Phylum Cnidaria or Coelenterata شعبة اللاسعات أو امعائية الجوف

Cnidaria (Gr. Kinde , nettle) : are animals with stinging cells called cnidocytes or cnidoblasts containing nematocysts .

Coelenterata (Gr. Koilos, hollow+ Gr. Enterron, gut) : are animals with coelenterons or gastrovascular cavity in which exracellular digestion occurs .

General Characteristics of Cnidaria

1- Body level of organization is of tissue level .

2- All aquatic , mostly marine , others freshwater .

3- Solitary or colonial .

4- Sessile (sedentary) or free- swimming .

5-Have radial symmetry (original primitive) or biradial .

6- Possess a special type of stinging cells called **cnidocytes** which contain stinging organelles called nematocysts . They are used for : locomotion , defense and food or prey capturing .

7-The body wall is made of two cellular layers , therefore , diploblastica :

A - The epidermis forms the outer layer of the body wall and the gastrodermis forms the inner layer.

B - Anon- cellular layer of mesoglea (mesohy1) is found between the two cellular layers . It is a gelatinous supporting layer.

8-The body wall surrounds a central cavity called gastrovascular cavity in which extracellular digestion takes place . It is also called coelenterons.

- It may be simple or divided into several spaces by mesenteries.
- It has one opening , the mouth which is used as mouth and anus .

9-Nerve cells (neurons) and sensory cells are present . They have appeared for the first time in animal kingdom. Nervous system is primitive consisting of a diffused network of neurons.

10-Exoskeleton or endoskeleton of chitinous , calcareous or protein component in some .

11- Reproduction may be :

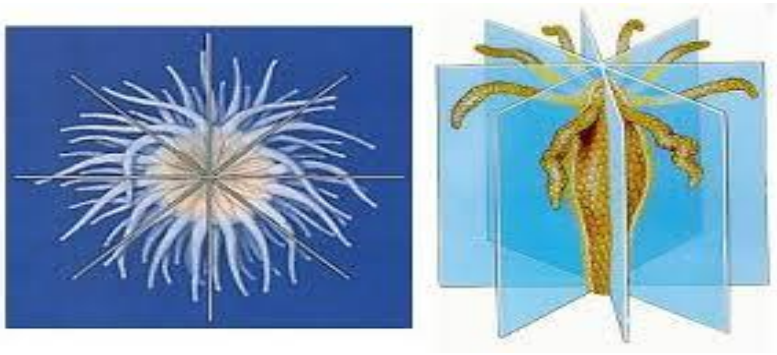
a. **Asexual** by budding , fragmentation , & regeneration.
b. **Sexual** by formation of gametes or sex cells (sperms and ova) and their union .

12-Two basic types of individuals are present , the polyps and medusa .

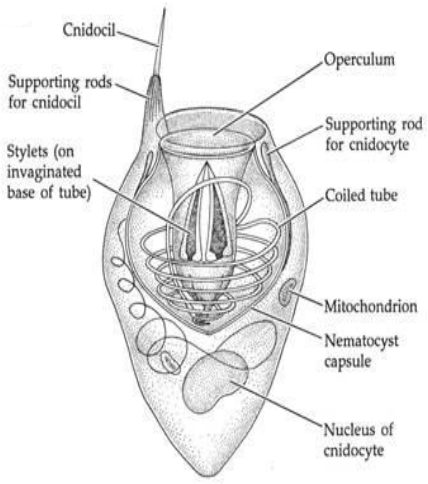
13-**Polymorphism** is observed in colonial forms (*Obelia* , *Physalia*) in which different types of zooids are observed which are morphologically different to perform different functions (division of labour). This phenomenon is absent in non- colonial forms .

14- **Metagenesis or alternation of generation** is another phenomenon found also in colonial forms .

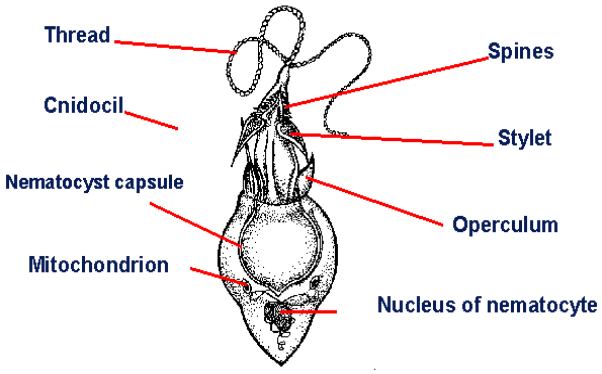
- In the life cycle of these cnidarians , the asexual polypoid form reproduces sexual medusoid form by budding, and the latter reproduces the former sexually by fusion of sperms and ova.
- Thus , the sexual and asexual generations alternate each other, as in *Obelia* .



