UG CBCS Semester-I

Metridium: A Sea Anemone

The largest class of phylum Coelenterate is Anthozoa or Actinozoa. They include exclusively marine and polypoid coelenterates, solitary as well as colonial, in which the medusoid stage is totally absent. An anthozoan polyp differs considerably from hydrozoan polyps (e.g. *Hydra*, *Obelia*) in several structural peculiarities. Colonial Anthozoa are mostly corals of different kinds. Solitary Anthozoa are sea anemones, belonging to the order Actiniaria. They are quite in abundance and best-known animals inhabiting warm coastal waters throughout the world. Common genera are *Adamsia*, *Edwardsia*, *Metridium*, etc.

Habits and Habitat

Metridium is a solitary marine sea anemone inhabiting warm coastal waters along the North Atlantic and Pacific coasts. It lives in shallow water or littoral zone, mostly attached to rocky bottom and other hard substrata, like wooden wharves and piers. It can creep slowly over the substratum. It is carnivorous feeding on minute organisms, crustaceans, worms, etc. It is very sensitive and highly contractile.

External Morphology

1. Shape, size and colour. *Metridium* is a cylindrical and radially symmetrical animal which measures 5 to 7 cm in length. Its colour is variable, but usually brownish or yellowish. Body is clearly divisible into three regions: oral disc, pedal disc and column.

2. Oral disc. Oral end of body or oral disc is slightly convex and bears a slit-like central mouth. Encircling the mouth are a large number of hollow tentacles forming a sort of crown.

3. Pedal disc. Aboral end of body is broad, fiat and called the basal or pedal disc or foot. With pedal disc the animal gets attached to the substratum.

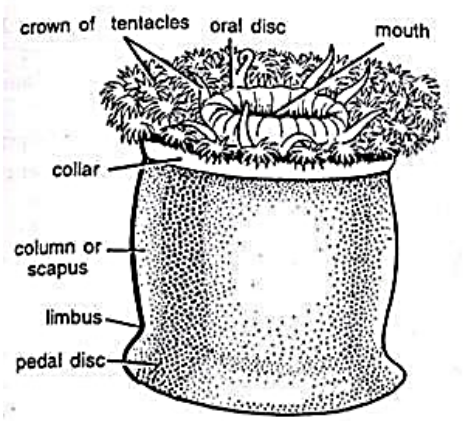

Fig. 1. *Metridium*. External structure.

4. Column. Middle part of body, which extends between oral disc and pedal disc, is referred to as the scapus or column. It can be greatly expanded or contracted. Column is demarcated from pedal disc by a groove called limbus. Column bears a prominent circular fold, the collar or parapet, at its junction with oral. Skin is soft but tough and is without skeletal structures.

Internal Morphology

Internal structure of *Metridium* is known from its longitudinal and transverse sections.

(I) Gastrovascular system

1. Pharynx or stomodaeum. Mouth leads into a tubular gullet or pharynx or stomodaeum. On either side of the pharynx is a ciliated groove called siphonoglyph (Gr., *siphon*, a tube + *glyphe*, carving). Individuals with 2 siphonoglyphs are called diglyphic. In some species there is only one siphonoglyph (monoglyphic). Sea anemone with one siphonoglyph is considered bilateral, and with 2 siphonoglyphs, biradial. Besides siphonoglyphs, cilia are present on other parts of pharynx also. Cilia of grooves beat to create water currents, which flows through mouth into body cavity and ensure a constant supply of oxygen for respiration. Cilia on other parts of pharynx carry food in and waste products out.

2. Gastrovascular cavity or coelenteron. Pharynx extends downwards about 2\3 of the way into the inner body cavity called gastrovascular cavity. It is partitioned into radial chambers by vertical partitions of body wall, called septa or mesenteries.

3. Mesenteries. Mesentries of *Metridium* must not be confused with the mesenteries of coelomate animals (e.g. frog, rabbit). There are two to types of mesenteries, complete and incomplete. Complete or primary mesenteries are 6 pairs and extend vertically from body wall to the wall of pharynx. Two pairs of complete mesenteries on the sides of siphonoglyphs are called directives. In the region of pharynx, complete mesenteries bear openings or ostia for circulation of water from one chamber to another. Below pharynx, their edges are free which recurve towards the body wall. Six pairs of complete mesenteries constitute the primary mesenteries. Spaces between these pairs are called exocoels. Lying in exocoels are pairs of secondary and tertiary mesenteries, which are incomplete. They are connected only to the body wall and do not reach the pharynx. Space between two mesenteries of each pair is called the endocoel.

