UG CBCS Semester-1

Phylum: Coelenterata (Cnidaria)

The phylum Cnidaria is a highly diverse assemblage that includes jellyfish, sea anemones, corals, and the comn,on laboratory *Hydra,* as well as many less familiar forms such as hydroids, sea fans, siphonophores, zoanthids, and myxozoans. There are about **13,400** living described species of cnidarians.

Much of the striking diversity seen in this phylum results from three fundamental aspects of their natural history. First is the possession of cnidae-unique, tubular structures contained within cellular capsules that aid in prey capture, defense, locomotion, and attachment. No other animal group produces cnidae, and all cnidarians produce them. Second is the tendency to form colonies or assemblages of individuals by asexual reproduction; the colony can achieve din,ensions and forms unattainable by single, nonmodular individuals. Third, many species of cnidarians exhibit a dimorphic life cycle that can include two entirely different morphologies: a polypoid form and an adult medusoid form. The dimorphic life cycle has major evolutionary implications touching on nearly every aspect of cnidarian biology. The unique polyp form of Cnidaria, their planula larvae, and stinging or adhesive cnidae are three of the key synapomorphies that define the phylum.

Cnidarians are invariably aquatic organisms, mostly dwelling in seas, but some species also inhabit in brackish and fresh waters. Metazoa, either sedimentary of free-swimming, with primary radial structure. Cnidarians are widely thought to be diploblastic metazoans at the tissue grade of construction. They possess radial or biradial symmetry, tentacles, cnidae, an endodermally derived incomplete gastrovascular cavity as their only "body cavity," and a middle layer (called mesenchyme, or mesoglea) derived primarily from ectoderm. They lack cephalization, a centralized nervous system, and discrete respiratory, circulatory, and excretory organs. This basic body plan is retained in both the polypoid and rnedusoid forms. The primitive nature of the cnidarian body plan is exemplified by the fact that they have fewer cell types than any other animals except the sponges and mesozoans.

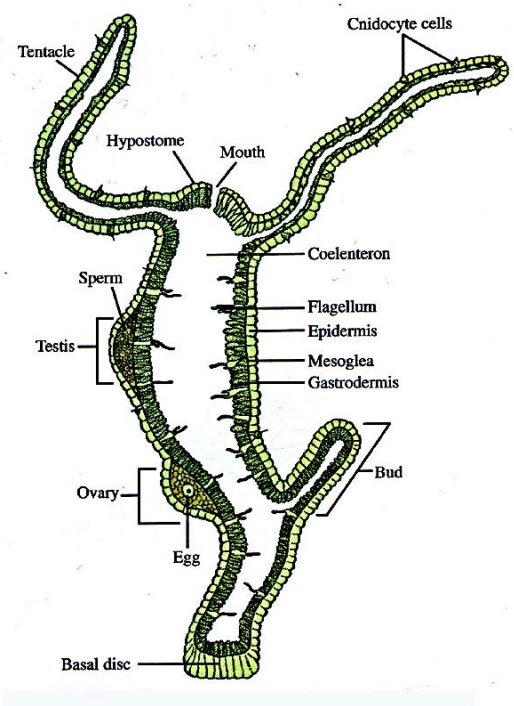

Figure: Hydra, body construction

Classification

Class I: Hydrozoa

Cnidaria with both polyp and medusoid forms in their living cycle.

General Structure. The body of a hydra consists of a simple two-layered tube, the trunk, normally attached at one end, the base, and surmounted at the other by a circle of tentacles, varying in number. The tentacles enclose a conical region, the hypostome, which bears at its apex the mouth. The body wall surrounds a digestive cavity or coelenteron, which extends into the tentacles. The cell layers, an outer epidermis and an inner gastrodermis, are separated from each other by a non-cellular supporting lamella. This structure corresponds functionally to an elastic skeleton. It serves as a place of attachment for the cells and gives support and elasticity to the entire organism. In hydrozoan medusae, or jellyfish, this layer is represented by a thick, watery jelly without cells, termed the mesogloea ("middlejelly").

