- Most of member are small and free living; terrestrial (soil), aquatic (fresh water and marine), and parasitic (on plants and animals)
- The body is cylindrical, this is the reason for their common name, round worms
- Bilateral symmetry
- Are pseudocoelomate; the mesoderm is only associated with the outer body wall (ectoderm). The mesoderm never splits and never located next to the inner endoderm
- The epidermis is mass of cellular material and nuclei without separated membranes. This epidermis secretes a thick outer cuticle. The cuticle is shed during the life of a nematode as it grow, usually four times before reaching the adult stage. This feature shared with Arthropoda called ecdysozoa.



- The body wall only contains longitudinal muscle.
- The muscle are activated by two nerves that run the length of the nematodes on both dorsal and ventral side. The ventral nerve has a series of nerve centers along and both nerves to a nerve ring and additional nerve centers located near the head.
- The digestive tract is complete, consisting of mouth, ribbon-like intestine and anus. Some round worm are predators feeding on small animals. Other are scavengers feeding on dead tissue. Many terrestrial once feed on living cells of plant roots. The parasitic once feed on host tissues
- Nutrient and west are distributed in the body cavity, whose contents are regulated by an excretory canal along side of the body.



- Reproductive organs lie in the fluid body cavity. Nematodes are dioecious (separate sex) and exhibit sexual dimorphism (male & female body distinct). Males are smaller, shorter and thinner and have a pronounced hook at the posterior end. The females are larger, longer and fatter
- Free living forms have a simple life cycle involving 4 juvenile instars on the path from egg to adult. Parasitic species have developed a wide rang of variations
- The anterior and posterior ends of the body often have cephalic and caudal papillae, which also contain cilia and are believed to be sensitive to mechanical stimulation
- Many nematodes are able to suspend their life processes completely when conditions become unfavorable, and then return to life when favorable conditions return this is known as **cryptobiosis**



- Sense organs, many species have simple, pigmented light receptors (**ocelli)**. The major chemosensory organs called **amphids (chemoreceptors)**, are anteriorly located pits. Similar structure called **phasmids (chemoreceptors)** are located at the posterior ends of the some nematodes.