Classification of Phylum Porifera:

Phylum Porifera, constitute of sponges that are the most primitive of the multicellular animals, lacking organs, but having well developed connective tissue. In comparison to other metazoans, the cells of sponge show a much higher degree of independence such that it resembles somewhat a protozoan colony.

The lack of any conspicuous movement of body parts of the sponges convinced Aristotle, Pliny and other ancient naturalists that sponges were plants. It was much later, in 1765, when internal water currents were first observed, that the animal nature of the sponges was established.

Sponges are found all over the world and at all depths of the ocean. However, most sponges prefer relatively shallow water, but some groups (glass sponges) prefer deeper waters. Poriferans present a great variety of external forms.

They may be saucer-shaped, cup-shaped, tubular, rod-shaped, foliaceous, trumpet-shaped, fan-shaped, mushroom-shaped, lobed, branched, irregular etc. The forms are even variable in the same species and is therefore of little use in identification. Adult sponges are usually sessile; the motile phase is the larva produced through sexual reproduction.

Etymology:

Latin: porus, pore; ferre, to bear

Diagnostic Features of Phylum Porifera:

i. Sedentary, aquatic, sessile adults, occurring singly or in colonies.

ii. Generally no characteristic symmetry is seen.

iii. Multicellular but with few cell types; tissue organisation very much restricted and lacking organs and co-ordination between cells.

iv. Body perforated by a number of pores.

v. They possess a canal system through which water current flows transporting food and oxygen.

vi. Characteristic flagellated cells called choanocytes, lines the inner side of the body wall and are related with water circulation and feeding.

vii. Absence of a true body cavity or gut.

viii. Presence of an elaborate skeletal system of either calcareous or siliceous spicules or protein (collagen, sometimes called spongin) fibres or a combination of these. Sometimes, foreign particles may also be present.

ix. Exclusively filter feeder;

x. Gas exchange by diffusion.

xi. Absence of nervous tissues.

xii. Both hermaphrodite and gonochoristic forms exist. Reproduction occurs both asexually by buds and gemmules, and sexually. The ova and sperms develop from the archaeocytes.

xiii. Development indirect through a free swimming, ciliated, planktonic larvae.

Scheme of Classification of Phylum Porifera:

Sponges were studied extensively by Grant in 1836 and gave the name Porifera. The classification of sponges is based almost entirely on microscopic skeletal structures. Such divisions are not unanimous particularly in the case of horny and siliceous sponges.

The phylum Porifera consists of 10,000 species of which 50 are fresh water ones. The classification followed in this text is based on the classificatory plan outlined by Ruppert and Barnes, 1994.

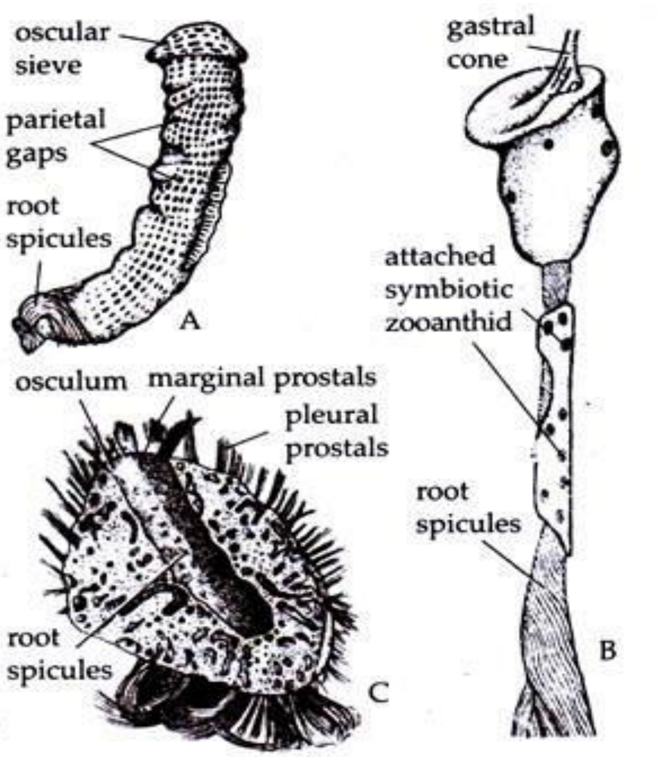
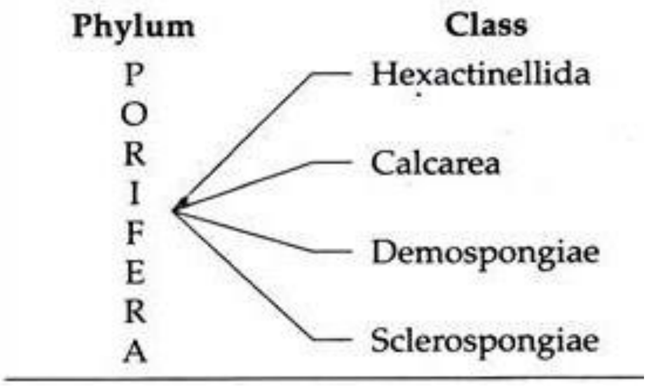


Fig. 1.17 : Some members of class Hexactinellida. A. *Euplectella*, B. *Hyalonema* and C. *Pheronema* (Longitudinal section).

