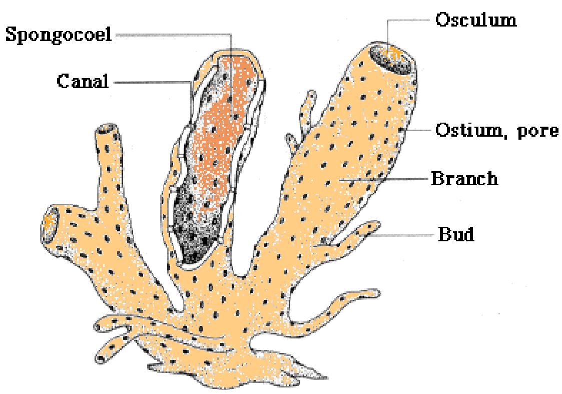
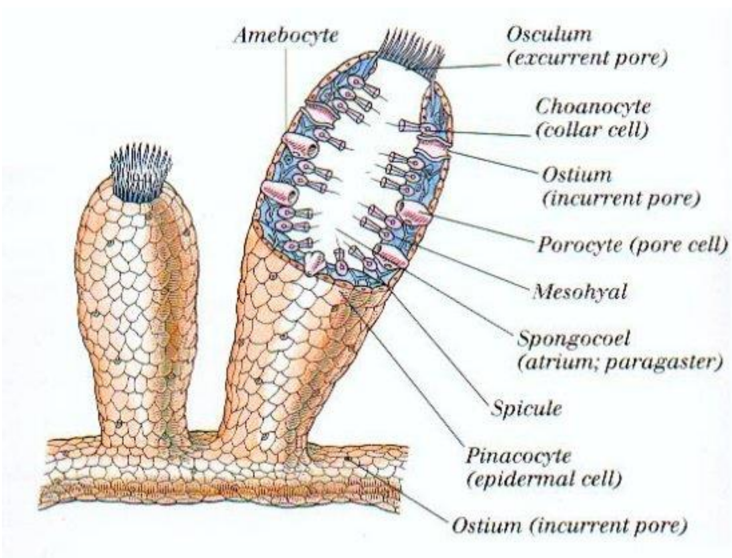
Phylum: PORIFERA

Sponges (The 'Pore-Bearers')





Porifera has been derived from 2 Greek words. Poros – pure and ferre – to bear. This phylum includes about 5000 species. They are the lowest multicellular animals or metazoans without true tissues, i.e., at “Cellular level” of body organization. Poriferans are pore-bearing first multicellular animals. The pores are known as ostia. The poriferans have a spongy appearance and are therefore called sponges. Sponges are simple invertebrate animals that live in aquatic habitats. Although the majority of sponges are marine, some species live in freshwater lakes and streams. They are found in shallow ocean environments to depths as great as five kilometers (km). All adult sponges are sessile, meaning they live permanently attached to rocks or other submerged objects and do not move about on their own. Some sponges grow in thin encrusting layers over surfaces. A few species can even bore into hard surfaces like clam shells, coral skeletons, and rock. Many sponge species grow upright in branching tree-like or tubular vase-like forms. While some sponges, like the giant barrel sponges of the Caribbean, reach several meters in diameter, most sponges are small organisms that often go unnoticed on the reef or seafloor. They have the ability to absorb and withhold fluids.

Important characteristics:

Their body possesses numerous, minute pores called ostia.
They are aquatic, mostly marine and few are fresh water.
They are sedentary and sessile except the free swimming, larval form.
They are multicellular animals having cellular grade of body organization.
They have cell aggregated body plan.
They are diploblastic having two body layers – outer ectoderm (also called as pinnacoderm) and inner endoderm (also called as conoderm).
They are usually asymmetrical but few are radially symmetrical (sycon).
They are acoelomates.
They have well developed canal systems where water enters through ostia into the body, circulates inside the body and goes out through osculum.
Water canal system helps in respiration, nutrition, excretion etc.
Their body is supported by skeleton called spicules which are made up of Calcium carbonate, Silica or Spongyn fibre.
Nutririon is holozoic.
Digestion is intacellular.
Excretion and respiration takes place by general body surface.

Classification

The phylum Porifera has four classes, namely the Calcarea, Demospongiae, Hexactinellida and Homoscleromorpha.