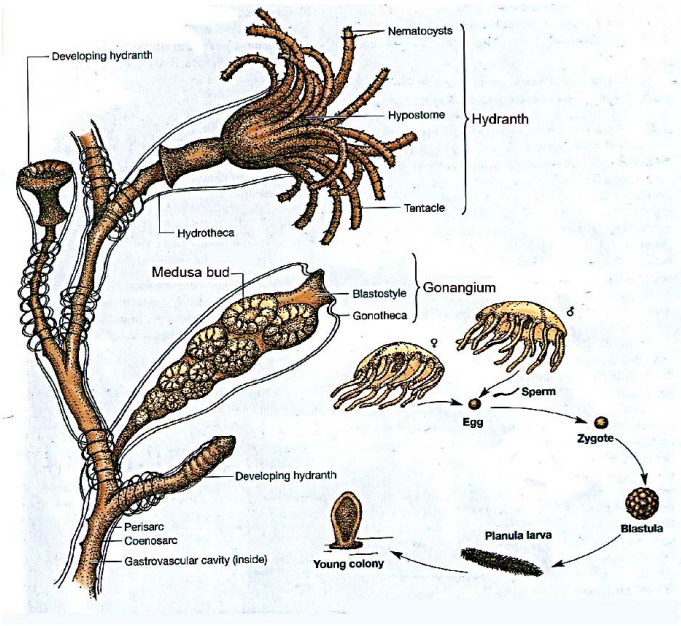

Figure: *Obelia* (Hydrozoa), life circle

Metabolism. The small animals serving as food for the hydra, after being paralyzed and held fast by the nematocysts, are brought to the mouth by the tentacles and are ingested by engulfing movements of the hypostome. The mouth is capable of a surprising degree of distension to accommodate large objects of food. Soon after its ingestion the food is shifted by peristaltic contractions of the body to a position in the distal half of the coelenteron, where the early stages of digestion occur. Although no structural differentiation exists other than the abundance of gland cells in the distal region, there is apparently a physiological division of the coelenteron into gastric and intestinal regions; the food mass is never found in the more proximal or basal part of the cavity.

The process of digestion in the hydra is twofold. Enzymes released from the gland cells bring about the disintegration of the softer parts of the food mass, liquefying it and hastening its breakdown into particles. The soluble products of this extracellular phase of digestion are absorbed directly by the gastrodermal cells. Finely divided particulate matter is ingested by pseudopodia formed by the large gastrodermal cells and comes to lie in food vacuoles within their cytoplasm. Here the intracellular phase of digestion occurs, which is presumably entirely comparable with the process as it occurs in an amoeba. The indigestible residues are cast off by the gastrodermal cells and, together with the resistant parts of the food mass in the coelenteron, are expelled through the mouth by a series of violent contractions of the body.

Reproduction and Development. At certain seasons of the year, particularly in autumn, hydras reproduce by syngamy, the union of gametes. The testes are usually located on the distal half of the trunk, the ovaries near the middle. Testes may appear first and ovaries later on the same animal, or both may be present together. Animals in which the same individual possesses both ovaries and testes are said to be hermaphroditic or monoecious. Monoeciousness may be the usual condition in hydras, although species in which the individuals seem to be exclusively male or female, hence dioecious, have been reported. There are no secondary sexual characteristics in hydras; only by observing the testes or ovaries can the sex of an individual be determined. These gonads appear as swollen protuberances from the epidermis in the characteristic regions. Within them, ova or spermatozoa a rise from interstitial cells. Fully matured spermatozoa may be seen moving actively within the testis; they are discharged by the periodic opening of the apex of the testis, which thus liberates successive swarms. The spermatozoon then swims about until it dies, or until it comes into contact with an ovum which has been exposed by the rupture of its epidermal covering.

The zygote formed by the union of these two gametes undergoes cleavage and secretes about itself a shell-like cyst, or theca. Within the theca, development proceeds until an outer layer of cells, the ectoderm, and an inner solid mass, the endoderm, have been formed. The embryo within its theca then becomes detached from the parent and drops to the bottom. Tentacles eventually develop; the embryo breaks from its cyst, becomes attached, develops a coelenteron, forms a mouth, and so becomes a miniature hydra. Zygotes developing in late autumn pass the winter with in the protective cyst.

