MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION

Origins of Multicellularity

Phylum Porifera

- Cell Types, Body Wall, and Skeletons
- Water Currents and Body Forms
- Maintenance Functions
- Reproduction

Phylum Cnidaria (Coelenterata)

- The Body Wall and Nematocysts
- Alternation of Generations
- Maintenance Functions
- Reproduction
- Class Hydrozoa
- Class Scyphozoa
- Class Cubozoa
- Class Anthozoa

Phylum Ctenophora

➢ Origins of Multicellularity

- Multicellular life has formed approximately **550 million years** ago. Although this seems a very long time, it represents only **10%** of the earth's geological history.
- Multicellular life arise in **Precambrian** and **Cambrian** boundary. The scientists take this period as evolutionary explosion. All the animal phyla appeared during this evolutionary era.
- Now **15 to 20 groups** of multicellular animals have become extinct.
- Since this initial evolutionary explosion, most of the history of multicellular life has been one of extinction.

There is a mystery in the evolution of multicellularity. There are two hypotheses about the origin of multicellular organisms:

1. Colonial hypothesis:

Many zoologists believe that multicellularity could have arisen as dividing cells remained together, in the fashion of many colonial protists. Although variations of this hypothesis exist, they are all treated here as the colonial hypothesis.

2. Syncytial hypothesis:

A syncytium is a large, multinucleate cell. The formation of plasma membranes in the cytoplasm of a syncytial protist could have produced a small, multicellular organism.