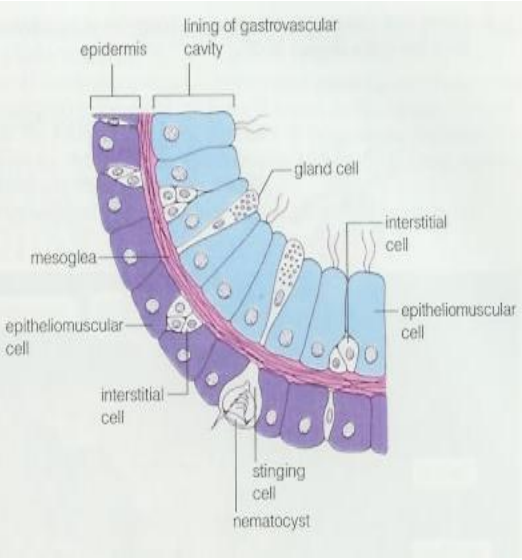
Radial symmetry



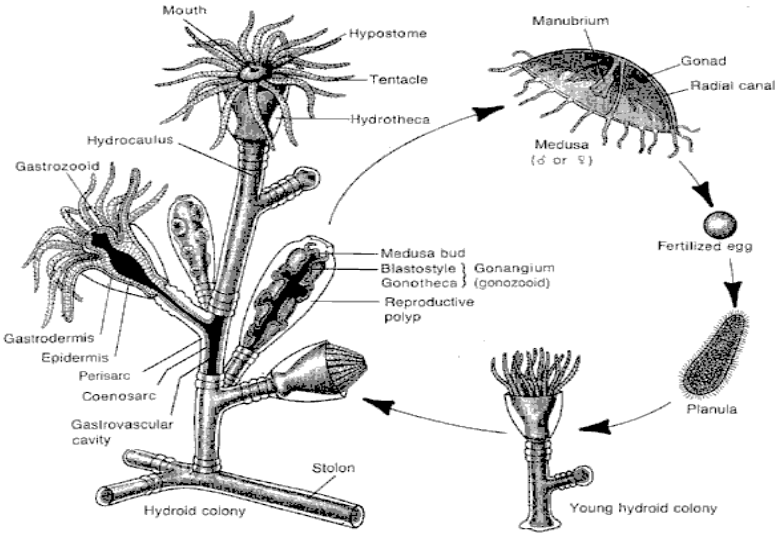
Cnidocytes before discharge



Cnidocytes after discharge



Body wall in cnidaria



Alternation of generation in *obelia*

Classification of Phylum Cnidaria

Strong molecular and morphological evidence now indicates that phylum Cnidaria is composed of **4 classes :**

1

Class Hydrozoa

Solitary or colonial ; asexual polyps and sexual medusa , although one may be suppressed , hydranth with no mesenteries , medusa (when present) with velum , gametes epidermal , mesoglea largely a cellular , marine and freshwater . Ex: *Hydra, Obelia , Physalia , Tubularia .*

2

Class Scyphozoa

Solitary , polyp stage reduced or absent , bell- shaped medusa without velum , gametes gastrodermal , mesoglea with mesenchymal cells of epidermal origin , all marines.

