**INVERTEBRATE ZOOLOGY- PHYLUM CNIDARIA (COELENTRATA)**

The phylum takes its name from cells called cnidocytes, which contain organelles (cnidae) characteristic of the phylum. Cnidarians are widespread in marine habitats, and there are a few in freshwater environments. There are no terrestrial species. The cnidarian body has two layers of cells (diploblastic animal). The outer layer (epidermis) derives from ectoderm and the inner layer (gastrodermis) derives from endoderm. The gastrodermis lines the gut cavity and functions mainly in digestion. As in the sponges, there is a middle layer of mesogloea; which helps to support the body and acts as a type of elastic skeleton. But cnidarians differ from sponges in that cnidarians’ cells are arranged into tissues and have distinct digestive cavity. They are considered primitive because they are radially symmetrical and they are the most primitive of animals whose cells are organized into distinct tissues, but they lack organs. All cnidarian forms fit into one of two morphological types (dimorphism): a polyp, or hydroid form, which is adapted to a sedentary or sessile life, and a medusa, or jellyfish form, which is adapted flora floating or free-swimming existence and both forms show radial symmetry.

**Polyps:** Polyp forms are tube-like. A mouth surrounded by tentacles defines the oral end of the body. The mouth leads into a blind gut or gastrovascular cavity. The aboral end of the polyp is usually attached to a substratum by a pedal disc or other devices. Located on the tentacles are stinging cells called cnidocytes. Within each cnidocyte is a small barbed harpoon called a nematocyst. Nematocysts are used for defense and to spear prey. Some nematocysts contain deadly toxins, while others contain chemicals that sting but do not kill. When triggered the nematocyst explodes forcefully and sinks into the cnidarian’s prey. The captured prey is then pushed into the cnidarian’s gasrtovascular cavity by the tentacles.

Polyps may reproduce asexually by budding, fragmentation. In budding, a knob of tissue forms on the side of an existing polyp and develops a functional mouth and tentacles. If a bud detaches from the polyp that made it, a clone is formed. If a bud stays attached to the polyp that made it, a colony will form and food may be shared through a common gastrovascular cavity. A shared gastrovascular cavity permits polyp specialization. Many colonies include several morphologically distinct polyps; each specialized for a certain function, such as feeding, reproduction, or defense. Such colonies exhibit polymorphism.

Other methods of asexual reproduction in polyps are fission, where an individual divides in half as one side of the polyp pulls away from the other side, or pedal laceration, where tissue torn from pedal disc develops into tiny new polyps. Pedal laceration and fission are common in sea anemones.

**Medusae:** The medusa body resembles a saucer or umbrella. They often exhibit tetramerous symmetry where body parts are arranged in four. The mouth is located in the center of the undersurface of the saucer-like body and it may be pulled downward into frilly lobes that extend a long way beneath the umbrella. Tentacles extend outward from the rim of the umbrella. Medusae are solitary and most swim freely in the water. The gelatinous mesogloea layer in medusa is quite thick, which is why cnidarians with the medusa body form are commonly referred to as jellyfish. Medusae have sensory structures for orientation (statocysts) and light reception (ocelli).

**CLASSIFICATION OF PHYLUM CNIDARIA**

There are four classes of cnidarians:

**Hydrozoa:** The most primitive cnidarians are members of class Hydrozoa. Solitary or colonial, asexual polyps and sexual medusa. The polyps or hydranths are small, without mesenteries in the coelenteron, and the medusa may have a velum. Colonial forms are commonly polymorphic. Gametes ripen in ectoderm. They have both freshwater and marine forms; freshwater hydrozoans are less common. The abundant freshwater genus *Hydra* is unique among hydrozoans because it has no medusa stage and exists only as a solitary polyp. Examples are *Hydra, Obelia, Physalia, Tubularia*.

**Scyphozoa:** Solitary; polyp stage reduced or absent. Medusae with the gelatinous mesogloea much expanded; no true velum. The medusa form is dominant but develops from a transient poly-like sessile stage. Life history commonly involves alternation of a very small polyp, the scyphistoma, with a medusa, which develops from an ephyra released by the polyp. Gonads are endodermal. Marginal sensory structures (rhopalia) with statocysts and/or ocelli. They are very common in all oceans. Examples are *Aurelia, Cassiopeia, Rhizostoma*.