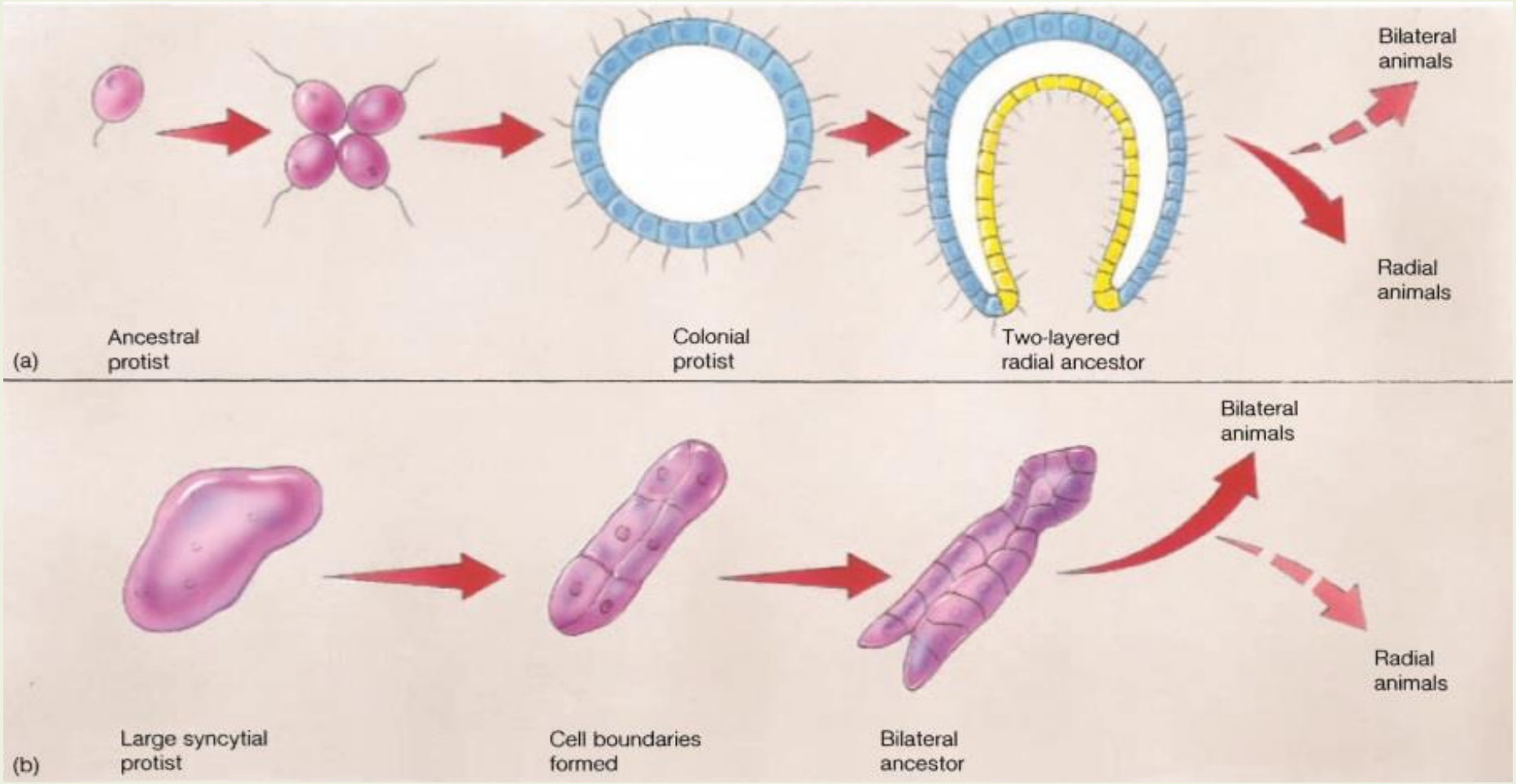


Fig: Two Hypotheses Regarding the Origin of Multicellularity. (a) The colonial hypothesis. Multicellularity may have arisen when cells that a dividing protist produced remained together. Cell invagination could have formed a second cell layer. This hypothesis is supported by the colonial organization of some Sarcomastigophora. (The colonial protist and the two-layered radial ancestor are shown in sectional views.) (b) The syncytial hypothesis. Multicellularity could have arisen when plasma membranes formed within the cytoplasm of a large, multinucleate protist. Multinucleate, bilateral ciliates support this hypothesis.

ANIMAL ORIGINS:

There are three views about the animal origins:

1. **Monophyletic:**

✓ It means that the multicellular animals had derived from a single ancestor.

❖ **Impressive similarities are present in animal cellular organization.**

For example:

(i) Asters formation during mitosis in most animals.

(ii) Certain cell junctions are similar in all animal cells.

(iii) Most animals produce flagellated sperm.

(iv) The proteins involved in movement are similar in most animal cells.

