

TDC FIRST SEM MAJOR : PAPER 1

UNIT 2 .PORIFERA: GENERAL CHARACTERISTIC AND CLASSIFICATIONUPTOCLASS ES: CANAL SYSTEM IN PORIFERA

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The word “Porifera” mainly refers to the pore bearers or pore bearing species. Based on the embryological studies, sponges are proved as animals and are classified into a separate Phylum in the animals .This phylum includes about 5000 species. Poriferans are pore-bearing first multicellular animals. The pores are known as Ostia.

Characteristics of Porifera are:

- Porifera are all aquatic, mostly marine except one family Spongillidae which lives in freshwater.
- They are sessile and sedentary and grow like plants.
- The body shape is vase or cylinder-like, asymmetrical or radially symmetrical.
- The body surface is perforated by numerous pores, the Ostia through which water enters the body and one or more large openings, the oscula by which the water exits.
- The multicellular organism with the cellular level of body organization. No distinct tissues or organs.
- They consist of outer ectoderm and inner endoderm with an intermediate layer of mesenchyme, therefore, diploblastic

- The interior space of the body is either hollow or permeated by numerous canals lined with choanocytes. The interior space of the sponge body is called spongocoel.
- Characteristic skeleton consisting of either fine flexible spongin fibers, siliceous spicules or calcareous spicules.
- Mouth absent, digestion intracellular.
- Excretory and respiratory organs are absent.
- Contractile vacuoles are present in some freshwater forms.
- The nervous and sensory cells are probably not differentiated.
- The primitive nervous system of neuron arranged in a definite network of bipolar or multipolar cells in some, but is of doubtful status.
- The sponges are monoecious.
- Reproduction occurs by both sexual and asexual methods.
- Asexual reproduction occurs by buds and gemmules.

- The sponge possesses a high power of regeneration.
- Sexual reproduction occurs via ova and sperms.
- All sponges are hermaphrodite.
- Fertilization is internal but cross-fertilization can occur.
- Cleavage holoblastic.
- Development is indirect through a free-swimming ciliated larva called amphiblastula or parenchymula.
- The organization of sponges are grouped into three types which are ascon type, sycon type, and leuconoid type, due to simple and complex forms.
- Examples: Clathrina, Sycon, Grantia, Euplectella, Hyalonema, Oscarella, Plakina, Thenea, Cliona, Halichondria, Cladorhiza, Spongilla, Euspondia, etc.

Classification of Phylum Porifera

Based on the type of skeleton system the phylum Porifera is divided into three classes

Class 1: Calcarea or Calcispongiae

Class 2: Hexactinellida or Hyalospongiae.

Class 3: Demospongiae

Class 1: Calcarea or Calcispongiae : (calcaris: lime / calcium))

Habitat: Exclusively marine

Habit: Solitary or colonial nature.

Endoskeleton: calcareous spicules composed of calcium carbonate

Symmetry: Radially symmetry

Shape: Cylindrical shape

Examples: Sycon, Leucosolenia

Class 2: Hexactinellida or hyalospongiae: (Hex: six, actin: ray, idea: terminal)

Habitat: Exclusively marine (deep sea)

Habit: Solitary in nature.

Endoskeleton: six- rayed siliceous spicules.

Symmetry: Radially symmetry

Shape: Cylindrical shape.

Examples: Euplectella, Hyalonemma

Class 3: Demospongiae : (Demos: frame)

Habitat: Mostly marine and some are freshwater

Endoskeleton: Siliceous spicules or sponging fibres or both or none

The spicules are monaxon or tetraxon but never six-rayed

Symmetry: asymmetrical.

Shape: Irregular

Canal system complicated.

Spongocoeal is totally absent. **Examples:** Spongilla.

CANAL SYSTEM IN PORIFERA OR CANAL SYSTEM IN SPONGES

Introduction

The water circulatory system of sponges also called as canal system is the characteristic feature of the phylum Porifera. Canal system is also known as aquiferous system. The canal system of sponges helps in food acquisition, respiratory gas exchange and also in excretion.

The numerous perforations on the body surface of the sponges for ingression and egression of water current are the main constituents of the canal system. Inside the body, the water current flows through a certain system of spaces where by the food is captured from the incoming water and the excretory material is sent out into the outgoing water.

Types of canal systems

Different sponges have different arrangement and grades of complexity of internal channels and accordingly the canal system is been divided into the following three types:

Ascon type of canal system

This canal system is the simplest of all the three. It is found in asconoid type of sponges like *Leucosolenia* and also in some of the developmental stages of all the syconoid sponges.

The body surface of the asconoid type of sponges is pierced by a large number of minute openings called as incurrent pores or ostia. These pores are intracellular spaces within the tube like cells called porocytes. These pores extend radially into mesenchyme and open directly into the spongocoel.