Phylum	Class	Sub-class	Examples
PORIFERA	Calcaria	Calcaronea	*Sycon, Leucosolenia*
		Calcinea	*Clathrina, Leucetta*
	Hexactinellida	Hexasterophora	*Euplectella*
		Amphidiscophora	*Hyalonema*
	Demospongiae	Tetractinomorpha	*Plakina, Asteropus, Axinella*
		Ceractinomorpha	*Halichondria, Clathria, Spongia, Spongilla*

Box. 1.1 : Scheme of classification of Phylum Porifera as in "Text book of Zoology — Invertebrates" by Parker and Haswell (eds. Marshall and Williams, 1972).



Systematic Resume:

Class Hexactinellida (Greek: hex, six; actions, rays):

i. Entirely marine, chiefly occurs in deep- water habitats, at a depth of 10-30 cm.

ii. Skeleton of 6-rayed or triaxon siliceous spicules often fused into vase-shaped structures.

iii. Pinacocytes absent, instead the epidermis forms a net-like syncytium formed from interconnecting pseudopodia of amoebocytes.

iv. Choanocytes are restricted to finger-like simple or folded chambers.

v. The spongocoel opens by a wide osculum.

Examples:

Euplectella (Fig. 1.17A), Hyalonema (Fig. 1.17B), Pheronema (Fig. 1.17C), Monoraphis.

Class Calcarea (Latin: Calcarius, limy):

i. Entirely marine, shallow coastal water species.

ii. Skeleton of separate spicules made of calcium carbonate (lime)*, either calcite or aragonite.

iii. Osculum narrow and provided with oscular fringe.

Examples:

Sycon (Scypha) (Fig. 1.21), Leucandra, Leucosolenia (Fig. 1.18A), Grantia (Fig. 1.18B).

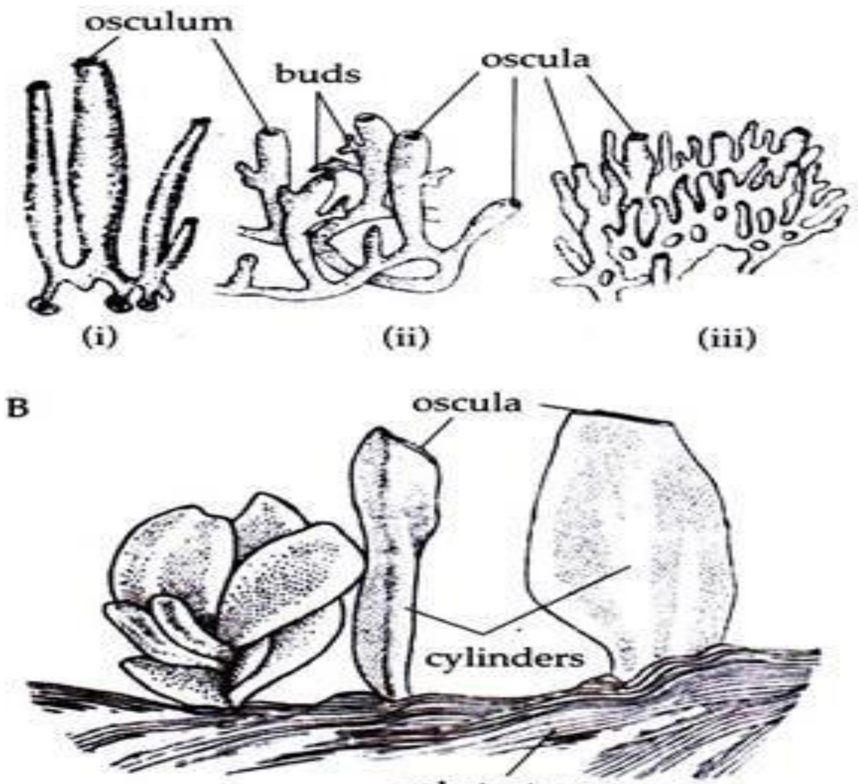


Fig. 1.18 : A. Types of *Leucosolenia* — (i) Simple, (ii) Branched and (iii) Reticulate; B. The purse sponge, *Grantia compressa*.