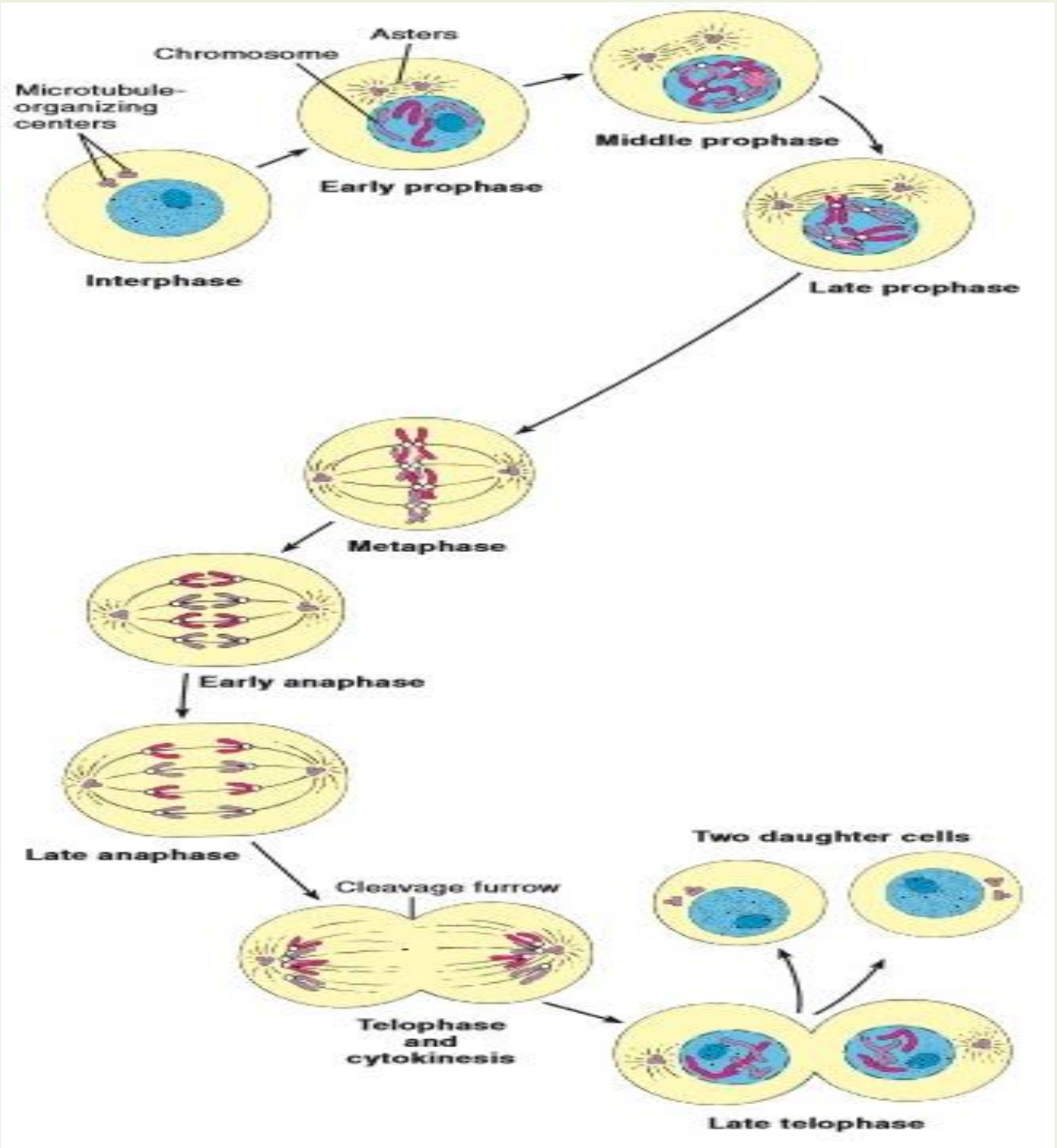


Fig: Continuum of Mitosis and Cytokinesis. Asters formation during mitosis

2. Diphyletic:

It means animals derived from two ancestors. This view is not much considered.

3. Polyphyletic:

It means animals are derived from many ancestors. Most of the zoologists accept polyphyletic view.

➢ PHYLUM PORIFERA

PHYLUM PORIFERA

- ✓ The Porifera or sponges, are primarily marine animals consisting of loosely organized cells.
- ✓ The approximately nine thousand species of sponges vary in size

Characteristics of the phylum Porifera include:

1. Asymmetrical or radially symmetrical

2. Three cell types: **pinacocytes**, **mesenchyme cells**, and **choanocytes**

3. Central cavity, or a series of branching chambers, through which water circulates during filter feeding

4. No tissues or organs

Fig: Phylum Porifera. Many sponges are brightly colored with hues of red, orange, green, or yellow. (a) *Verongia sp*. (b) *Axiomella sp.*

CLASSIFICATION OF THE PORIFERA

Phylum Porifera (po-rif′er-ah)*
The animal phylum whose members are sessile and either asymmetrical or radially symmetrical; body organized around a system of water canals and chambers; cells not organized into tissues or organs. Approximately 9,000 species.

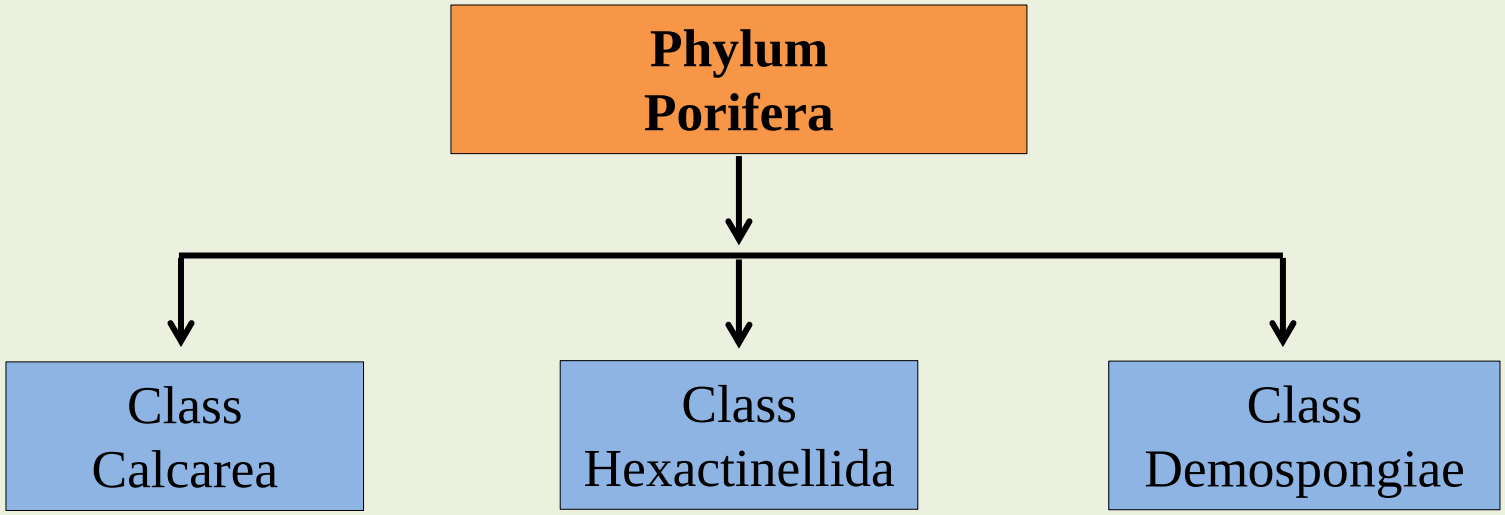
Class Calcarea (kal-kar′e-ah)
Spicules composed of calcium carbonate; spicules are needle shaped or have three or four rays; ascon, leucon, or sycon body forms; all marine. Calcareous sponges. *Grantia (Scypha)*, *Leucosolenia*.