The spongocoel is the single largest spacious cavity in the body of the sponge.

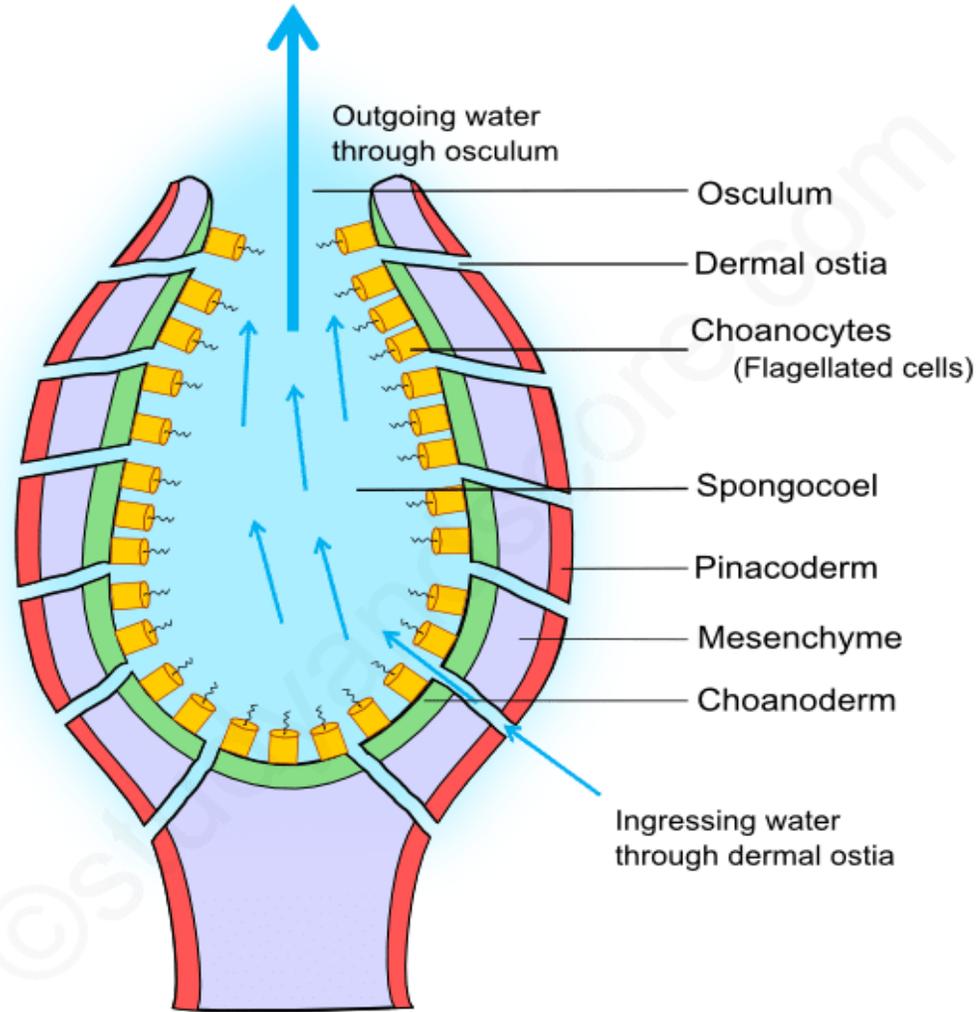
The spongocoel is lined by the flattened collar cells or choanocytes.

Spongocoel opens outside through a narrow circular opening called as osculum located at the distal end and it is fringed with large monaxon spicules.

The surrounding sea water enters the canal system through the ostia. The flow of the water is maintained by the beating of the flagella of the collar cells. The rate of water flow is slow as the large spongocoel contains much water which cannot be pumped out through a single osculum.

Course of water current in Asconoid type canal system

Ingressing water- Ostia - Spongocoel - kiss - outside



Ascon type canal system (Ex: Leucosolenia)

Sycon type of canal system

Sycon type of canal system is more complex compared to the ascon type. This type of canal system is the characteristic of syconoid sponges like Scypha.

Theoretically this canal system can be derived from asconoid type by horizontal folding of its walls. Also embryonic development of Scypha clearly shows the asconoid pattern being converted into syconoid pattern.