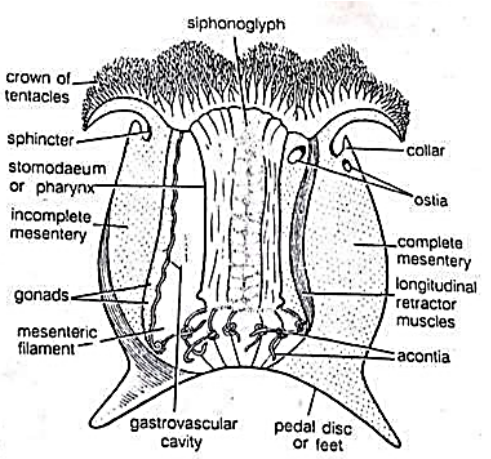

Fig. 2. *Metridium.* Vertical section to show internal structures.

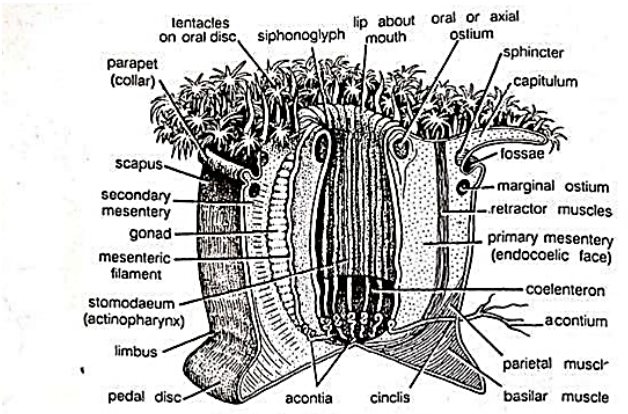

Fig. 3. *Metridium.* Diagrammatic V.S.

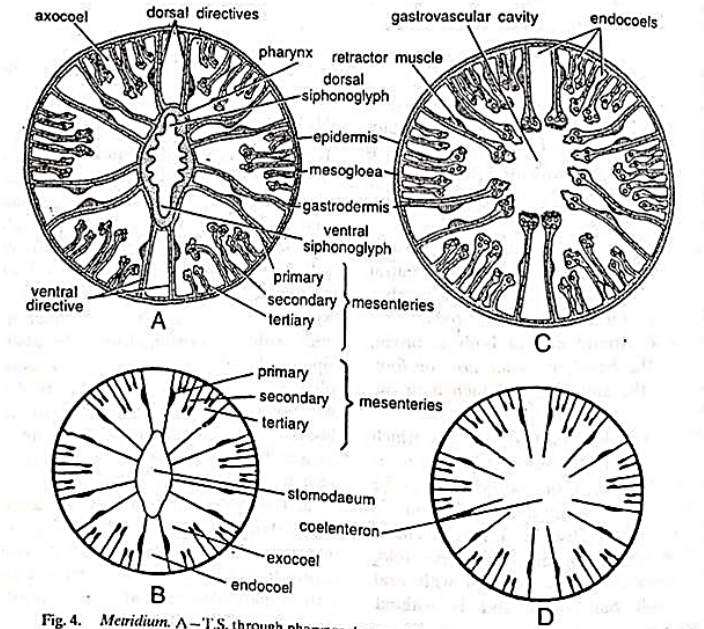

Fig. 4. *Metridium.* A – T.S. through pharyngeal region. B – Diagrammatic T. S. through pharyngeal region showing arrangement of mesenteries. C – T.S. below pharynx. D – Diagrammatic T.S. below pharynx showing arrangement of mesenteries.

Below pharynx, free edges of mesenteries are called mesenteric filaments which are trilobed in appearance. Attached to the bases of mesenteries are thread-like acontia (Gr., *akontion*, dart) which bear nematocysts and gland cells. Acontia can be protruded through mouth or through pores (cinclides) in body wall, to overcome the prey. Otherwise, in ordinary life, acontia serve to kill any food remaining alive into the gastrovascular cavity.

(II) Histological structure

Histology of *Metridium* is more or less typical and similar to that of other coelenterates.

1. Body wall. Body wall consists of the usual two layers, outer epidermis and inner gastrodemus, with a gelatinous mesogloea in between.

(a) Epidermis. It covers the outer body surface and consists of tall columnar supporting cells along with sensory, glandular and stinging cells. Subepithelial muscle cells and nerve cells are also present.

(b) Gastrodermis. It lines whole of the gastrovascular cavity and includes epithelio-muscle, sensory, nerve, glandular and stinging cells.

(c) Mesogloea. It is much thicker than that of *Hydra* and *Obelia* and contains a large number of fibres and wandering amoebocytes.

2. Pharynx or stomodaeum. It is derived from invaginated ectoderm, so that it is lined by epidermis on its inner side and covered by gastrodermis on outer side. Epidermis is ciliated and rich in mucous gland cells.