Class Hexactinellida (hex-act″ in-el′id-ah)
Spicules composed of silica and usually six rayed; spicules often fused into an intricate lattice; cup or vase shaped; sycon or leucon body form; found at 450 to 900 m depths in tropical West Indies and eastern Pacific. Glass sponges. *Euplectella* (Venus flower-basket).

Class Demospongiae (de-mo-spun′je-e)
Brilliantly colored sponges with needle-shaped or four-rayed siliceous spicules or spongin or both; leucon body form; up to 1 m in height and diameter. Includes one family of freshwater sponges, Spongillidae, and the bath sponges. *Cliona*, *Spongilla*.

*The class Sclerospongiae has been recently abandoned and its members assigned to Calcarea and Demospongiae.

CLASSIFICATION OF PORIFERA



➢ CELL TYPES, BODY WALL, AND SKELETONS

Sponge cells are specialized for particular functions. This organization is often referred to as division of labor.

Pinacocytes

- ✓ Thin, flat cells line the outer surface of a sponge.
- ✓ Pinacocytes may be mildly contractile, and their contraction may change the shape of some sponges.
- ✓ In a number of sponges, some pinacocytes are specialized into tubelike, contractile **porocytes**, which can regulate water circulation.

Mesohyl

- ✓ Just below the pinacocyte layer of a sponge is a jellylike layer called the mesohyl.

Mesenchyme cells

- ✓ Amoeboid cells
- ✓ Move about in the mesohyl.
- ✓ Specialized for reproduction, secreting skeletal elements, transporting and storing food, and forming contractile rings around openings in the sponge wall.

Choanocytes

- ✓ Fagellated cells that have a collarlike ring of microvilli surrounding a flagellum.
- ✓ Microfilaments connect the microvilli, forming a netlike mesh within the collar.
- ✓ The flagellum creates water currents through the sponge.
- ✓ Collar filters microscopic food particles from the water.