Ex. *Aurelia, Cassiopeia, Rhizostoma*

3

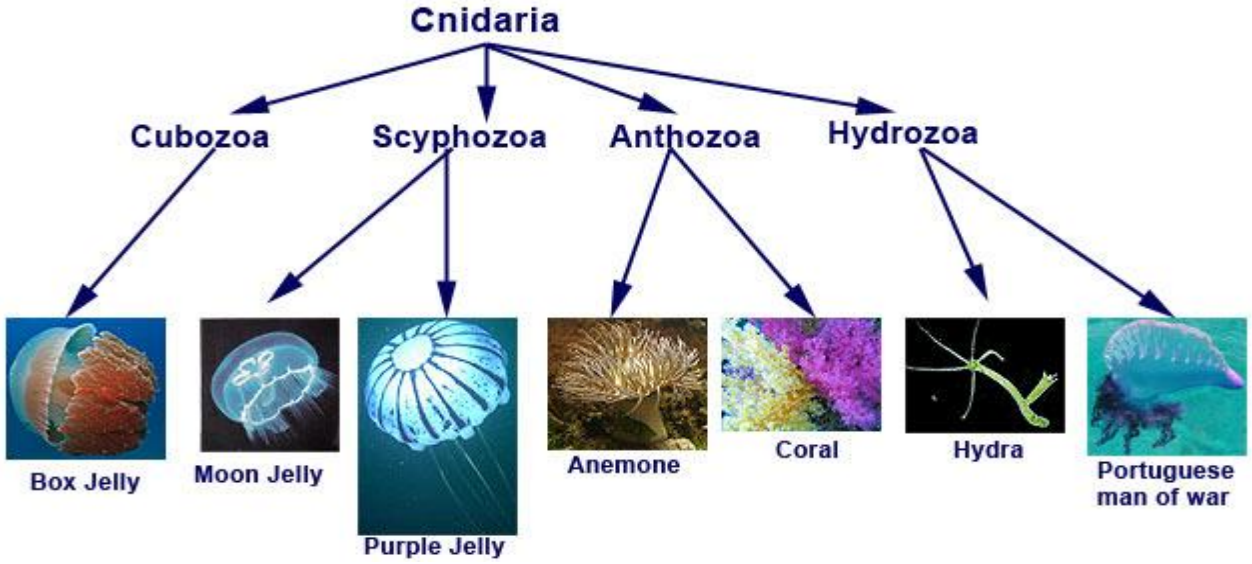
Class Cubozoa

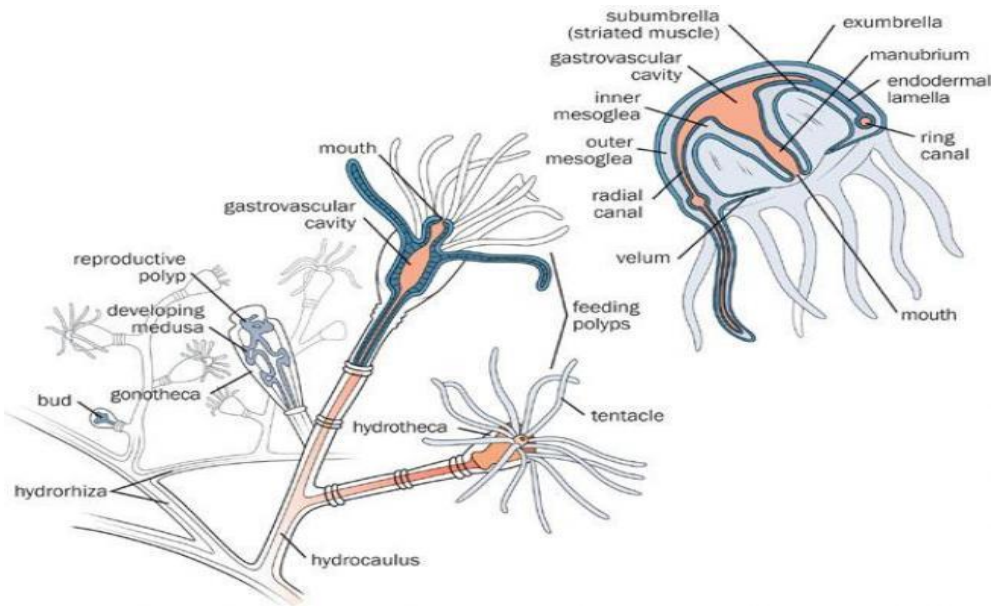
Solitary, polyp stage reduced , medusa cuboidal in shape , with tentacles or group of tentacles hanging from a blade- like pedalium at each corner of the umbrella, gametes gastrodermal , all marine. Ex: *Chironex* , *Carybdea* , *Tripedalia* , *Chropsalmus* .

4

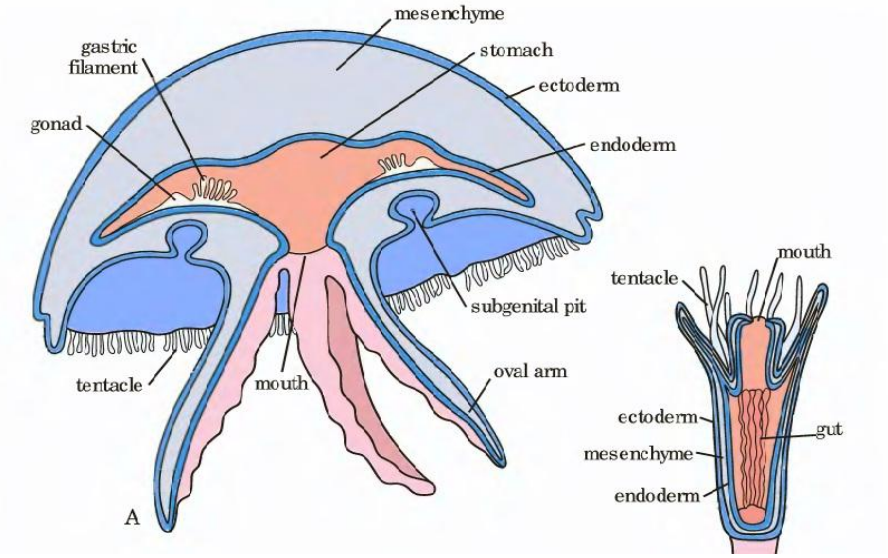
Class Anthozoa

All polyps , no medusa , solitary or colonial gastrodermal cavity subdivided by mesenteries or septa bearing nematocysts , all marine . Ex: *Metridium* , *Cerianthus* , *Gorgonia* , *Tubipora* .