Class Demospongiae:

(Greek: demos, people; sponges, sponge):

i. Mostly marine but a few are fresh water and is the largest class containing over 90% of the total sponge species.

ii. Skeleton composed of siliceous spicules, spongin fibers or both.

iii. Choanocytes form very small, round type of flagellated chambers.

Examples:

Spongilla (fresh water sponge) (Fig. 1.19A), Euspongia (bath sponge) (Fig. 1.19C), Cliona (boring or sulphur sponge) (Fig. 1.19B), Halichondria, Chalina (Fig. 1.19D), Hippospongia (horse sponge).

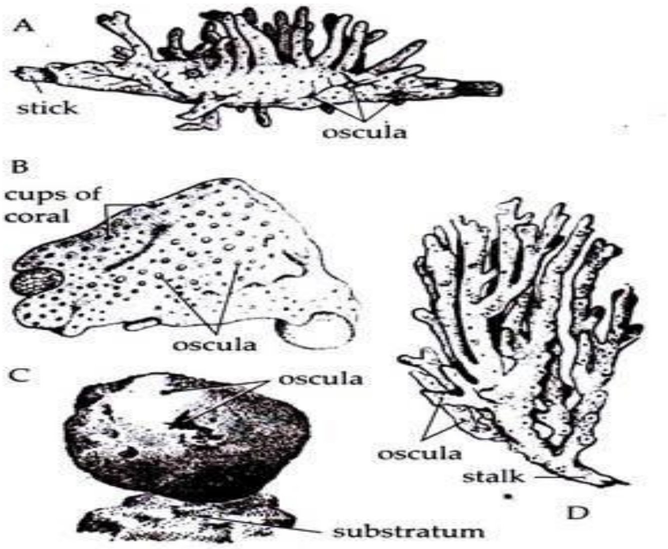


Fig. 1.19 : A. *Spongilla locustris,* B. *Cliona,* C. *Euspongia officianlis,* D. *Chalina oculata.*

Class Sclerospongiae:

i. Marine, exhibits cryptic habits and prefer caves.

ii. Skeleton contains spicules of both silica and aragonitic calcite as well as spongin (Fig. 1.20).

iii. Spicules, Spongin fibers and the surrounding living tissues rest on a solid basal skeleton of calcium carbonate or are enclosed within calcium carbonate chambers.

Examples:

Acanthochaetetes, Astrosclera, Stromatospongia.

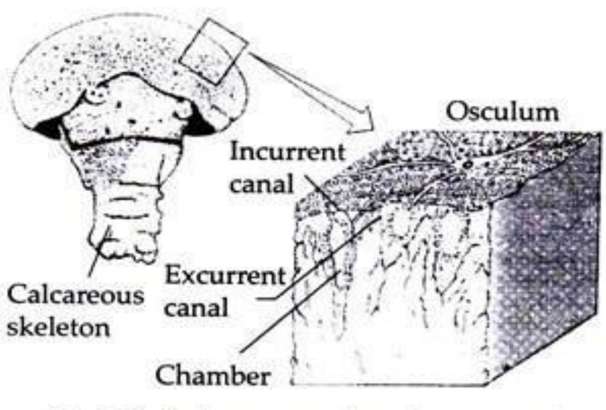


Fig. 1.20 : A sclerospongae (not drawn to scale).

Canal System of the Sponges:

It is evident from the term ‘porifera’ that the surface of the body bears a large number of pores, minute in size and inhalant in function. These pores open into a system of channels, which, after penetrating almost all the portions of the body, open to the exterior by an opening known as osculum, at the tip of the branch.

All the canals are collectively called canal system. The canal system in Scypjia (Sycon) is known as syconoid type. It establishes a continuous passage for the inflow and outflow of water within the body of a sponge (Fig. 19.2).