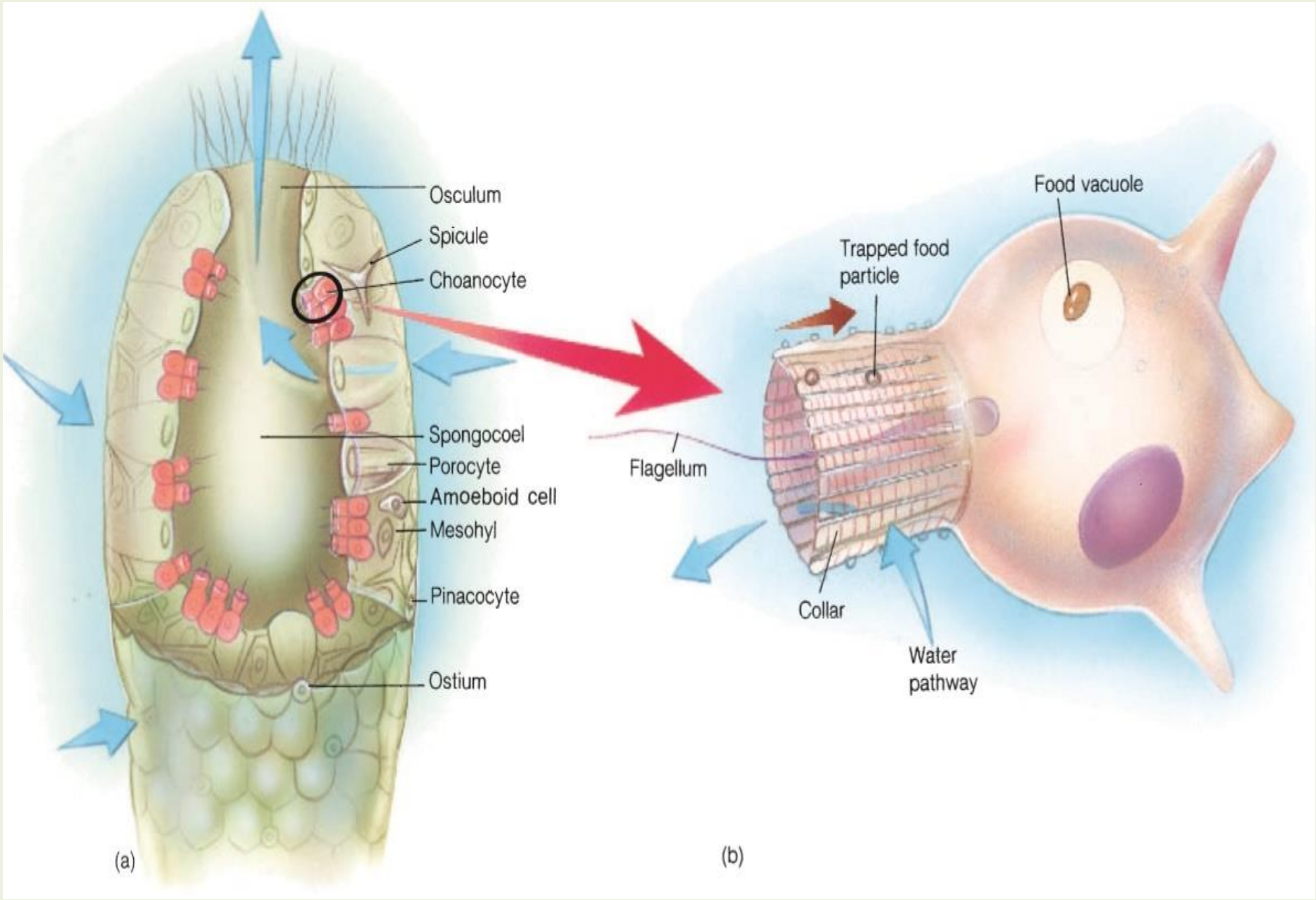


Fig: Morphology of a Simple Sponge.

➢ Skeleton of Sponges

• spicules

- ✓ Sponges are supported by a skeleton that may consist of microscopic needlelike spikes called **spicules**.
- ✓ Spicules are formed by amoeboid cells, are made of **calcium carbonate or silica**, and may take on a variety of shapes.

• spongin

- ✓ the skeleton may be made of spongin (a fibrous protein made of collagen), which is dried, beaten, and washed until all cells are removed to produce a commercial sponge.