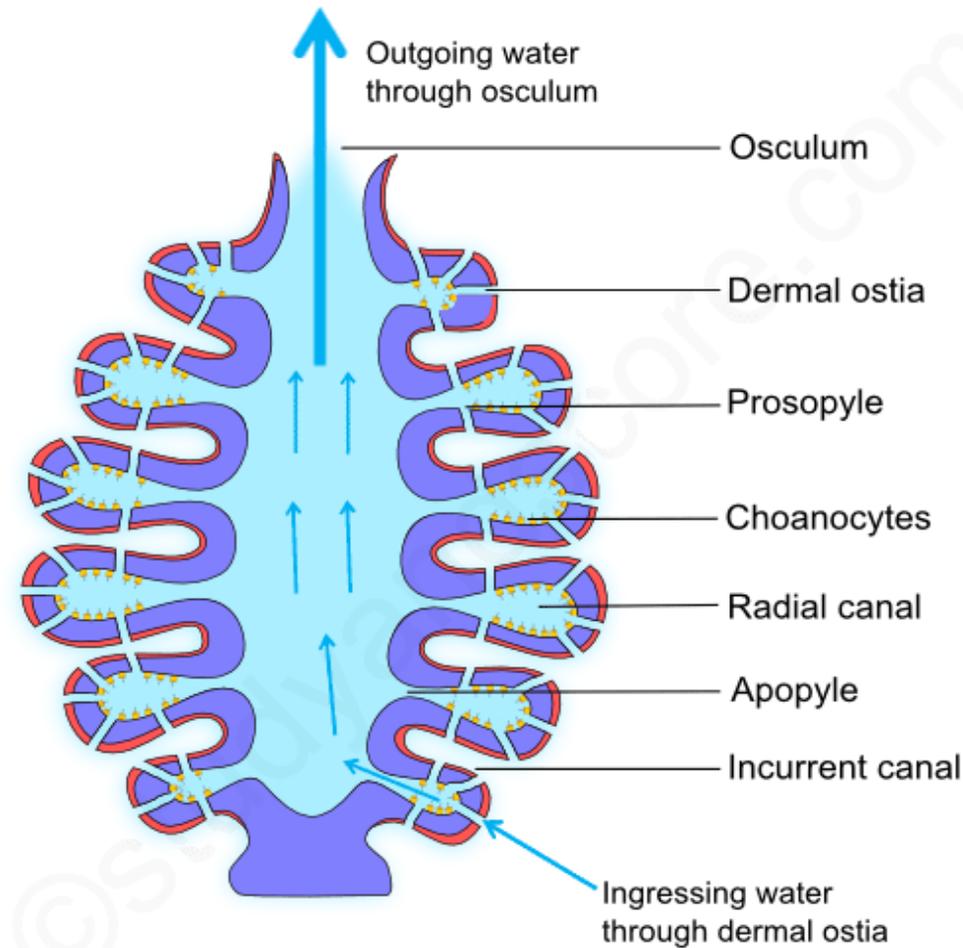
Body walls of syconoid sponges include two types of canals, the radial canals and the incurrent canals paralleling and alternating with each other. Both these canals blindly end into the body wall but are interconnected by minute pores.

Incurrent pores also known as dermal ostia are found on the outer surface of the body. These incurrent pores open into incurrent canals.

The incurrent canals are non-flagellated as they are lined by pinacocytes and not choanocytes. The incurrent canals lead into adjacent radial canals through the minute openings called prosopyles. On the other hand radial canals are flagellated as they are lined by choanocytes. These canals open into the central spongocoel by internal ostia or apopyles.

In sycon type of canal system, spongocoel is a narrow, non-flagellated cavity lined by pinacocytes. It opens to the exterior through an excurrent opening called osculum which is similar to that of the ascon type of canal system.

Course of water current in Syconoid type canal system : Ingressing water- dermal ostia - incurrent canal - Prosopyles - Radial canals - Apopyles - Spongocoel - kiss - Outside



Sycon type canal system (Ex: Scypha)