**Cubozoa:** Tropical, cuboidal medusae that swim strongly. The medusa phase dominates in animals in the cubozoan class. Cubozoan medusae are commonly called box jellies because they have a cube shape with a single tentacle or group of tentacles hanging from a blade-like pedalium at each corner of the umbrella; margin of umbrella entire without velum but with velarium. Stings of some species such as the sea wasp can inflict severe pain and even death among humans. The sea wasp lives in the ocean along the tropical northern coast of Australia. Examples are *Tripedalia, Carybdea, Chironex, Chiropsalmus*.

**Anthozoa:** The largest class of cnidarians is class Anthozoa. All polyps; no medusae;solitary or colonial. Oral end is a disc with central mouth and hollow tentacles arising at margin and /or on surface. Polyps are with vertical divisions (mesenteries) bearing nematocysts in the coelenterons-coelenteron is divided by radial mesenteries that extend inwards. An anthozon polyp reproduces sexually, although the polyps of some species also reproduce asexually. Asexual reproduction results in a colony if daughter polyps remain attached to one another. Gonads are endodermal; all marine. Examples are *Metridium, Anthopleura, Ceranthus, Antipathes,Plexaura, Renilla*.

**NUTRITION:** All cnidarians are carnivores. Most use their cnidae and associated toxin to capture food, although none is known actually to pursue prey. Sessile polyps depend for food on organisms that come into contact with their tentacles. Once a food item is captured, tentacles move it to the mouth, either by bending in that direction or by passing it to tentacles nearer the mouth. The mouth opens, the lips grasp the food, and muscular actions complete the swallowing. Digestion begins extracellularly in the gastrovascular cavity. Enzymes break food down into small fragments. Then cells lining the cavity engulf the fragments, and digestion is completed intracellularly. This allows cnidarians to feed on organisms larger than their own individual cells.

**RESPIRATION & EXCRETION:** Respiration and excretion in cnidarians are carried on by individual cells that obtain their oxygen directly from water either that in the coelenteron or that of the environment and return metabolic wastes to it. Thus, all physiological functions are carried out at no more than the tissue level of differentiation.

**LOCOMOTION:** Cnidarians can move parts of their bodies (mainly the tentacles) and change the body shape. Locomotion (movement from place to place) occurs in medusa and also in a few polyps. Movement by muscle contraction requires a skeleton, because muscles must have some restraint to pull against in order to have any effect, and after contracting they must be re-extended, but the skeleton need not be hard. They use the incompressibility of water to serve as a hydrostatic skeleton.

**NERVOUS SYSTEM & ORGANS OF SENSATION:** The nerve net of cnidarians is one of the least examples of a diffused nervous system. The plexus of nerve cells is found both at the base of the epidermis and at the base of the gastrodermis forming two interconnected nerve nets. Cnidarians nerve nets are peculiar in that many of the synapses have vesicles of neurotransmitters on both sides, allowing transmission across the synapse in either direction. Another peculiarity of cnidarian nerves is the absence of any sheathing material (myelin) on the axons. Cnidarians do not have a local concentration of nerve cells that would approximate a central nervous system.

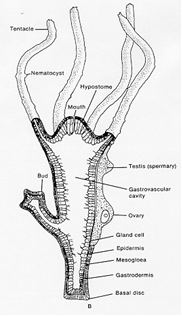
Medusae have a more highly developed nerve net than do polyps, a feature that is associated with the more active way of life of medusae. Swimming is coordinated by the nervous system. Nervous systems that are capable of conducting nerve impulses both quickly and slowly give these animals considerable behavioural responsiveness and flexibility. Statocysts, located between the tentacles or near the tentacular base, inform animal of its orientation with respect to gravitational forces. Light-sensitive ocelli occur in some medusae of each of the three classes that possess this stage. Such sensory structures are closely associated with a nerve net.

**REPRODUCTION:** Reproduction in cnidarians varies among the different species. They may reproduce by means of asexual reproduction, sexual reproduction, or both. Polyps generally perform asexual reproduction by budding, in which an outgrowth from the body wall separates to form a new polyp or medusa. Medusae primarily reproduce sexually- they produce gametes and a gamete (sperm) from a male medusa fuses with a gamete (egg) from a female medusa to form a zygote. The zygote develops into a larva, which in turn develops into a polyp or medusa.