Hydras frequently produce new individuals by budding, a process referred to as asexual reproduction. It is, essentially, reproduction by cell division. It differs, however, from the asexual reproduction of protozoans in that the mass of new cells produced is organized by some integrating influence into a multicellular individual with the characteristics of the parent. There is first an accumul at ion of nutrient material in the gastrodermal cells at some place toward the middle of the body, and cells in the epidermis of this region divide repeatedly to form a bud-like swelling. An extension of the coelenteron grows into the bud, which then appears as a blindly ending outgrowth of the two layers of the body wall. Tentacles appear as evaginations of epidermis and gastrodermis, and finally a mouth is formed. If food is abundant, the bud may remain attached to the parent for some time, and in exceptional cases it may rebud to form several generations in a branching system. Usually, however, the connection between parent and offspring becomes constricted, and the bud is detached as an independent individual as soon as the tentacles and mouth become functional.

Class II: Scyphomedusae

Cnidaria with medusoid stage as the main stage in the life cycle. Most of the jellyfishes called hydromedusae are small, like Gonionemus, or smaller. The amount of solid or living material in such individuals would be small, however, because jellyfishes are composed chiefly of water. The bulk of their substance consists of the "jelly," which in these forms is a gelatinous mass conspicuously provided with cells resembling connective-tissue elements of higher animals.The jelly itself may thus be considered as intercellular material, comparable with the fibro us substance of connective tissue or the ground substance of cartilage. In scyphomedusans specialized organs of equilibration, termed statocysts, are located at intervals around the margin of the bell; these sense organs are important in the free-swimming locomotion of jelly fishes, and similar though simpler statocysts occur also in hydromedusae.

The genera *Cyanea* and *Aurellia* are representative *Scyphomedusae* found in North Atlantic waters. In typical cases the life cycle of a scyphomedusa consists of the following sequence: a planula larva develops from a zygote; this larva produces an attached polyp generation, the scyphistoma, from which freeswimming medusae arise in succession by transverse budding or strobilization. The young medusae released from the strobila are saucerlike individuals called ephyrae; they grow and transform into adult, sexually reproducing jellyfishes. Asexual reproduction of the polypoid generation, by budding to produce additional polyps, has also been reported.

Class III: Anthozoa

Cnidaria with only polyp stage represented in their life cycle. The Anthozoa are represented by the sea anemone, *Metridium dianthu*. As in anthozoans generally, the sea anemone is provided with a somewhat flattenedoral disk surrounded by tentacles. The epidermis turns in at the mouth and hangs downward into the coelenteron to form a tubular pharynx or stomodaeum. This pharynx is attached to the lateral body wall by a series of radiating partitions or septa, which thus divide the upper part of the coelenteron into radial compartments, continuous with the undivided cavity below. The biradial symmetry characteristic of many Anthozoa is produced by the presence of one or more heavily ciliated grooves or gutters, called siphonoglyphs, traversing the pharynx longitudinally from its outer to its inner edge. These grooves presumably function to provide active currents of fresh, aerated water to the inner parts of the animal, and to flush away wastes. Other representative anthozoans are the true corals, such as *Astrangia danae*, a northern coral, and the many species aboundin in tropical seas. The coral individual resembles a small sea anemone lying in a limy, cup-like skeleton secreted by its epidermal cells. The stony mass of a coral head or reef, covered completely by the living substance of its polyps, is contributed to by the secretory activites of large numbers of these individuals, producing skeletal material beneath them and forming new polyps by budding or subdivision as the size of the mass increases. The living individuals are found only at the surface, the underlying stony material is uninhabited, except as it may be invaded by a variety of worms, crustaceans, bivalves, and other animals of the reef. The part played by corals in the formation of coral islands and of the limestone in various deposits has given these coelenterates an important role in geologic history.