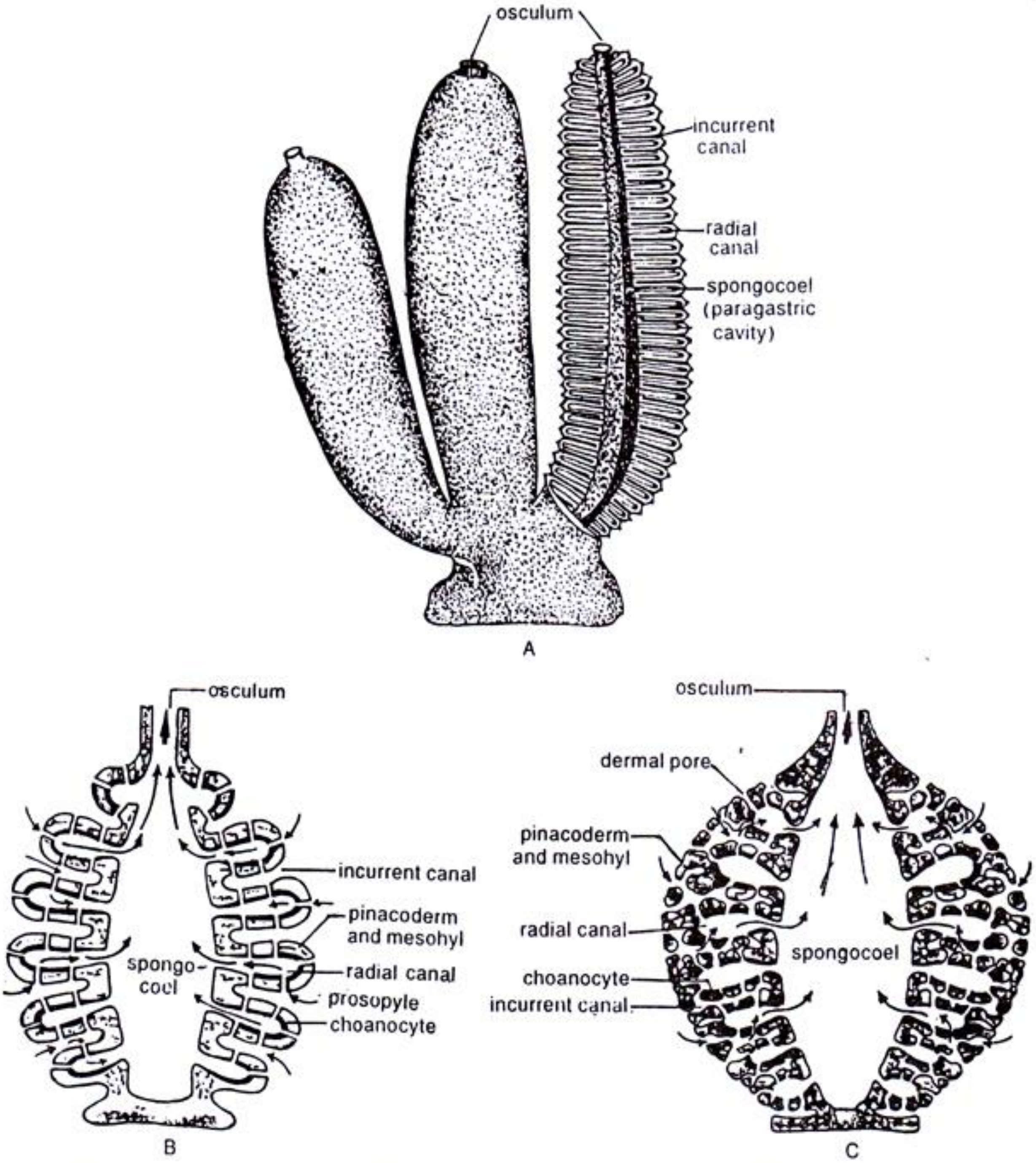


Fig. 19.2. Scypha sp. (Sycon) and Syconoid canal system. A. sycon sp. (slightly magnified), a portion of a colony (the right cylinder (branch) bisected longitudinally). B. Syconoid canal system (early stage without cortex). C. Syconoid canal system (final stage with cortex)

The following structures are found in association with the canal system of Scypha. (Fig. 19.3, 19.4):