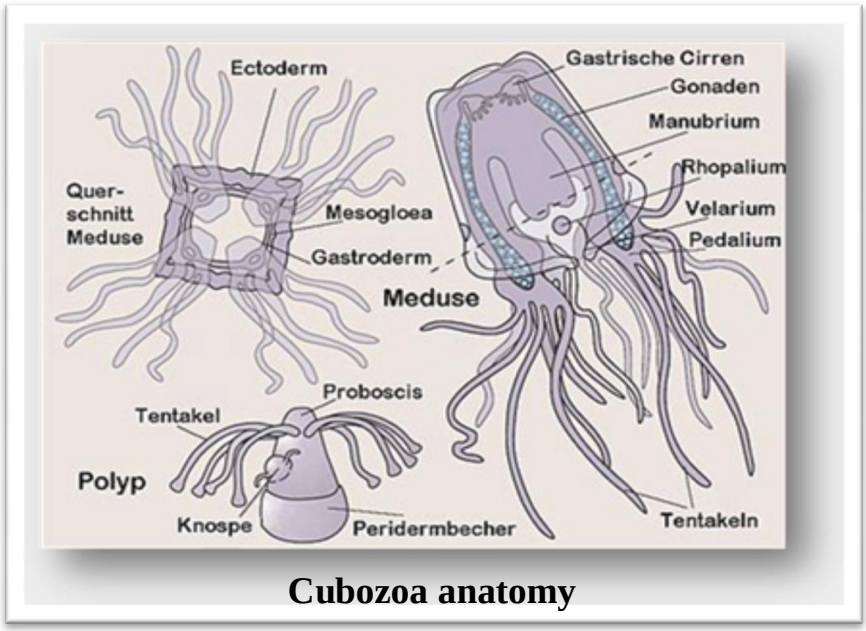




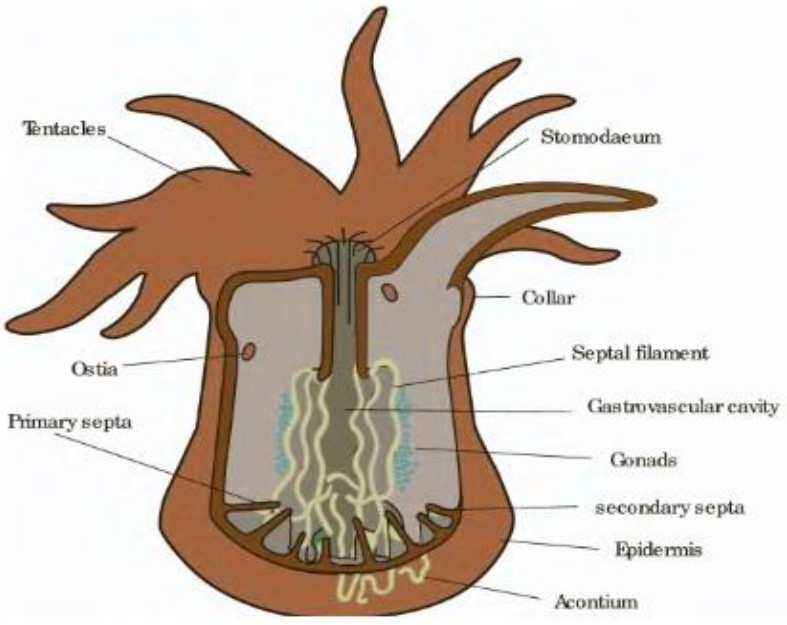
Hydrozoa anatomy



Scyphozoa anatomy



Cubozoa anatomy



Anthozoa anatomy

Hydra

Derivation of the Name

1- This name was given to *Hydra*, by Linnaeus after the great serpentine the nine- headed dragon of ancient Greek mythology . When one of its heads was cut off , two new ones immediately appeared in its place . This monster was slain by Herculus .

2- Hydra means water serpent .

3- It is able to generate its lost parts and to form two anterior ends (head regions) or oral cones when its anterior end is split into two parts .

Systematic Position of Hydra

Domain	**Eukarya**
Kingdom	Animalia
Phylum	Cnidaria
Class	Hydrozoa
Order	Hydrida
Genus	*Hydra*

There are several genera and species of this coelenterate , among them are :

Chlorohydra viridis
Pelmatohydra oligactis
Hydra vulgaris
Hydra gangitica

Hydra is a solitary, polypoid from (polyp) there is no medusoid form (medusa) polymorphism or mutagenesis in its life cycle .

Habit and Habitat

1- *Hydra* is cosmopolitan freshwater cnidarians found in ponds, pools, streams, springs, rivers.

2- It is observed attached by its basal disc to a substratum, swimming, looping, hanging , ect.

Morphology or External Features

The body of *Hydra* is usually divided into 3 regions:

1- Hypostome or oral cone .

2- Stalk or column .

3- Pedal disc, basal disc or foot .

Oral Cone

1- Represents the distal end or the free end of the organism .

2- Cone- like structure curring the mouth , hence called oral cone .

3- It lies bellow the mouth , therefore called hypostome .