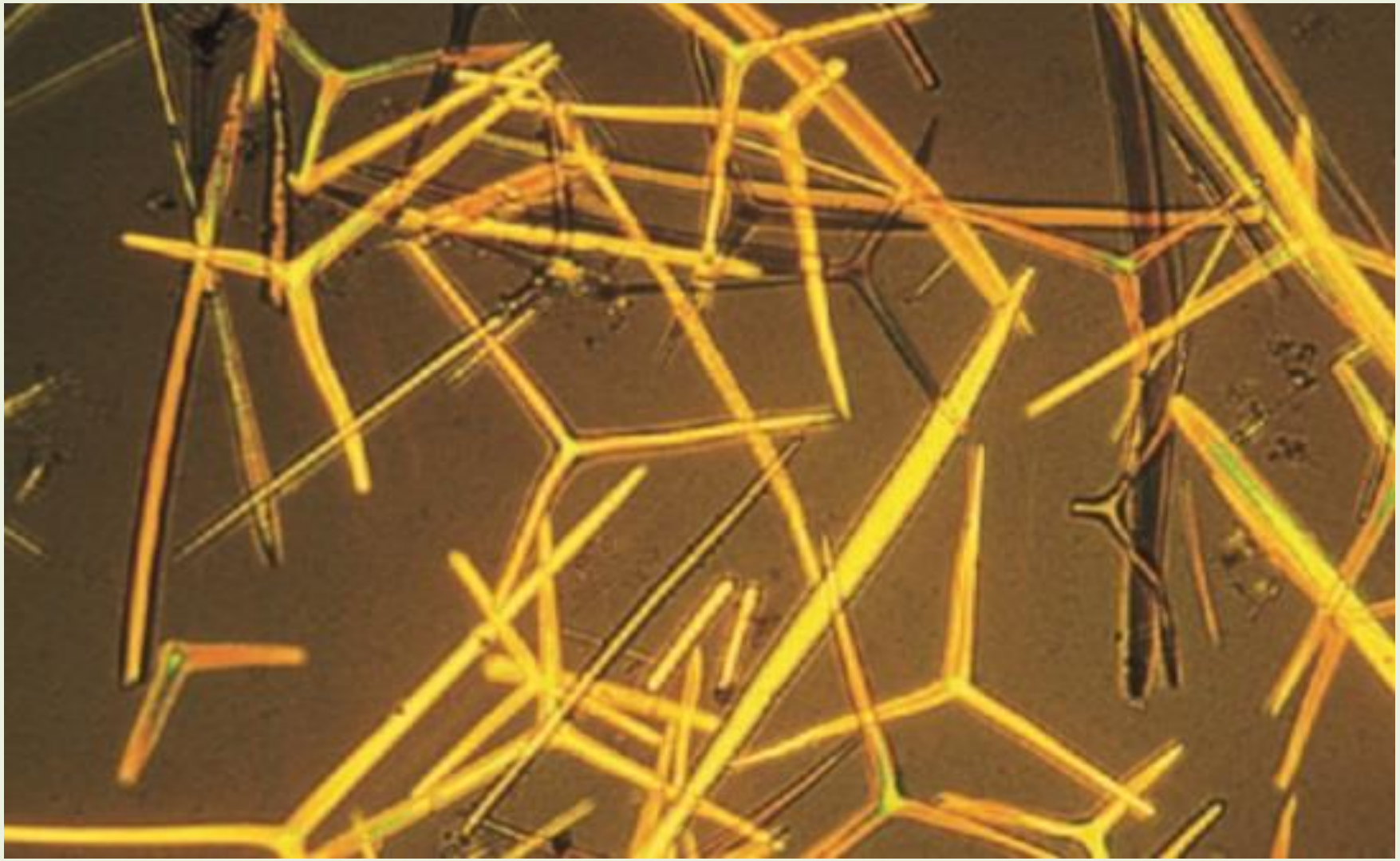


Fig: Sponge Spicules. Photomicrograph of a variety of sponge spicules

➢ WATER CURRENTS AND BODY FORMS

Methods of food filtration and circulation reflect the body forms in the phylum.

Zoologists have described three sponge body forms.

Ascon

- ✓ The simplest and least common sponge body form is the ascon.
- ✓ Ascon sponges are **vaselike**.
- ✓ **Ostia** are the outer openings of porocytes and lead directly to a chamber called the spongocoel.
- ✓ Choanocytes line the spongocoel, and their flagellar movements draw water into the spongocoel through the ostia.
- ✓ Water exits the sponge through the **osculum**.

sycon

- ✓ Sponge wall appears folded.
- ✓ Water enters through **dermal pores.**
- ✓ Dermal pores are the openings of invaginations of the body wall, called **incurrent canals.**
- ✓ Pores in the body wall connect incurrent canals to **radial canals**, and the radial canals lead to the **spongocoel.**
- ✓ Choanocytes line radial canals, and the beating of choanocyte flagella moves water from the **ostia**, through incurrent and radial canals, to the spongocoel, and out the **osculum.**

Leucon

- ✓ Extensively **branched** canal system.
- ✓ Water enters the sponge through **ostia** and moves through branched **incurrent canals**, which lead to **choanocyte-lined chambers**.
- ✓ Canals leading away from the chambers are called **excurrent canals**.
- ✓ Proliferation of chambers and canals has resulted in the absence of a spongocoel, and often, multiple exit points (**oscula**) for water leaving the sponge.