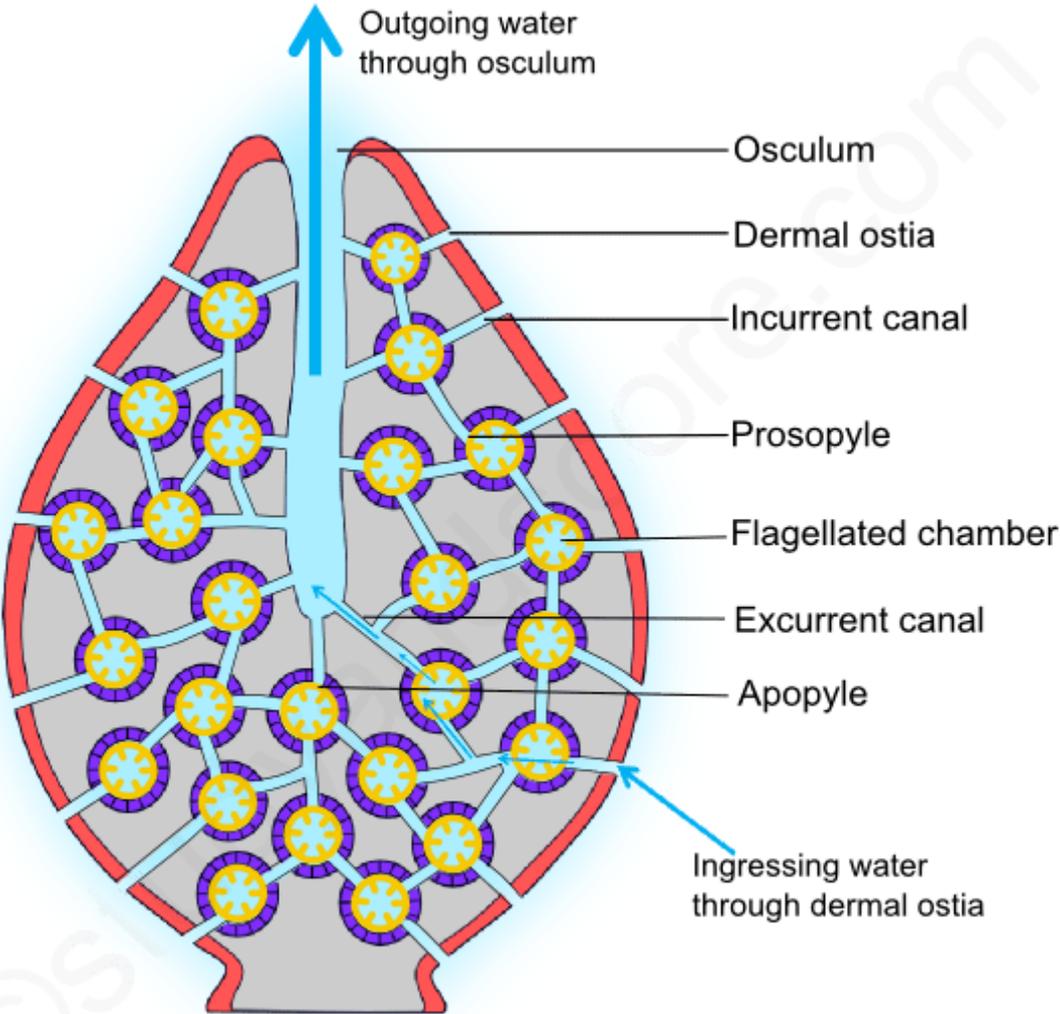
Sycon canal system takes a more complex form in few species like Grantia, where the incurrent canals are irregular and branching forming large sub-dermal spaces. This is due to the development of cortex, involving pinacoderm and mesenchyme spreading over the entire outer surface of sponge.

Leucon type of canal system

This type of canal system results due to further folding of body wall of the sycon type of canal system. This canal system is the characteristic of the leuconoid type of sponges like Spongilla. In this type the radial symmetry is lost due to the complexity of the canal system and this result in an irregular symmetry.

The flagellated chambers are small compared to that of the asconoid and syconoid type. These chambers are lined by choanocytes and are spherical in shape. All other spaces are lined by pinacocytes. The incurrent canals open into flagellated chambers through prosopyles. These flagellated chambers in turn communicate with the excurrent canals through apopyles. The excurrent canals develop as a result of shrinkage and division of spongocoel. The large and spacious spongocoel which is present in the asconoid and syconoid type of canal systems is absent here. Here the spongocoel is much reduced. This excurrent canal finally communicates with the outside through the osculum.

Course of water current in Leuconoid type canal system :Ingressing water - dermal ostia - incurrent canal – Prosopyles- Flagellated chambers - Apopyles - progression canals - kiss - Outside



Leucon type canal system (Ex: Spongilla)

Leucon type of canal system has the following three successive grades in its evolutionary pattern:

Eurypylous type: This is the simplest and the most primitive type of leuconoid canal system. In this type the flagellated chambers directly communicate with the excurrent canal through broad apertures called the apopyles. Ex: Plakina

Aphodal type: In this type of canal system the apopyles are drawn out as a narrow canal called aphodas. This connects the flagellated chambers with the excurrent canals.

Ex: Geodia

Diplodal type: in some of the sponges, along with aphodas another narrow tube called prosodus is present between incurrent canal and flagellated chamber. This arrangement gives rise to diplodal type of canal system.