Class Calcarea

Exclusively marine, calcareous sponges predominantly inhabit shallow tropical waters. They are often small and delicate, with thin coalescent tubes or a vase-like form. The majority are white or cream, but may also be pink, red or yellow. Calcium carbonate spicules are present, with limited variation in spicule morphology.

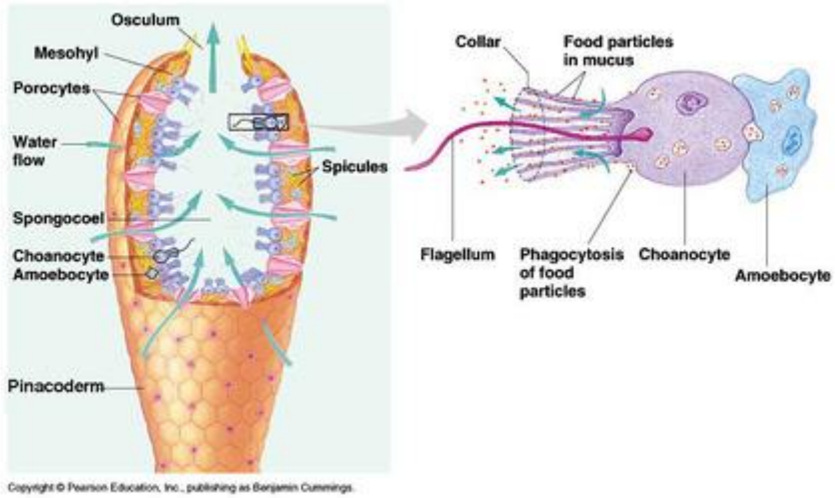
Class Demospongiae
Comprises the largest and most diverse group, inhabiting both marine and freshwater environments. Huge variety in both form and colour. Siliceous spicules present and/or skeleton of spongin fibres or fibrillar collagen.

Class Hexactinellida
Also known as glass sponges; exclusively marine and largely restricted to both hard and soft substrates in deeper environments (beyond 400 m). Dull colouration and variable body form, but never encrusting. Some species have large, conspicuous, hair-like spicules visible to the naked eye. Siliceous six-rayed spicules present, with highly diverse spicule morphologies. Often long lived and fragile, they are particularly susceptible to disturbance.

Class Homoscleromorpha
Small group of marine sponges inhabiting predominantly shallow environments, often found in dark or semi-dark ecosystems (e.g. caves). Encrusting or lobate with a smooth surface, often small and delicate. Small siliceous spicules present, but lacking a well-organised skeleton.

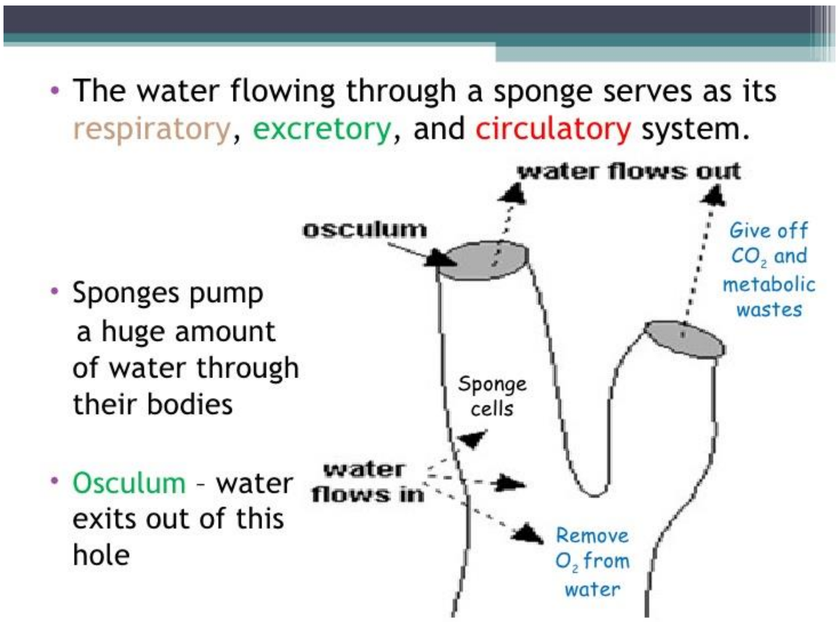
Movement
Although adult sponges are fundamentally sessile animals, some marine and freshwater species can move across the sea bed at speeds of 1–4 mm (0.039–0.157 in) per day, as a result of amoeba-like movements of pinacocytes and other cells. A few species can contract their whole

bodies, and many can close their oscula and ostia. Juveniles drift or swim freely, while adults are stationary.