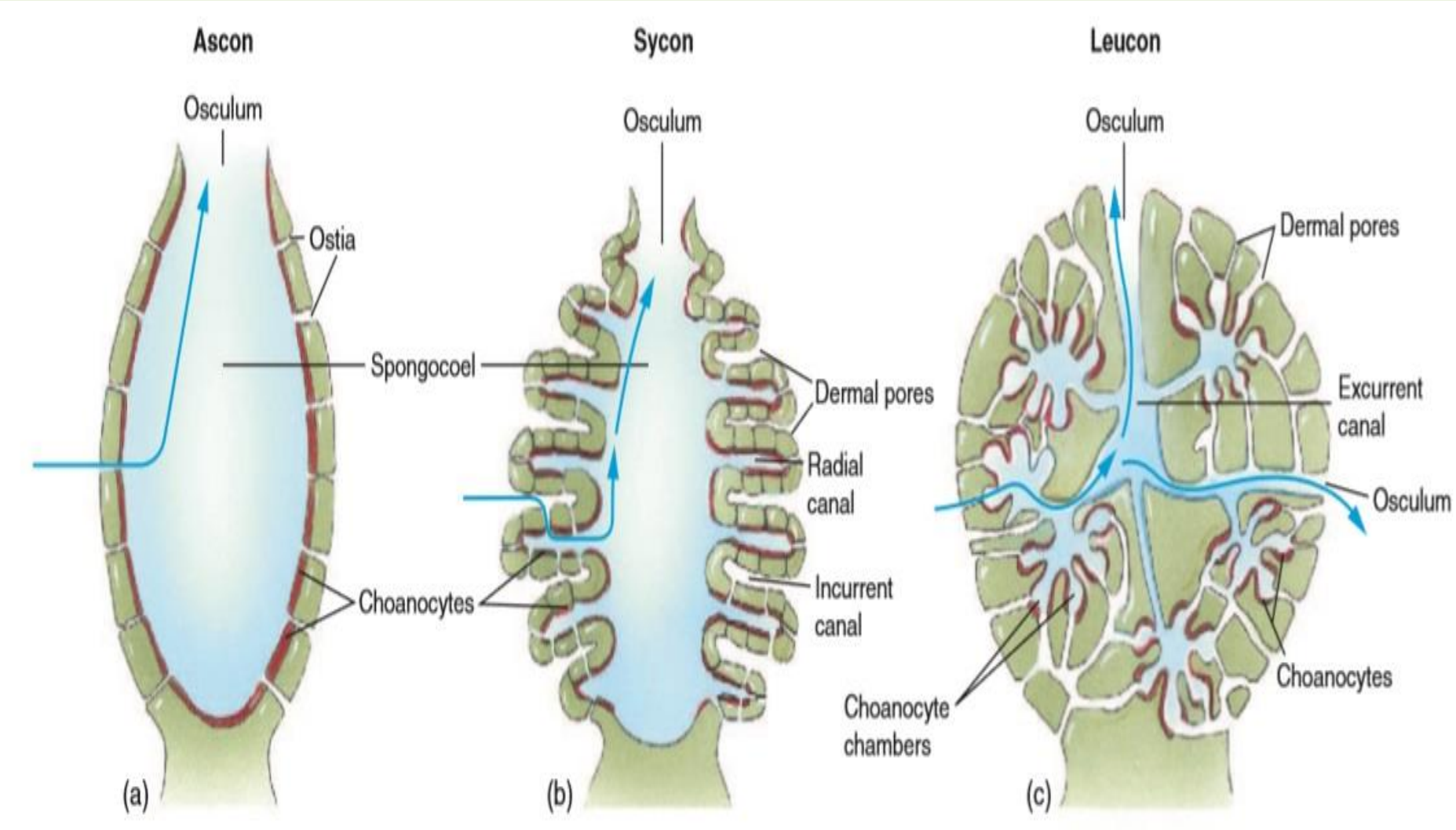


Fig: Sponge Body Forms. (a) An ascon sponge. Choanocytes line the spongocoel in ascon sponges. (b) A sycon sponge. The body wall of sycon sponges appears folded. Choanocytes line radial canals that open into the spongocoel. (c) A leucon sponge. The proliferation of canals and chambers results in the loss of the spongocoel as a distinct chamber. Multiple oscula are frequently present. Blue arrows show the direction of water flow.

➢ MAINTENANCE FUNCTIONS

Nutrition:

- ✓ Sponges feed on particles that range in size from **0.1 to 50 µm.**
- ✓ A few deep-water carnivorous sponges (***Asbestopluma***) can capture small crustaceans using spicule-covered filaments.
- ✓ **Choanocytes** filter small, suspended food particles.
- ✓ Digestion begins in the food vacuole by **lysosomal enzymes** and pH changes.
- ✓ Partially digested food is passed to amoeboid cells, which distribute it to other cells.

- **Filtration is not the only way that sponges feed.**
- ✓ **Pinacocytes lining incurrent canals** may phagocytize larger food particles (up to 50 µm).
- ✓ Sponges also may absorb by active transport nutrients dissolved in seawater.
- ✓ Nitrogenous waste (principally ammonia) removal and gas exchange occur by diffusion.
- ✓ Sponges do not have nerve cells to coordinate body functions

➢ REPRODUCTION

- **Sexual Repoduction**

✓ Most sponges are **monoecious.**

✓ Certain **choanocytes** lose their collars and flagella and undergo meiosis to form flagellated sperm. Other choanocytes probably undergo meiosis to form eggs.

✓ In most sponges, early development occurs in the **mesohyl**.