4- Bears 4-12 slender, hollow and contractite tentacles which are used for capturing the prey and locomotion . They may reach 7 cm when fully stretched .

Stalk

1- It is tubular, cylindrical, elongated, highly flexible and contractile part between the hypostome and foot .

2- Stalk may be without any out growth , then *Hydra* is called ***Hydra* plain** , or it may carry testes (spermaries) , then it is called ***Hydra* male**, or it may carry an ovary (generally one), then it is called ***Hydra* female**.

3- The stalk may carry both testes and ovaries , then it is named ***Hydra* hermaphrodite**.

4- Testes are small , round or conical , many, generally near the hypostone .

5- Ovary is large and dome- shaped and generally one near the foot .

Foot

1- It is flattened disc- shaped aboral end of the body, generally attached to a substratum.

2 - Its epidermis is supplied with mucous cells which secrete sticky substance (mucus) for the attachment of the organism to an object .

3- The epidermis also contains another type of secretary cells which secrete gas in the mucous material to form a large gas bubble for floating .

Histology of the Body Wall of *Hydra*

1- *Hydra* is diploblastica.

2- Body wall and tentacles consists of two cellular layers :

a. Epidermis

b. Gastrodermis

3- A non- cellular gelatinous layer , the mesohy1 (mesoglea) is found between the two cellular layers .

A- Epidermis

1- This layer is derived from the ectoderm.

2- Epidermis consists of six types of cells :

1

Epitheliomuscular Cells

They are numerous , large columnar cells , These cells form a protective covering . Their bases extend along the oral aboral body axis and contain myofibrils which also extend lengthwise and cause shortening of the stalk and tentacles when they contract .

2

Interstitial Cells

interstitial cells are small , round cells , with large nucleus .These cells are found in groups among the bases of the pitheliomuscullar cells, therefore called interstitial cells. They are reserve cells , spare cells , embryonic cells , undifferentiated cells totipotent or pluripotent cells because they are able to form any other cell type when needed .

3

Gland Cells

Secretory columnar or cylindrical cells. Gland cells are found around the mouth and the foot region . They secrete mucus and/ or gas bubbles facilitating swallowing the prey, or floating movement .

4

Sensory Cells

They are slender , long , spindle- shaped cells with apical sensory cilium or hair. At their bases, they have long, fibrous processes which synapse with nerve cells. These cells are scattered among other cell types , particularly around the mouth and on tentacles and foot .

5

Nerve Cells

Nerve cells neurons are arranged in two networks , one on either side of mesohy1 or mesoglea . In epidermal side, they appear to the multipolar , and their axons form synapses with sensory cells and junctions with epitheliomuscular cells and cnidocytes .

6

Cnidocytes

Cnidocytes or cnidoblasts are distributed throughout the epidermis , but are concentrated in hypostome and tentacles . These stinging cells contain nematocyst and thread of various functions .

Three functional types of nematocysts are observed in *Hydra* , they are :

a. Penetrants : They penetrate the prey and inject toxin or poison into it.

b. Volvents : They recoil and entangle the preys .

c. Glutinants : They secrete an adhesive substance used in locomotion or attachment. These are of two subtypes, according to their size , small and the large ones .

B - Gastrodermis

This layer lines the gastrovascular cavity and **contains three kinds of cells.**

1

Interstitial Cells

They are quite similar morphologically, topographically, and physiologically to those observed and decribed in epidermis.

2

Gland Cells

They are columnar in shape and secretory (glandular) in nature. Those around the mouth opining secrete mucus to facilitate the swallowing the preys. Those in the hypos tome and column regions secrete enzymes in the gastrovascular cavity causing the digestion of the prey or large food particles into small ones. This kind of digestion of food outside the cells inside the gastrovascular cavity is called **extracellular digestion**.

3

Nutritive- muscular Cells

They are large, tall, columnar cells. their bases extend laterally at right angle to the body axis and contain myofibrils which also extend laterally. When these myofibrils contract, they decrease the diameter of the stalk, or the gastrovascular cavity. Their free apices bear cilia (two per cell) and many pseudopodia .

Cilia are used to circulate food particles and fluids present inside the digestive gastro vascular cavity. Pseudopodia are used to engulf small food particles and form food vacuoles. When food is available, they contain a large number of food vacuoles in which food is digested by the help of lysosomes (enzymes). This type of digestion which is carried out inside the cell is called **intracellular digestion**.