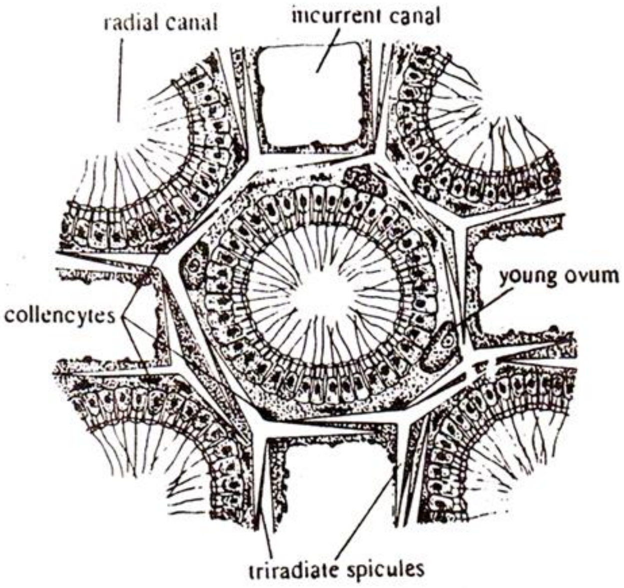


Fig. 19.3. Scypha sp. Longitudinal section passing through the wall of a branch

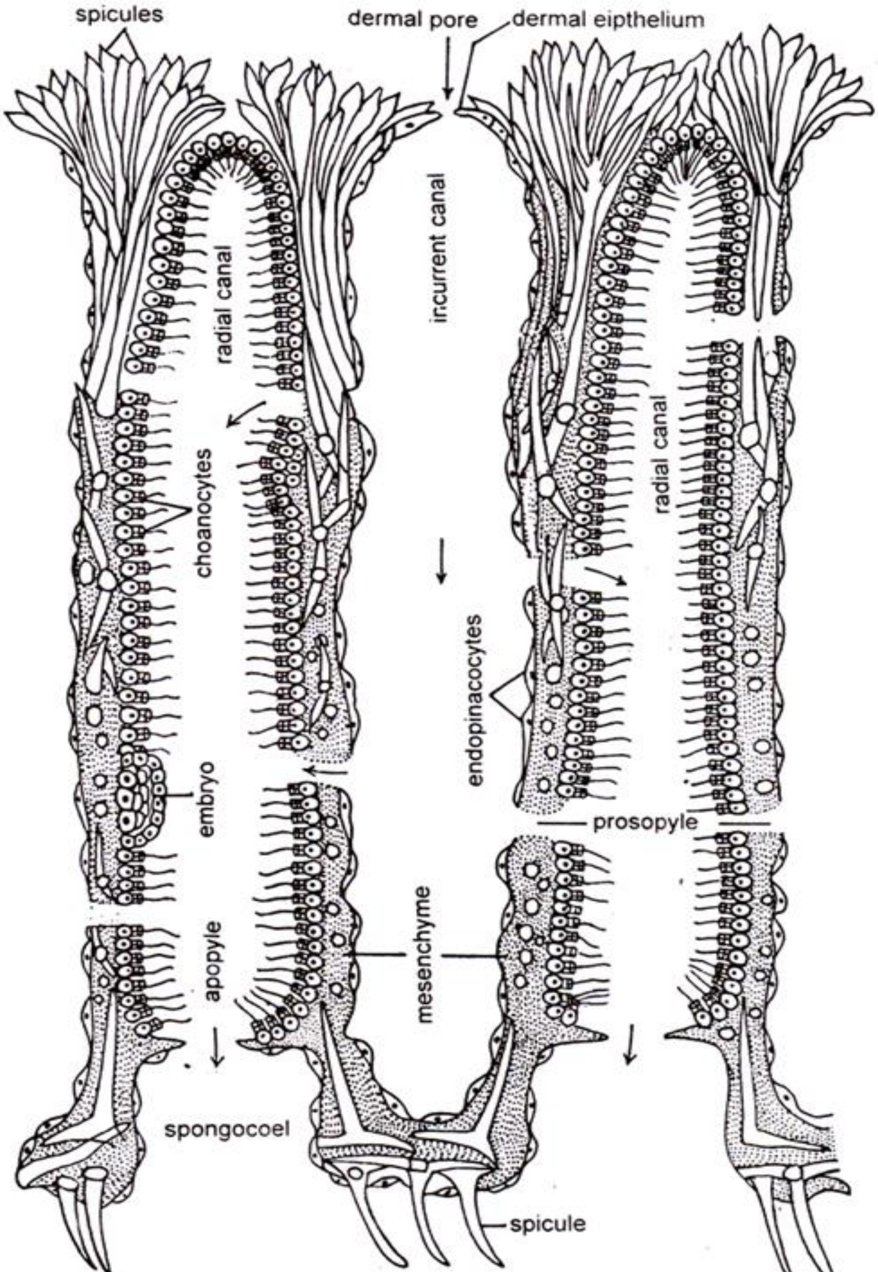


Fig. 19.4. Scypha sp. **Transverse section through a branch**

:

1. Spongocoel:

At the free end of a branch, a fairly large aperture known as osculum is present. Osculum leads internally into a canal, the spongocoel, which runs along the middle of the branch and receives a large number of ex-current canals of the branch.

The Para gastric cavities or spongocoels of different branches in a colonial form, are in communication with one another through a broad chamber at the base. The cavity is lined by flattened cells of ectodermal origin, the pinacocytes.

2. Incurrent Canal:

The surface of each branch of Scypha is provided with alternate elevations and depressions. At each depression a group of minute pores known as inhalant pores or Ostia are present. Ostia lead internally into the incurrent canal. The canal is dilated towards the outer end and narrower and blind at the inner end. It is lined by flattened cells of ectodermal origin, the pinacocytes.

3. Radial Canal:

Lying alternate and parallel to the incurrent canals are the radial canals. The radial canals are situated opposite to the points of elevations on the surface. Each canal is narrower and blind towards the outer end but broad and open at the inner end. It is lined by flagellated choanocyte cells of endodermal origin. The radial canals are connected with the incurrent canals by narrow passages known as prosopyles.

4. Ex-Current Canal:

These are short but wide canals. Each canal is situated along the same long axis of the radial canal. It is lined by flattened cells of ectodermal origin. The ex-current canal is connected at the outer end with the radial canal by an aperture, the apopyle, and at the inner end with the Para gastric cavity by a large aperture, the gastric or internal ositum.