✓ Cleavage of a zygote results in the formation of a **flagellated larval stage.**

✓ The larva breaks free, and water currents carry the larva out of the parent sponge. The larva settles to the substrate and begins to develop into the adult body form

- **Asexual Repoduction**

- ✓ Asexual reproduction of freshwater and some marine sponges involves the formation of resistant capsules, called **gemmules**, containing masses of amoeboid cells.
- ✓ When the parent sponge dies in the winter, it releases gemmules, which can survive both freezing and drying.
- ✓ When favorable conditions return in the spring, amoeboid cells stream out of a tiny opening, called the **micropyle**, and organize into a sponge.

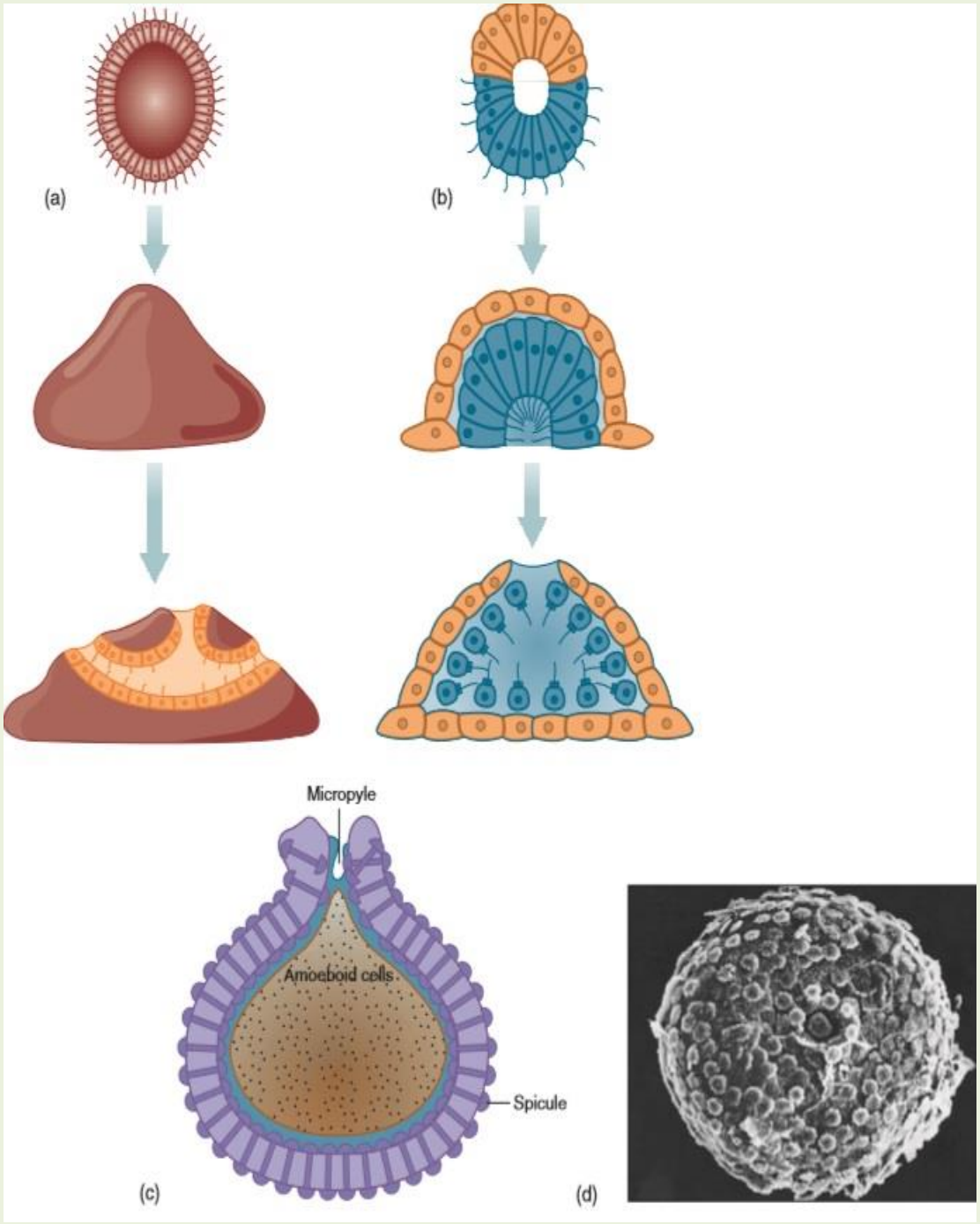


Fig: Development of Sponge Larval Stages.