3. Mesenteries. Each mesentery is composed of two layers of gastrodermis, enclosing a central layer of mesogloea. Gastrodermal layers are continuous with the gastrodermis of body wall. Upper portion of a mesenteric filament appears tnlobed in cross section, consisting of a central ridge or cnidoglandular band or tract, bearing nematocysts and gland cells secreting digestive enzymes, and two lateral ridges (ciliated bands or tracts) bearing tall ciliated cells. This upper trilobed part of mesenteric filament serves for digestion and water circulation.

Lower part of each mesenteric filament is without ciliated bands and represented only by the cnidoglandular band having nematocysts and gland cells. It is exclusively digestive. Some of its cells are phagocytes, which engulf food particles to carry on intracellular digestion. Cnidoglandular band, forming the lower part of mesenteric filament, is produced into a thread-like acontium at the base of mesentery.

4. Nematocysts. Stinging cells or nematocysts of sea anemone are long, faintly curved and do not bear cnidocils. Two types of nematocysts occur, spirocysts and nematocysts proper.

(a) Spirocysts. These are limited to tentacles and oral disc. Each has a thin single-walled capsule and a long, smooth, spirally coiled thread tube of even diameter, devoid of spines. It stains with acid dyes and is permeable to water.

(b) Nematocysts proper. These occur everywhere and each has a thick double-walled capsule, stains with basic dyes, is impermeable to water except at discharge and contains a tube of variable nature but usually armed by spiral rows of spines. Nematocysts proper are of 3 types: (i) basitrichous isorhizas with thread tube spiny at the base only, without butt and opening at the tip, (ii) microbasic mastigophores with a rounded capsule, long butt with spiral spines and a long thread tube closed at the tip, and (ii) microbasic amastigophores with an oval capsule, short butt with spiral spines and without a thread. There is no skeleton in anemones.

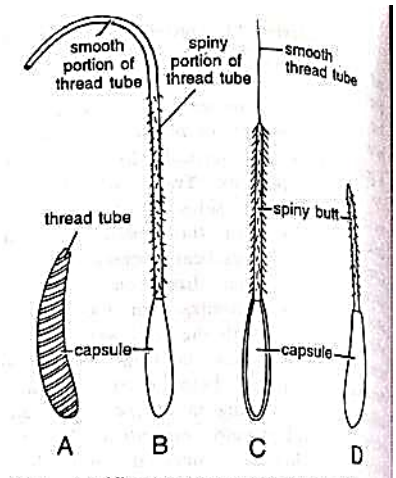

Fig. 7. *Metridium.* Types of nematocysts. A—Spirocyst. B—Basitrichous isorhiza. C—Microbasic mastigosphore. D—Microbasic amastigophore.

(III) Musculature

Sea anemones perform various characteristic movements, so that their muscular system is better developed than in *Obelia* and *Aurelia*, particularly the gastrodermal musculature. Myoepithelial cells are organized into well developed muscles. In *Metridium*, epidermal musculature is limited to longitudinal fibres in tentacles and radial fibres in oral disc, but absent in column and pharynx. Gastrodermal musculature consists of circular muscles in tentacles, oral and pedal discs, gullet and column wall. At the junction of the column and oral disc, circular fibres form a distinct sphincter. It covers the oral disc and tentacles when retracted.

In a mesentery runs a thick longitudinal or retractor muscle, which appears as a prominent projection or bulging in a transverse section.

(IV) Nervous system

Specific sense organs do not occur in anemones. Nervous system is very simple, basically similar to that of other coelenterates, and is synaptic. It is represented by a typical diffuse nerve net with an indication of a centralized nervous control. It consists of an epidermal plexus, between epithlia and muscular layers, and a gastrodermal plexus, atleast in septa; the two are connected through mesogloca. Each plexus consists of delicate nerve fibres and large ganglion cells occurring chiefly in tentacles, oral disc and pharynx. Reflex behaviour is poor due to lack of a centralized nervous system.

(V) Gonads

Metridium, like majority of sea anemones, is dioecious, i.e., sexes are separate. Gonads (testes and ovaries) are simple and occur as thickened bands, generally on the incomplete mesenteries, lying parallel to and behind the mesenteric filaments.

Physiology

I. Movements and locomotion. Sea-anemones are sluggish creatures. Well developed musculature enables *Metridium* to perform many characteristic movements. It can extend and contract its column and tentacles and partly evert its gullet and mesenteries. It frequently retracts its oral disc, along with tentacles in gullet and closes the margin over it by means of the sphincter. In the process, gullet is transversely folded, water is discharged through mouth and acontia are protruded through cinclides.

Sea anemone is capable of slight locomotion. It can slide about slowly and change its position by slow-creeping movements performed by muscular undulations of its pedal disc. This movement, however, is too slow i.e. about 8 cm per hour.