***Hydra*:** This is a small freshwater commonest polyp, readily obtainable coelenterate. It is found in freshwater ponds, pools, lakes, streams and ditches. It usually remains attached to submerged vegetation or with any solid object. When it is undisturbed its body remains extended with tentacles spread out and shows expansion and contractions without any apparent reason. It is carnivorous in habit and feeds on small insects, insect larvae and small crustaceans. It is solitary in habit. It has cylindrical body and it is visible to the naked eyes and when fully extended, it becomes elongated and slender.

It is tubular and sessile but its proximal end is drawn out into a slender stalk at the end of which is basal disc or pedal disc for attachment to the substratum. The gland cells in the disc region secrete adhesive substance for attachment and gas bubble for floating. The free distal end or oral end of the body bears hypostome which bears an aperture at its apex called, mouth. The mouth opens into the gastrovascular cavity or enteron. The hypostome is encircled by a circlet of tentacles, which have nematocysts. Conical testes occur near the oral end while rounded ovaries are located near the aboral end.

The body wall consists of two cellular layers, an outer epidermis derived from ectoderm and inner gastrodermis derived from endoderm. It is diploblastic. In between the layers is a thin non-cellular layer of jelly-like substance called mesogloea. The epidermis is made up of small cubical cells and is covered with a delicate cuticle. It forms a thin layer, about one-third of the thickness of the body wall. This layer contains several types of cells-epithelio-muscular, interstitial, gland, cnidoblast, sensory, nerve and germ cells. The epidermis is protective, muscular and sensory in function. The gastrodermis is made up chiefly of large columnar epithelial cells with irregular flat bases. The free ends of the cells give a jagged and uneven contour to the coelentron in cross section. The gastrodermis forms about two-thirds of the body wall and is secretory, digestive, muscular and sensory. The cells of gastrodermis include nutritive, muscular, interstitial, sensory, nerve and gland cells. This layer is mainly nutritive in function.



**LOCOMOTION:** The body of a *Hydra* can extend in length or can contract to a tiny, gelatinous mass. Unlike colonial polyps *Hydras* can loop and move about freely by gliding on a basal disc, aided by mucous secretions. They may even climb, swim, turn end over end or detach themselves and, by forming a gas bubble on the basal disc, float to the surface. All movements in *Hydra* are caused by the contraction or the relaxation of the contractile muscle fibres. As the gastrodermal muscle fibres are less developed in most part of the body wall, the movements are largely due to the contractions of the epidermal muscle fibres.

**NUTRITION:** It is exclusively carnivorous and feeds principally on small aquatic animals captured by the tentacles aided by the nematocysts. The tentacles hold the captured food, contract and bend over the mouth to transfer it into the mouth and subsequently into the enteron. Digestion is both extracellular and intracellular. The undigested materials are ejected through the mouth.

**RESPIRATION & EXCRETION:** There are no special organs for respiration and excretion. Gaseous exchange occurs through the general body surface. Nitrogenous wastes are largely in form of ammonia, which also diffuses through the general body surface.

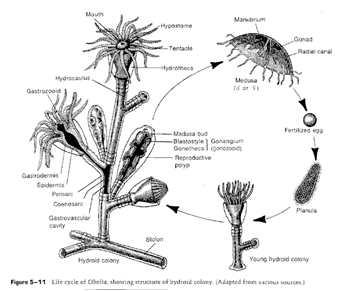
**OSMOREGULATION:** The water that continuously enters into the body cells by endosmosis is finally collected into the gastrovascular cavity and from here expelled out through the mouth due to a wave of muscle contraction passing from the basal disc region to the hypostomal region.

**NERVOUS SYSTEM:** It possesses a very primitive type of nervous system. There are two nerve nets, one in connection with the ectoderm which is more highly developed, and the other near the endoderm, the two nerve nets lie in and on either side of the mesogloea. But the ectodermal nerve net is more strongly developed and in particularly concentrated around the mouth and basal regions. The two nerve nets are joined to each other and to the sensory cells of both ectoderm and endoderm; they are also joined to the epithelia-muscular cell. There is no brain and ganglia.