Ex: Spongilla

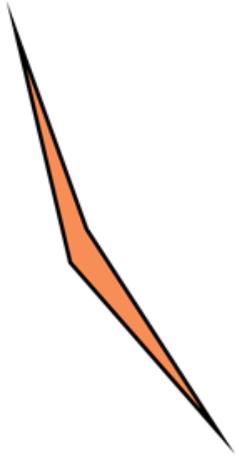
Functions of the water current or significance of Canal system

Water current plays the most vital role in the physiology of the sponges. The body wall of the sponges consists of two epitheloid layers the outer pinacoderm and the inner choanoderm. Pinacoderm consists of porocytes cells which bear openings called ostia. Choanoderm is composed of choanocytes or collar cells. The choanocytes have collar of microvilli around the flagellum. The water current is caused by beating of flagella of the collar cells. The following are the functions of the water current which enters the body of the sponges through the canal system:

- **All exchanges between sponge body and external medium are maintained by means of this current.**
- **Food and oxygen are brought into body through this water current**
- **Also the excreta are taken out of the body with the help of this water current.**
- **The reproductive bodies are carried out and into the body of the sponges by the water current.**

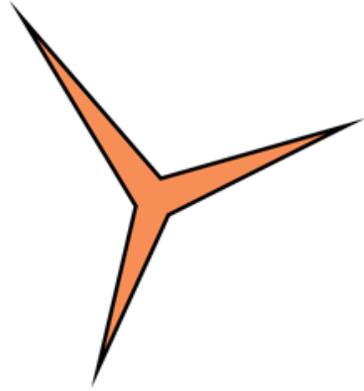
SPICULES OF SPONGES

Monoaxon



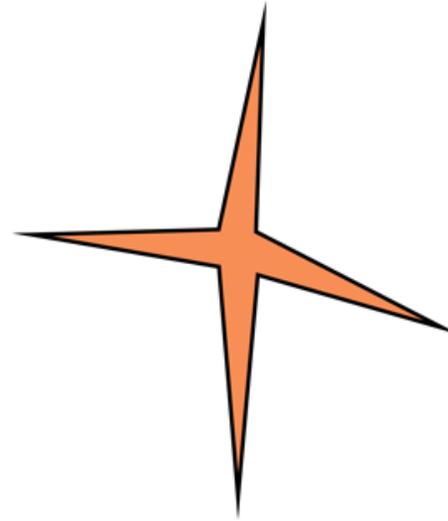
Diactine

Triaxons



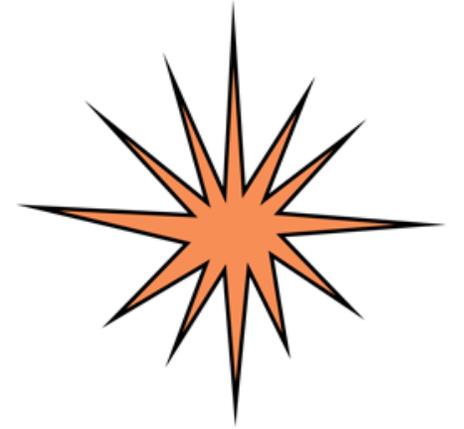
Triactine

Tetragon



Tetracline

Polyaxon



Polyactine

Meaning of Spicules:

The spicules or sclerites are definite bodies, having a crystalline appearance and consisting in general of simple spines or of spines radiating from a point.

They have an axis of organic material around which is deposited the inorganic substance, either calcium carbonate or hydrated silica. They present a great variety of shape and as reference to the shape is essential in the description of sponges, a large terminology exists.

Classification of Spicules:

First, spicules are of two general kinds—megascleres and microscleres. The spicules are further classified according to the number of their axes and rays.

Words designating the number of axes end in axons, those referring to the number of rays end in actine or actinal.