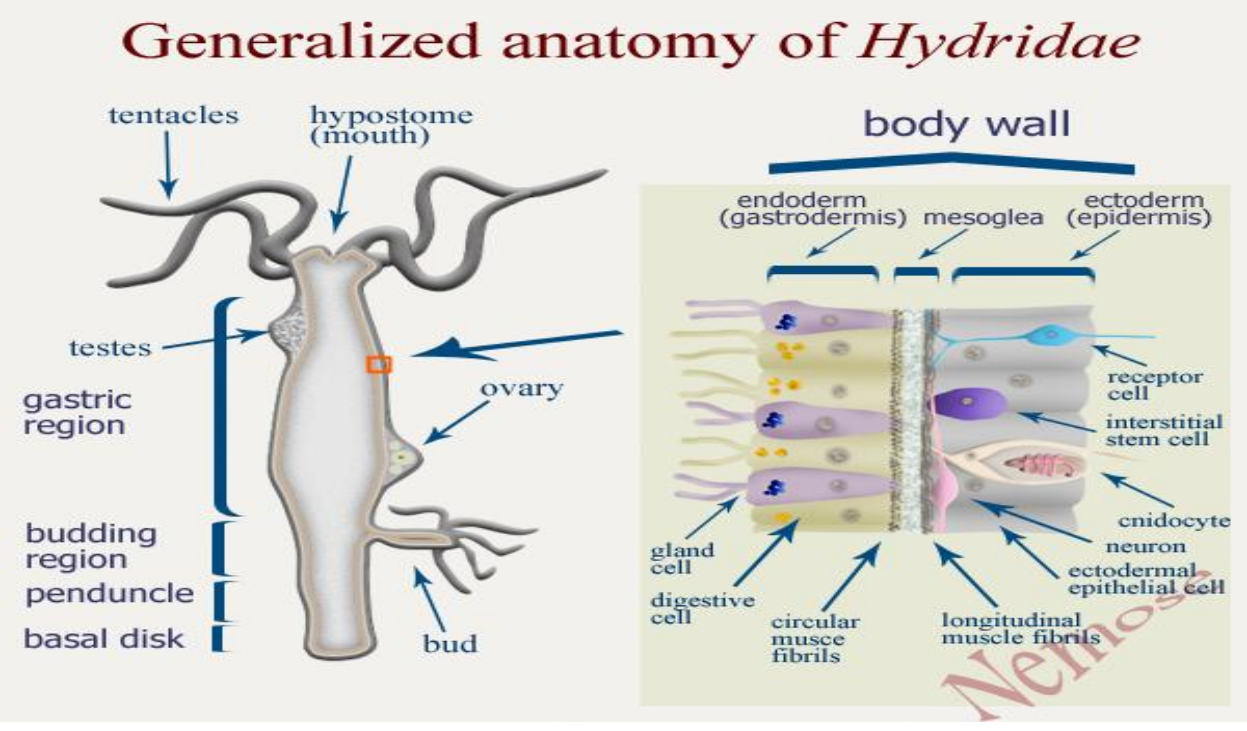
Mesoglea or Mesohyl

1- It is non- cellular layer.

2- Mesohy1 lies between the epidermis and gastrodermis.

3- Mesoglea is a gelatinous or jelly – like sticky proteinaceous substance.

4- This layer binds the two cellular layers to each other supports the body and acts as a type of elastic skeleton .



Nutrition

1- *Hydra* is carnivorous. It captures and feeds on small crustaceans , insect larvae , tadpoles , young crayfishes , nematodes and annelids .

2- Tentacles capture the preys by the help of cnidocytes .

3- Tentacles contract and put the prey inside the mouth .

4- The prey even though sometimes larger than *Hydra* is swallowed by the help of mucus secreted by the gland cells present around the mouth opining .

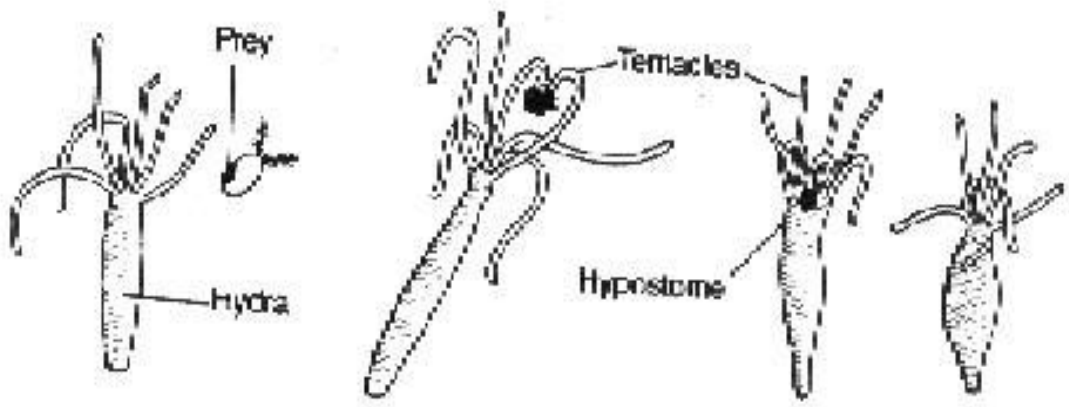
5- In gastrodermis, enzymes which are secreted by the glandular cells digest the prey into small particles inside the gastrovascular cavity (extracellularl digestion) .

6- Cilia of nutritive – muscular cells help in circulation and distribution of these small food particles .