Course of Water Current:

Due to the rapid backward movement of the flagella of the cells lining the radial canals, a constant water current is maintained in the canal system. The rate of flow of water can, of course, be regulated by increasing or decreasing the diameter, of the different apertures in the canal system.

Water from outside enters the incurrent canals through Ostia and from there to the radial canals through the prosopyles. It passes from radial canals to ex-current canals through the apopyles and from there to the spongocoel through gastric Ostia and, thence, to the exterior through the osculum.

Role of the Canal System:

The canal system serves various functions:

1. It serves the purpose of nutrition. The food such as diatoms, protozoans, etc., are carried by the water current and reach the radial canals where they are picked up and digested by the flagellate cells.

2. Oxygen for respiration is carried by the streaming current of water.

3. It functions for excretion. Current of water, passing out of the osculum, also remove the carbonic acid and other nitrogenous waste matters.

4. The outward current takes away the reproductive units from the body of the sponge.

5. The complicated canal system also increases the surface area of the animal which is directly exposed to water.

4. Histological Elements Constituting the Wall of Sponges:

The different microscopic elements constituting the body wall of Scypha are known as histological elements. The elements may be divided into three groups—cell elements, skeletal elements and mesenchymal substance (Figs. 19.3-19.6).

1. Cell Elements:

The cells of the sponges are fairly differentiated, but, excepting choanocytes, others seem to be only modified forms of undifferentiated amoeboid cells corresponding to the primitive connective tissue cell of higher animals.

Following different types of cells are found in the body wall of Scypha (Fig. 19.5-19.6):

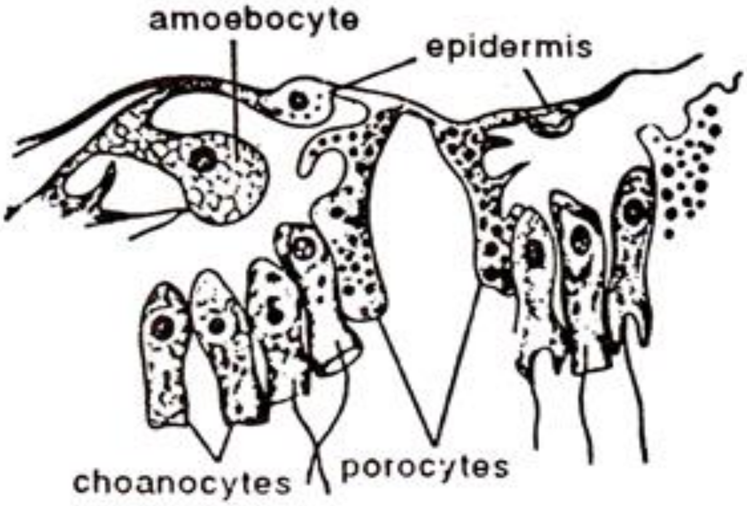


Fig. 19.5. Scypha sp. Section of the body showing different types of cells

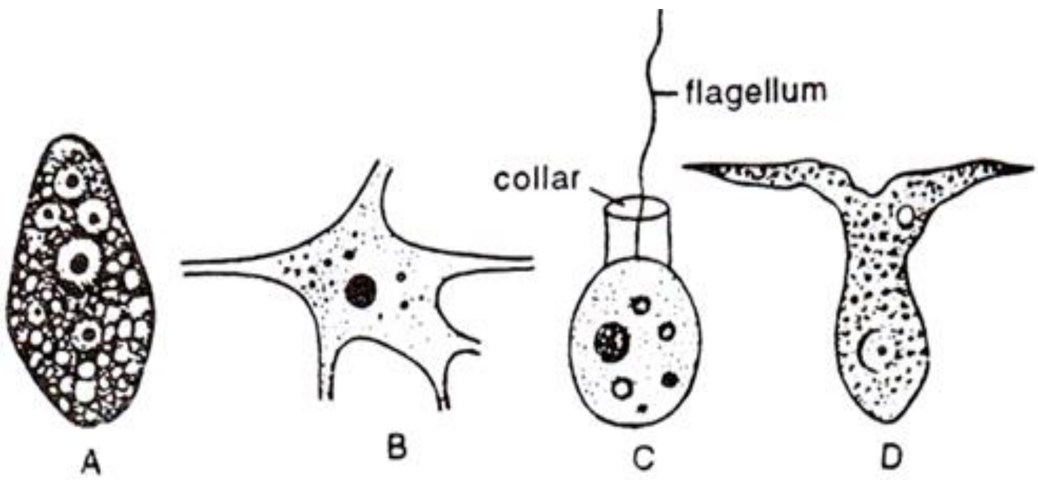


Fig. 19.6. Scypha sp. Types of cells.
A. Archaeocyte. B. Amoebocyte. C. Choanocyte. D. Epidermal

a. Ecotodermal cells:

These are flattened scale-like cells with inconspicuous nuclei and their edges are closely cemented together to form an epithelium. The cells of the dermal layer covering the outer surface of the sponge are known as pinacocytes.