2. Nutrition. Nutrition has been extensively studied in *Metridium* because of its large size and availability in abundance.

(a) Food. It is quite voracious and feeds upon molluscs, crustaceans, sea-urchins, fish, etc.

(b) Ingestion. The prey is captured and partly paralyzed, before ingestion, by the nematocysts of tentacles, oral disc and acontia, then carried through the greedy mouth, down the gullet into gastrovascular cavity or coelenteron. Some prey is gripped directly by mouth and gullet, both of which can gape widely. Cilia of gullet, other than those on siphonoglyphs, reverse their beat, so that the captured food is swept down the gullet, into coelenteron, which is hardly more than digestive sac. It has been known that reversal of ciliary beat is due to direct stimulation by chemical agents (food). Food is held by mesenteries and broken into smaller particles.

(c) Digestion. Digestion is both extracellular and intracellular. Food is digested by hydrolysing enzymes secreted by acontia and gland cells of mesenteric filaments, and absorbed by gastrodermis. Undigested wastes are ejected through mouth.

3. Respiration and excretion. Oxygen dissolved in water directly diffuses in and carbon dioxide and nitrogenous wastes diffuse out. This is facilitated as all parts of epidermis and gastrodermis come in contact with water. Beating of cilia of gullet and siphonoglyphs set up a constant current of water entering through siphonoglyphs and leaving through the sides of gullet. Gastrodermal cilia also helps in circulation inside the gastrovascular cavity.

4. Reproduction. Reproduction in Metridium is both asexual and sexual.

(a) Asexual reproduction. Pedal laceration or fragmentation is the predominant method. In this process, as the animal moves about, pieces of pedal disc are torn off and left behind, each regenerating into a small anemone at the old site. This accounts for the common occurrence of

a large mother *Metridium*, surrounded by a whole brood of little anemones produced by this asexual method. Anemones regenerated from such pedal fragments naturally present many irregularities in the number and arrangement of mesenteries and siphonoglyphs.

A few instances of budding from column or pedal disc have been reported but these may be misinterpretations. Longitudinal fission has also been reported. Transverse fission is known only in the young individuals of primitive sea anemone, *Gonactinia prolifera*.

(b) Sexual reproduction. *Metridium* is dioecious having separate male and female individuals. Sex cells originate from the interstitial cells of gastrodermis and mature in mcsogloea of mesenteries. Gonads (testes or ovaries) form longitudinal bands just behind mesenteric filaments. Mature eggs and sperms, released from gonads, leave through mouth and external fertilization occurs in se;-water. Fertilized egg or zygote develops into a slender, bilaterally symmetrical, free-swimming and ciliated planula larva. Its blastopore becomes the mouth and it feeds upon minute organisms. It creeps on the bottom and finally settles down in some rocky crevice attaching with its aboral end. With the growth of tentacles, septa and mesogloca, it metamorphoses into a miniature anemone. Pharynx is formed as a stomodeal invagination and mesenteries develop from the column wall. A medusa stage is totally absent. Thus, life cycle of *Metridium* is simple and does not show an alternation of generations.

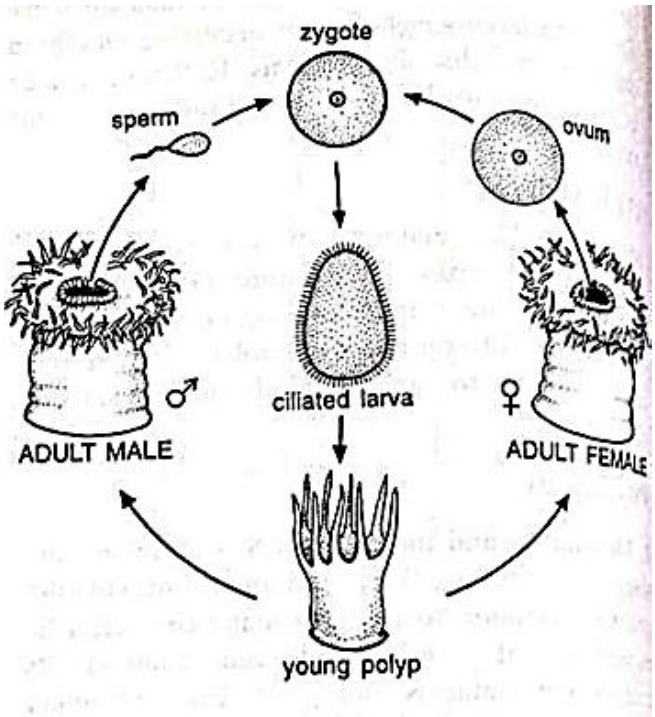

Fig. 10. *Metridium.* Stages in sexual reproduction and life cycle

References:

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