7- Pseudopodia of nutritive- muscular cells engulf small food particles, food vacuoles are formed, lysosomes are added and intracellular digestion takes place inside nutritive – muscular cells.

8- Two kinds of digestion are observed in *Hydra* or cnidarians , an extracellular digestion in gastrovascular cavity and an intracellular digestion inside the nutritive muscular cells .

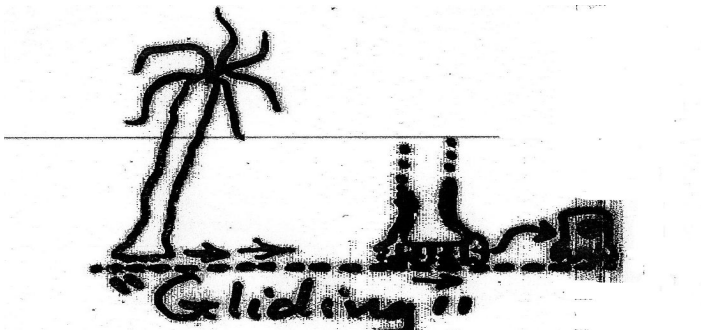
9- Indigestible food inside food vacuoles is thrown in the gastrovascular cavity. The remaining parts of the prey in gastrovascular cavity are thrown outside via the mouth when *Hydra* contracts, thus the acts as mouth acts as mouth and anus.



Locomotion

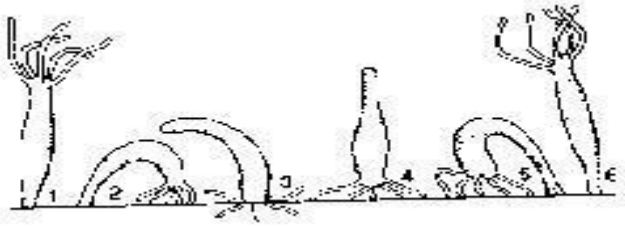
Unlike colonial polyps which are permanently attached , ***Hydra*** **can move freely using several methods :**

1- Gliding : *Hydra* can glides or slides slowly over a smooth surface . Cells of basal disc send pseudopodia like projections causing creeping amoeboid movements . This movement is aided by mucous secretions of the gland cells of the basal disc.

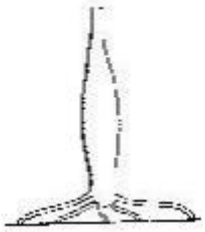


2- **Looping** : It bends over like a loop till it attaches its tentacles to the substratum. Then is moves its foot close to its attached tentacles . Finally it frees its tentacles and body becomes erect.

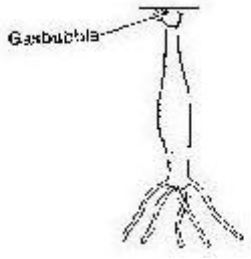
3- Somersaulting : The animal somersaults like an acrobat . First, the body is bent and tentacles are attached. Basal disc is freed and brought near the tentacles and is raised up (*Hydra* becomes inverted or upside down) . Then, *Hydra* bends and the foot is attached to the substratum . Tentaculr end is freed, raised up, *Hydra* becomes straight as in normal condition.



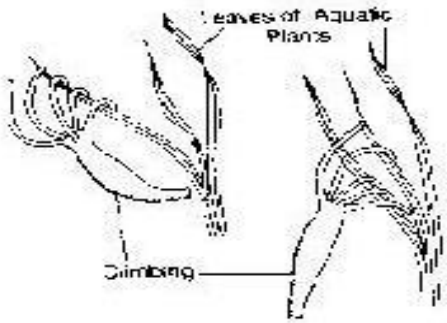
4- Walking : It bends its stalk and attaches its tentacles. Then it raises up its foot *Hydra* dose a handstand on its tentacles. Now the animal moves walk in an inverted condition using its tentacles as if they were legs .



5- Floating or Surfacing : Secretory cells of the foot secrete mucus and gas. A gas bubble is formed just beneath the foot. *Hydra* frees its foot , rise in the water and float at the surface upside down or hanged by the gas bubble.



6- Climbing : This method is used when *Hydra* changes its location in a limited area. Tentacles are extended and attached to an object near the animal . Foot is then released . The whole body contracts , then foot is attached near the tentacles. The tentacles are freed and the body extended including the tentacles which are attached to another place. These steps are repeated.



7- Swimming : *Hydra* frees itself from a substratum . It swims in the water by the undulating wave- like movement of body.