**REPRODUCTION:** It reproduces asexually and sexually. Asexual reproduction is by budding and regeneration. Sexual reproduction is by the fusion of gametes. Fertilized ovum is called the zygote. Development begins soon after fertilization and the zygote undergoes cleavage or segmentation. Cleavage is holoblastic resulting in equal-sized cells called blastomeres. This later leads to blastulation, gastrulation and encystation. Encysted embryo remains dormant until favourable condition of water and temperature and then, hatches. The embryo elongates and a circlet of tentacle buds develops at one end with a mouth appearing in their midst. As embryo increases in size, the cyst ruptures and a young *Hydra* with tentacles hatches out. There is no free larval stage in the development of *Hydra*.

***Obelia*:** Unlike *Hydra* which is a solitary polyp, *Obelia* is a colonial hydroid and has a complex life-cycle due to the occurrence of a free-living medusa stage. It consists of a horizontal thread-like root called hydrorhiza which attaches to the substratum and from which a vertical branching stem known as hydrocaulus arises. The hydrorhiza and hydrocaulus are hollow tubes. The hydrocaulus bears zooids or polyps on either side in a cymose formation. Each polyp has a stem and a terminal head called a hydranth which is the nutritive zooid of the colony. Towards the base of the hydrocaulus in the axils of the polyps are reproductive polyps called blastostyles. The polyps, their tubular connections and blastostyles are made of ectoderm, mesogloea and endoderm, these layers are together are coenosarc and its cavity is an enteron which is continuous and common to all the members. Digested food is distributed in solution through the enteron. The entire colony is covered by a tough, yellow chitin secreted by the epidermis; this covering is known as perisarc. The perisarc forms the exoskeleton and it covers the hydrorhiza, hydrocaulus and their branches. Perisarc, surrounding the hydranth, dilates to form a loose, vase-shaped, protective investment, the hydrotheca and the one covering the blastostyle, forms a loose, transparent, vase-like capsule, the gonotheca, having a terminal collar-like constriction. The blastostyle and the gonotheca is called gonangium. *Obelia* is trimorphic, that is, it has thre kinds of zooids viz, nutritive zooids; budding zooids and sexual zooids. polyps or hydranths are nutritive zooids, gonangia or blastostyles are budding zooids and medusae are sexual zooids. The medusa is modified zooid as a hollow bud from the coenosarc of the blastostyle. It has a distinct tetramerous radial symmetry with most structures occurring in fours or multiples of four.

**The Medusa:** The arched saucer-like body is referred to as bell. It has a convex upper, ex-umbrella (aboral surface) and a concave lower, sub-umbrella (oral surface). The aboral surface is smooth and rounded. In *Obelia*, the velum, which is characteristic of most hydromedusae, is rudimentary and is not visible. Numerous tentacles extend from the margin of the bell. In life, the manubrium hangs like a pendulum into the center of the sub-umbrella space below the oral surface.



The mouth is in the center of the free, oral end of the manubrium and it leads into gastrovascular cavity of the medusa. The manubrium is well supplied with cnidocytes. The coelenteron or gastrovascular cavity consists of the stomach at the base of the manubrium, where extracellular digestion occurs, and a set of ciliated canals used to distribute partly digested food. The mouth opens into the spacious lumen of the manubrium which empties into the stomach. Four radial canals extend from the stomach to the periphery of the bell where they join the circular ring canal in the margin of the bell. The mesogloea of the ex-umbrella is thin. Consequently, the radial canals are easier to see in sub-umbrella view. Projecting from the middle of the radial canals are four gonads and since sexes are separate, they are either four ovaries or four testes. Twenty to thirty solid tentacles radiate from the edge of the bell. The tentacle epidermis has abundant sensory cells and cnidocytes. The cnidocytes are concentrated in rings, or batteries, and are used to sting and subdue the prey. A swollen tentacular bulb in the base of each tentacle is the site of intracellular digestion and cnidocyte formation. There are eight spherical statocysts spaced evenly around the margin of the bell. Each is at the base of a tentacle. The statocysts are hollow, thin-walled. Epidermal vesicles contain a calcareous statolith and a ciliated sensory epithelium. There are no ocelli in *Obelia*.