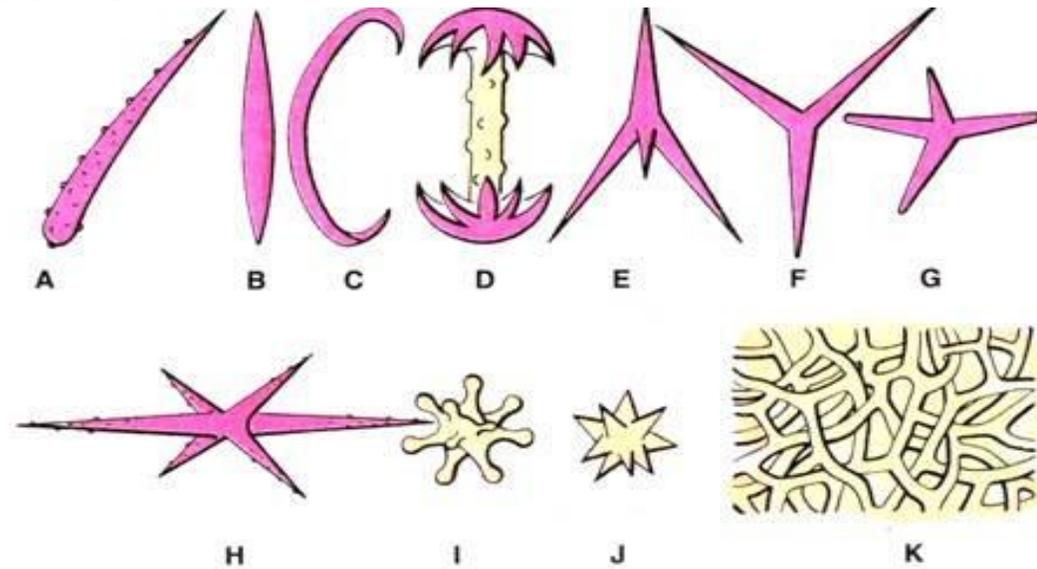


Fig. 28.9. Spicules and spongin. A—Monactinal monaxon; B—Diactinal monaxon; C—Curved monaxon; D—Monaxon with hooked ends; E—Tetraxon; F—Triradiate; G—Calthrops; H—Hexactinal triaxon; I and J—Polyaxon; K—Spongin fibres.

1. Megascleres:

The megascleres are the larger skeletal spicules that constitute the chief supporting framework of the sponge. There are five general types of megasclere spicules, viz., monaxons, tetraxons, triaxons, polyaxons and spheres.

(i) Monaxons:

These are formed by growth in one or both directions along a single axis, which may be straight or curved. When growth has occurred in one direction only, the spicule is called monactinal monaxon or style. Styles are typically rounded (strongylote) at one end and pointed (oxeote) at the other. Styles in which the broad end is knobbed are called tylostyles; those curved with thorny processes are acanthostyles.

Usually the pointed end of styles projects to the exterior. Monaxons that develop by growth in both directions from a central point are named diactinal monaxons, diactines or briefly rhabds. Rhabds pointed at each end are oxeas, lance-headed at each end, tornotes; rounded at the ends, strongyles and knobbed at each end, like a pin head, tylotes.

(ii) Tetraxons:

Tetraxon spicules are also called tetractines and quadriradiates. They consist typically of four rays, not in the same plane, radiating from a common point. The four rays of the tetraxon spicule may be more or less equal, in which case the spicule is called a calthrops.

Generally one ray, rhabdome, is elongated bearing a crown of three smaller rays; such spicules are termed triaenes. By loss of one smaller ray results into a diaene. If the elongated ray bears a disc at both ends, it is called amphidisc. Loss of elongated ray results into a triradiate or triactinal spicule, called a triod characteristic of calcareous sponges.

(iii) Triaxons:

The triaxon or hexactinal spicule consists fundamentally of three axes crossing at right angles, producing six rays extending at right angles from a central point. From this basic type all possible modifications arise by reduction or loss of rays, branching and curving of the rays, and the development of spines, knobs, etc., upon them. The triaxon spicules are characteristic of class Hexactinellida.

(iv) Polyaxons

These spicules in which several equal rays radiate from a central point.

(v) Spheres:

These are rounded bodies in which growth is concentric around a c

(vi) Desma:

A special type of megasclere known as desma occur in a number of sponges. A

desma consists of an ordinary minute monaxon, triadial, or tetraxon spicule,

termed the crepis, on which layers of silica have been deposited irregularly.

Desmas are named from the shape of the crepis, as monocrepid, tricrepid and

tetracrepid. They are usually united into a network and such a reticulated

skeleton is called lithistid.

2. Microscleres:

The microscleres are the smaller flesh spicules that occur strewn throughout the mesenchyme. However, they do not form the supporting framework. The microspheres are of two types, viz., spires and asters.

(i) Spires:

Spires are curved in one plane or spirally twisted and exhibits many shapes. The most common types are the C-shaped forms, called sigmas; the bow-shaped ones, or toxas and the chelas with recurved hooks, plates or flukes at each end. When two ends are alike, chelas are called isochelas, when unlike, anisochelas. Spirally twisted sigmas are termed sigmaspires.

ii) Asters:

Asters include types with small centres and long rays and large centres and small rays. Among the small centred forms are oxyasters with pointed rays, strongylaster with rounded ends and tylasters with knobbed rays. Large-centred forms include spherasters with definite rays and sterrasters with rays reduced to small projections from the spherical surface.

Short spiny microscleric monaxons are known as streptasters, of which the principal sorts are the spirally twisted spirasters, rod shapes or sanaidasters, plesioasters with a few spines from a very short axis, and amphiasters with spines at each end. Microscleric forms of diactines are microrhabds, microxeas, and microstrongyles.

Development of Spicules:

Spicules are secreted by mesenchyme cells, called scleroblasts. Very little is known about the formation of various kinds of spicules. The process is best known for calcareous spicules. On the basis of development, the spicules may be primary which owe their first origin from a single mother cell or scleroblast, or secondary which arise from more than one scleroblast.

(i) Development of monaxon spicules:

In calcareous sponges, a monaxon spicule is secreted within a binucleate scleroblast, probably arising by the incomplete division of an ordinary scleroblast. The calcium carbonate is deposited around an organic axial thread in the cytoplasm between the two nuclei.