Reproduction

***Hydra* reproduces by two methods:**

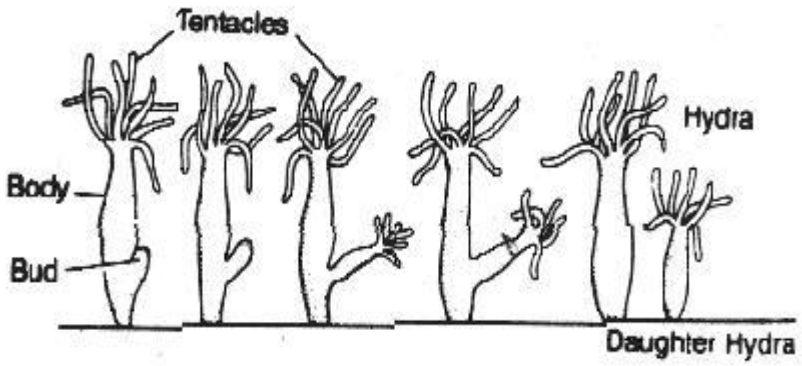
1- A sexually .
2- Sexually.

1- Asexual Reproduction :

1- *Hydra* reproduces asexually by **budding** .

2- Interstitial cells divide and form an outgrowth or an out pocket or bud which develops into a young *Hydra* with mouth and tentacles .

3 - Eventually, it detaches from the parent .



2- Sexual Reproduction :

1- *Hydra* reproduces sexually by sperms and ova (gametes or sex cells) .

2- Most species are dioecous.

3- Temporary gonads (testes or ovaries) appear in autumn.

4 - They are stimulated by lower temperature and reduced aeration of stagnant water.

5- Blastula is formed followed by gastrula.

6- Ovum or egg remains attached to the body and exposed to sperms.

7- Sperms are shed into the water.

8- Zygote is formed and undergoes holoblastic cleavage.

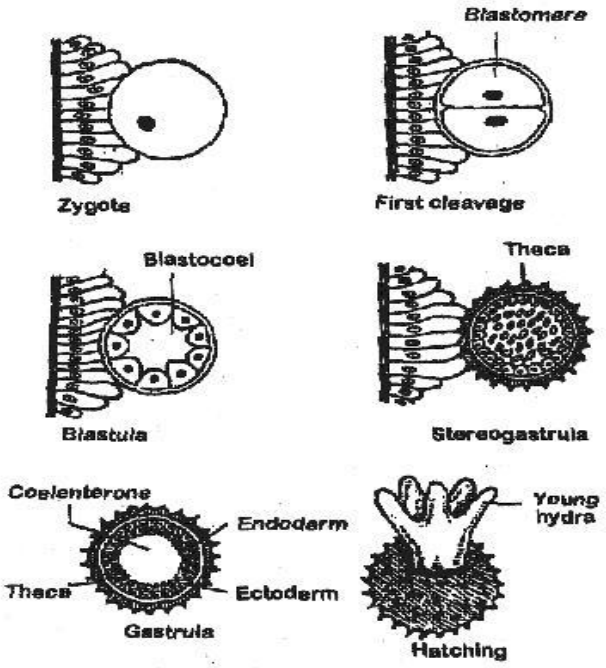
9- Delamination takes place.

10- A spiny cyst is formed around the embryo.

11- The spiny embryo breaks loose from the parent.

12- The cyst protects the embryo from adverse environmental conditions in winter.

13- A young *Hydra* hatches from the cyst in spring when conditions are favourable.



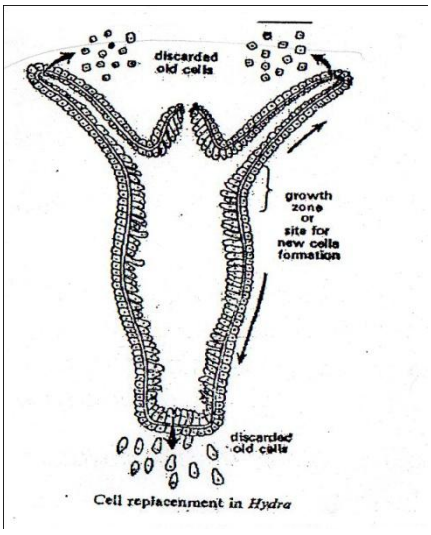
Cell Flow or Immortality

1- *Hydra* is potentially immortal.

2- Old *Hydra* replaces its old cells every 45 days.

3-New cells are formed from interstitial cells (spare cells, pluripotent, totipotent cells) of the growth zone just below the hypostome .

4- *Hydra* becomes active when it renews its cells.



Regeneration

1- *Hydra* has a great power of regeneration.

2- It has a great ability to form its lost parts.

3- Interstitial cells play an important role in regeneration and cell flow.

4- If the *Hydra* is cut transversely into several pieces usually each one will from a new *Hydra*.

5- When the *Hydra* is split longitudinally into two parts , two *Hydra* as are formed.

6- If the oral end (the hypostome) is split into two parts a *Hydra* with two oral cones will be formed , and if each new oral cone is split again, a *Hydra* with four hypostomes will be produced .

7- When the hypostome of male *Hydra* with testes is cut removed , then replaced by a hypostome of a young *Hydra* , all testes or spermaries will turn to buds with tentacles (but no mouth `) .