**LOCOMOTION:** It is sessile and thus does not move from place to place. But the annular constrictions of perisarc permit slight swaying movement under the influence of water currents and also the polyps can contract and expand their bodies. But medusa and the planula larva move freely around.

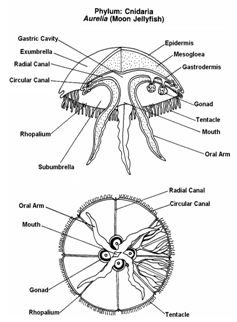
**NUTRITION:** The polyps are the feeding zooids of the colony with the aid of their tentacles armed with nematocysts. Digestion is both extracellular and intracellular.

**RESPIRATION & EXCRETION:** No special organs for these. Oxygen from the surrounding water diffuses directly into the cells and carbon dioxide and nitrogenous excretory products diffuse out.

**REPRODUCTION:** This is done asexually and sexually. Asexual reproduction is by budding. Sexual reproduction is by fertilization of the gametes produced by the medusae that are dioecious. The zygote undergoes complete cleavage to form the blastula with blastocoel, and then the gastrula. The gastrula elongates and become ciliated to form the planula and later hydrula which gives rise to *Obelia* colony.

***Aurelia* (Jelly-fish):** Occurs in coastal waters of tropical and temperate oceans of the world close to the surface of water. It is cosmopolitan in distribution. It lives either singly or in large groups found floating or swimming freely. In Jelly-fish, medusa is the dominant phase in the life history having a free-living planula larva, reduced fixed polypoid phase and a free-swimming disc-like ephyra larva.

The medusa of *Aurelia* is flattened, saucer-shaped gelatinous structure called bell or umbrella. It exhibits tetramerous radial symmetry. The body is shallowly convex above and concave below and is fringed by a row of closely spaced delicate marginal tentacles. These are interrupted by eight equally spaced indentations (notches), each with a sense organ (tentaculocyst or rhopalium) between two lappets. Each rhopalium is a club-shaped and contains a hollow statocyst for equilibrium and one or two pits lined with sensory epithelium. There is no velum like those hydrozoan medusa because it lacks muscles and nerve ring. It has only velarium or pseudovelum. Central in the concave oral surface is the mouth, on a short manubrium, between four tapering oral arms that are used in capturing and ingesting prey and which are grooved and bear nematocysts along their edges. A short gullet through the manubrium connects to the enteron. Many radial canals extend through the mesogloea from the four gastric pouches to a ring canal in the bell margin. Each sense organ comprises a pigmented eyespot, a hollow statocyst and two sense pits. The exterior surface is covered by epidermis; and the lining of the digestive system and canals from mouth inward, the gastric tentacles, and the gonads are gastrodermis.



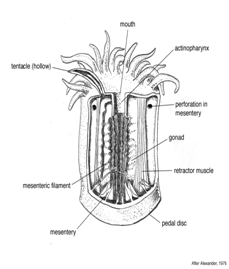
The mouth leads into a stomach. Internally, extending out down from the stomach are four gastric pouches in which gastrodermis extend down in tentacle-like projections called gastric filaments. These filaments are covered with nematocysts to quiet any prey that may still be struggling. Gastric filaments are lacking in hydromedusae. It feeds on small planktonic animals. The bell has relatively short tentacles, not used in capturing prey. Food items are caught in mucus on the umbrella surface, and are carried to ‘food pockets’ on the umbrella margin by cilia. From there, ciliated oral lobes move food to the gastrovascular cavity. Cilia in the gastrodermis layer keep a current of water moving to bring food and O2 into the stomach and to expel wastes.