As the spicule lengthens, the two nuclei draw apart until the scleroblast divides into two.

One cell, the founder is situated at the inner end, the other the thickener at the outer end of the spicule, since monaxon spicules usually project from the body wall.

The spicule is laid down chiefly by the founder which moves slowly inward, establishing the shape and length. The thickener deposits additional layers of calcium carbonate, also moving inward during this process. When the spicule is completed, both cells wander from its inner end into mesogloea, the founder first and the thickener later. The development of siliceous spicules is poorly known and requires further exploration. It appears that in most cases they are formed completely with one scleroblast called silicoblast.

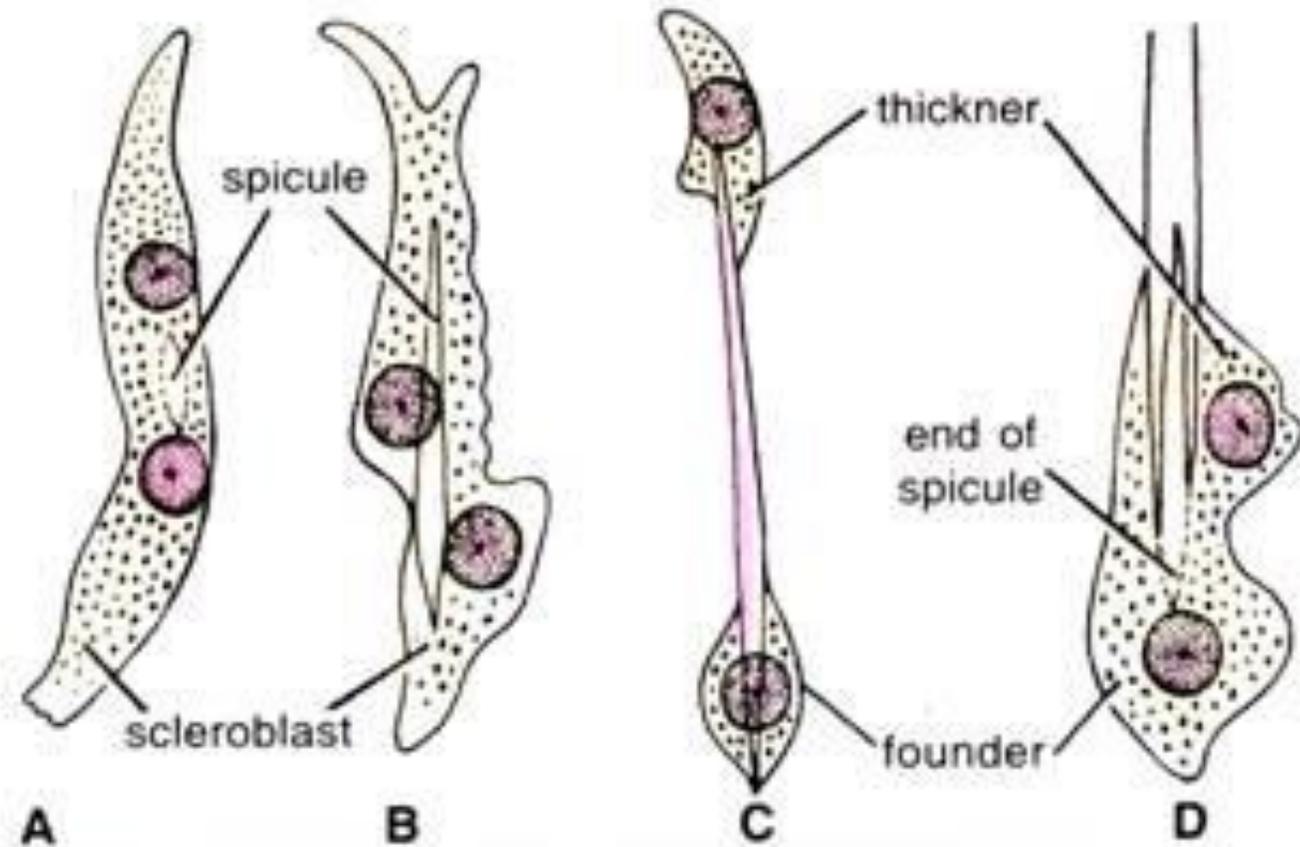


Fig. 28.10. Secretion of a monaxon spicule.

(ii) Development of triaxon spicules:

Triaxon or triradiate calcareous spicules are secreted by three scleroblasts which come together in triangle and divide in two, each into an inner founder and an outer thickener. Each pair secretes a minute spicule and these three rays are early united into a small triradiate spicule.

Each ray is then completed in the same manner as a monaxon spicule. Later on, three rays or spicules unite together forming a triaxon or triradiate spicule.