Each pinacocyte has a thickened central bulging containing a nucleus. Some pinacocytes (endopinacocytes) also line the incurrent canals and spongocoel. They are highly contractile and those lining the incurrent canals are called skeletogenous cells.

b. Endodermal cells:

These are columnar cells, each with a large nucleus, one or more vacuoles and bears flagellum at the inner end, the base of which is surrounded by a delicate, transparent, collar-like up growth. Such cells are known as choanocytes and are restricted to the radial canals.

c. Myocytes:

These are fusiform contractile cells around the ostia, prosopyles and apopyles effecting the closure of the apertures, and are usually arranged in a circular fashion to form a sphincter.

2. Mesenchyme Substance:

The mesenchyme consists of a gelatinous, transparent matrix generally known as mesogloea, supposed to be protein in nature. It affords rigidity to the animal. The mesogloea contains—to some extent—free wandering cells or amoebocytes.

Following types of amoebocytes are found in Scypha:

a. Amoeboid wandering cells:

Amoeba-like and can move from place to place. They are concerned with the nutrition of the animal.

b. Collencytes:

The cells bear slender branching pseudo- pods and connect the different elements of the body. If bipolar, collencytes are termed desmacytes or fibre cells.

c. Chromocytes:

These are with lobose pseudopods and contain pigments. The colouration of the sponge is dependent on these pigments.

d. Thesocytes:

Cells with lobose pseudo- pods and store reserve food materials.

e. Scleroblasts:

The cells secrete the skeletal elements or spicules.

They are of two types:

i. Calcoblasts:

Amoebocytes secreting calcareous spicules.

ii. Silicoblasts:

Amoebocytes secreting siliceous spicules.

f. Reproductive cells:

These are modified amoebocytes and possibly also modified choanocytes.

g. Porocytes:

Also known as pore cells, they are tubular and with a central canal acting as an incurrent passage. The pores can be closed by a thin cytoplasmic sheet, the pore diaphragm. Porocytes are possibly transformed pinacocytes. The mesenchyme is responsible, after all, for one of the most important characters in sponges, that is, secreting the skeletal elements.

3. Skeletal Elements:

These are hard structures connected together in such a way as to support and protect the soft parts of the body. These structures are pointed and are made of calcium carbonate and known as spicules. Spicules develop from the scleroblasts and one scleroblast is required to form each arm of a spicule.

The spicules may be needle-like or club-shaped and range from one to many axes,—or monaxon to polyaxon,—of which triaxon is the most abundant type (Fig. 19.4) There are spicules where the body is round and the growth is concentric.

These are known as spheres while the crepis—on being deposited with layers of silica in an irregular fashion is termed Desma. The club-shaped spicules projecting on the outer surface beyond the ectoderm are known as oxeote spicules.

Spicules are responsible for the framework of Scypha. Although the primary function of the calcareous skeleton is to support, it also serves to buffer the mesenchyme against any drop in pH that could cause hardening of the ground substance.

5. Reproduction and Development in the Sponges:

Reproduction in sponges takes place both by asexual and sexual means (Fig. 19.7):