**REPRODUCTION:** Asexually reproduction is by budding while sexual reproduction is by gonads produced by the medusa. The male gametes from male medusa are discharged internally and leave the body through the mouth with outgoing water current. These are then drawn into the body of female medusa through the mouth with water current. Fertilization occurs when the male and the female gonads fuse together in the gastric pouch of the female medusa to form the zygote. Hence, fertilization is internal. The zygotes are passed out of the mouth of the female medusa along with outgoing water current and get attached in the grooves of the oral arms; each zygote gets enclosed in a pouch where it undergoes development. The zygote gives rise to the blastula, gastrula and become planula larva that is free-swimming. The planula after a brief existence loses its cilia and metamorphosed to form small polyp or hydratuba which has no perisarc. The hydratuba may bud other hydratubae and later undergoes a process of transverse fission called strobilation to become scyphistoma or stobila. Each disc in the scyphistoma is an ephyra larva. This later becomes the medusa which starts off another set of male and female gonads.

**SEA ANEMONES (*Meridium*):** It is called sea anemones because of their flower-like appearance. They occur in all seas being especially abundant in warmer climates in shallow and coastal water in solitary or in colonial polyps. It has a short cylindrical body. On the upper and flat oral disc are many short hollow tentacles around a slit-like mouth. The pedal disc is expanded and is used for fixing the animal to solid objects in the sea; it adheres by mucous secretion and by muscles of the basal disc. But the animal is not sedentary because it can creep by gliding motion of the basal disc. The column is cylindrical and differentiated into upper short, thin-walled capitulum and a lower main thick-walled scapus. The gullet or stomodeum, is a flat tube connecting the mouth and internal cavity (enteron). Along one or both sides of the gullet is a smooth ciliated furrow, the siphonoglyph, in which water passes to the enteron. Internally, the body is divided into radial compartments by six pairs complete septa or mesenteries that extend vertically from the body wall to the gullet; between these are other incomplete septa, attached to the body wall but not reaching the gullet. In the septa, beneath the oral disc are openings or ostia, through which water can pass between the internal compartments. The pores also aid in rapid discharge of water from the body when the animal is endangered and contrasts to a small size. Muscles are well developed in sea anemones, but the arrangement is quite different from that in hyrdozoa. Longitudinal fibres of the epidermis occur only in the tentacles and oral disc of most species. The strong longitudinal muscles of the column are gastrodermal and located in the septa. Gastrodermal circular muscles in the column are well developed.

Most anemones can glide slowly along a substrate on their pedal discs. They can expand and stretch their tentacles in search of small vertebrates and invertebrates. When disturbed, they contract and withdraw their tentacles and oral disc. Some anemones swim to a limited extent by rhythmical bending movements, which may permit escape from enemies.

Sea anemones are carnivorous, feeding on fish or almost any live animals of suitable size. Some species live on minute forms caught by ciliary currents. Respiration and excretion are done by the process of diffusion as the epidermis and gastrodermis remain in constant contact with water.



**REPRODUCTION:** Reproduction is asexually or sexually. Asexual reproduction commonly occurs by pedal laceration or longitudinal fission, occasionally by transverse fission or budding. In sexual reproduction, the sexes are separate. Eggs and sperms leave the gonads through the mouth, and fertilization occurs in the water. The zygote develops into a slender ciliated gastrula; septa soon appear in the archenteron, the blastopore becomes a mouth, and long stiff cilia grow on the aboral end as planula larva. This larva creeps on the bottom, and then attaches by the aboral end. With growth of the tentacles, septa, and mesogloea, it becomes a miniature anemone.

**Diagnostic features**

1) Tissue grade of organization with 2 tissue types:

a) gastrodermis

b) epidermis

They have a layer of mesoglea (a protein) between the tissues.

Their symmetry is radial.

Their nerve cells, are organized in a loose “nerve net”.

They have a cnidocyte (nettle cell) which contains the nematocyst

Their most obvious unique feature is their highly specialized stinging cells (nematocysts).

**Adaptive Features**

Hydrostatic Skeleton: This type of skeleton allows Cnidarians to move quickly and easily through the water.

Nematocytes:Cnidarians use their nematocytes to stun, kill, or paralyze their prey and to protect them

Tentacle : They may use their tentacles to drag their prey into the "mouth" alive.

**IMPORTANCE OF CNIDARIANS**

* Cnidarians skeleton is used in jewelry.
* All cnidarians have the potential to affect human physiology owing to the toxicity of their nematocyst.
* Coral skeletons are used as building material, either in blocks or slaked cement.
* Extracts of many cnidarians, mostly anthozoans, have heart-stimulant, anti-tumor and anti-inflammatory properties.