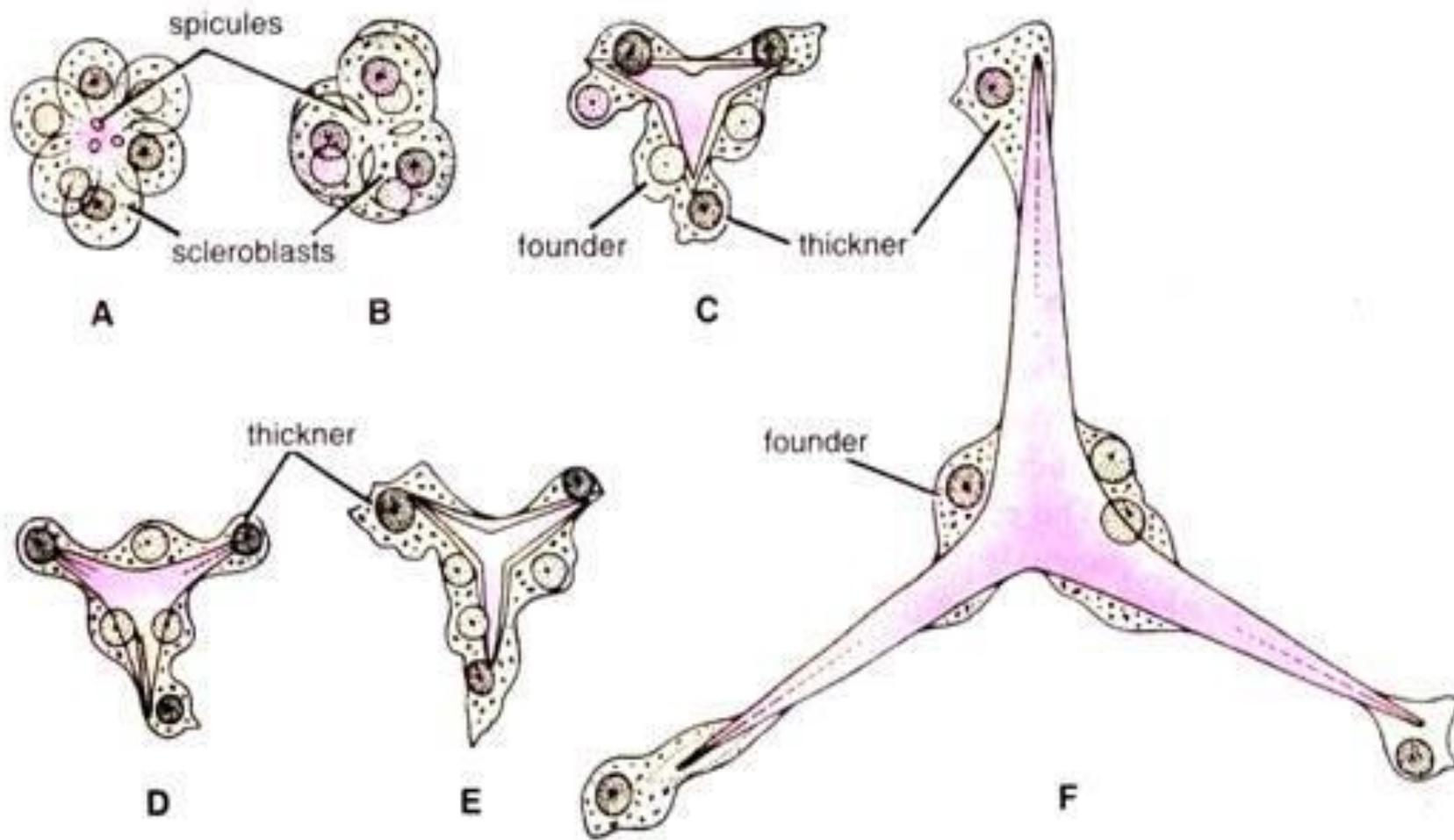


Fig. 28.11. Secretion of a triaxon spicule.

(iii) Development of other spicules:

In the formation of quadriradiate or tetraxon spicules, the fourth ray is added to forming triradiate spicule by an additional scleroblast. The hexactinal spicules of Hexactinellida arise in the centre of a multinucleate syncytial mass which is probably formed by repeated nuclear division of an original silicoblast.

Taxonomic Importance of Spicules:

The main basis of the classification of Phylum Porifera is the skeletal structures found in them. We have seen that Phylum Porifera has been divided into three classes:

- 1. Class Calcarea: Having calcareous spicules.**
- 2. Class Hexactinellida: Having six-rayed (hexasters) siliceous spicules.**
- 3. Class Demospongiae: Having siliceous spicules and spongin fibres.**