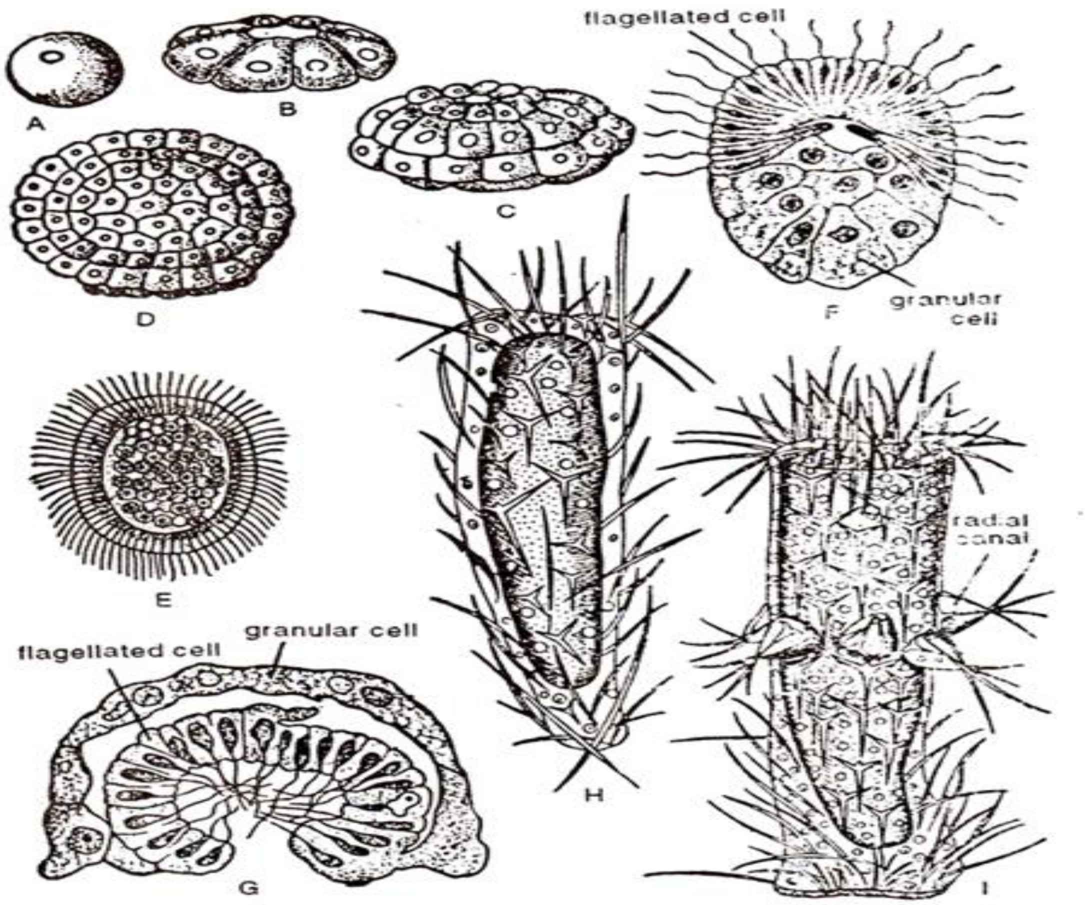


Fig. 19.7. Scypha sp. Development.
A. A zygote. B. 8-cell stage. C. 32-cell stage. D. An early blastula. E. A parenchymula larva of *Leucosonelia* sp. F. An amphiblastula. G. A gastrula. H–I. A young sponge

A. Asexual Reproduction:

It is effected by internal buds or gem- mules. Some of the amoebocytes come to lie in the mesogleal layer around the lining cells of the radial canals, and after repeated division a mass of cells or the gemmule is formed. This process is known as gemmation.

A gemmule cannot escape to the outside until the branch in which it grows is separated from the main body of the sponge and lost. For this reason, gemmules are formed in older branches. By the time of its liberation the; gemmule is transformed into an amphiblastula, the subsequent development of which is like that of the same in sexual reproduction.

B. Sexual Reproduction:

Sponges are monoecious, i.e. ova and sperms develop in the same individual. Sexual reproduction is effected by the formation of the archaeocytes (specialized amoebocytes). Sex organs are absent. The mesenchyme around the gastral layer of the flagellated chamber is the seat of the sex cells.

Spermatozoon is with a round head and a long tail. Spermatozoa from another sponge are carried to the radial canal with water current. The ovum is large and round and remains attached to the maternal tissue. Fertilization takes place within the body.

The fertilized egg of Scypha divides vertically and eight concial cells are formed. These cells then undergo horizontal cleavage, with the result the eight long cells and eight small cells are formed enclosing a blastocoel.

The long cells are destined to form the future epidermis while the small cells form the future choanocytes. The eight small cells increase in size, elongate, and each acquires a flagellum on its inner side. The larger cells do not divide, instead, they assume a round form and become granular.

The mouth opening appears at their middle which absorbs the neighbouring cells. This stage of the blastula is known as stomoblastula. The blastula-undergoes inversion and the flagellated cells are brought outside.

The embryo at this stage is known as amhiblastula (Fig 19.7F). This is a typical calcareous larva. It escapes from the parent and has two types of cells—the small narrow flagellated cells and the large round granular cells.

After a brief period of free existence which may last for a few to several hours, the larva undergoes gastrulation, in which the flagellated half is invaginated into or overgrown by the large granular cells (Fig. 19.7G.).

It attaches itself to some solid object by the blastoporal end and is gradually transformed into a narrow cylinder and then to a small sponge. The flagellated cells become the collared cells, while the granular cells become numerous and form the dermal epithelium.

The mesenchyme cells are formed from both the layers. Gradually, the cylinder (larva) increases in thickness. With the growth of the intermediate layer the radial and other canals gradually appear.

6. Commercial Sponge:

Sponges are mostly beneficial to man. Skeleton of some sponges are used to manufacture commercial sponge, which is of great economic importance. The sponging skeleton is treated with hydrochloric acid and the spicules dissolve.

The residue left after the acid treatment is further subjected to chemical treatment, and the skeleton becomes marketable as the ‘bath sponge’. Sponges are extensively used in bath rooms, laboratories and in surgical operations.