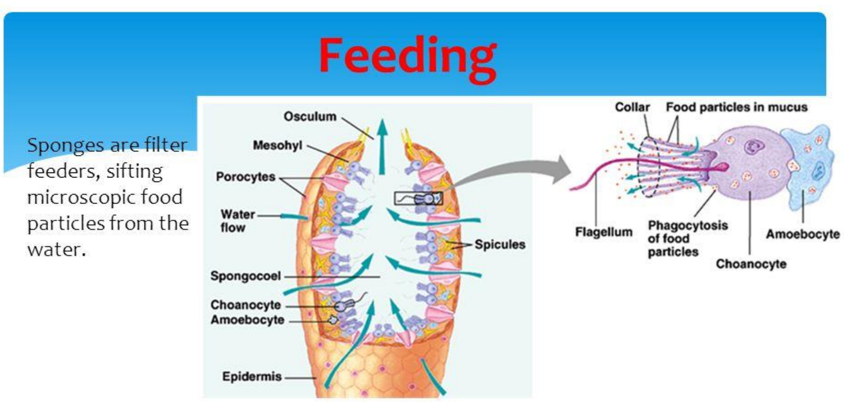


Respiration, feeding and excretion

All cells in a sponge are in contact with or near to seawater. Because each cell exchanges oxygen and carbon dioxide and discharges waste products into the seawater. Sponges do not have distinct circulatory, respiratory, digestive, and excretory systems – instead the water flow system supports all these functions. They filter food particles out of the water flowing through them. Particles larger than 50 micrometers cannot enter the ostia and pinacocytes consume them by phagocytosis (engulfing and internal digestion). Particles from 0.5 µm to 50 µm are trapped in the ostia, which taper from the outer to inner ends. These particles are consumed by pinacocytes or by archaeocytes which partially extrude themselves through the walls of the ostia. Bacteria-sized particles, below 0.5 micrometers, pass through the ostia and are caught and consumed by choanocytes. Since the smallest particles are by far the most common, choanocytes typically capture 80% of a sponge's food supply. Archaeocytes transport food packaged in vesicles from cells that directly digest food to those that do not. At least one species of sponge has internal fibers that function as tracks for use by nutrient-carrying archaeocytes, and these tracks also move inert objects.



A few species that live in waters where the supply of food particles is very poor prey on crustaceans and other small animals. So far only 137 species have been discovered. Most belong to the family Cladorhizidae, but a few members of the Guitarridae and Esperiopsidae are also carnivores. In most cases little is known about how they actually capture prey, although some species are thought to use either sticky threads or hooked spicules. Most carnivorous sponges live in deep waters, up to 8,840 m (5.49 mi). Most known carnivorous sponges have completely lost the water flow system and choanocytes. However, the genus Chondrocladia uses a highly modified water flow system to inflate balloon-like structures that are used for capturing prey.



<u>Fundamental question: How do choanocytes help sponges feed?</u>

Choanocytes are specialized cells that use their flagella to move a steady current of water (and food!) through the sponge.

Endosymbionts

Freshwater sponges often host green algae as endosymbionts within archaeocytes and other cells, and benefit from nutrients produced by the algae. Many marine species host other photosynthesizing organisms, most commonly cyanobacteria but in some cases dinoflagellates. Symbiotic cyanobacteria may form a third of the total mass of living tissue in some sponges, and some sponges gain 48% to 80% of their energy supply from these micro-organisms. Sponges that host photosynthesizing organisms are most common in waters with relatively poor supplies of food particles, and often have leafy shapes that maximize the amount of sunlight they collect. A recently discovered carnivorous sponge that lives near hydrothermal vents hosts methane-eating bacteria, and digests some of them.

Reproduction

All cells in a sponge are in contact with or near to seawater. Because each cell exchanges oxygen and carbon dioxide and discharges waste products into the seawater, a sponge has no respiratory, circulatory, or excretory system. Sponges can reproduce either asexually or sexually. Asexual reproduction (without eggs and sperm) often occurs by budding, similar to growing a new branch on a tree. Cells on the side or base of the parent begin to bulge out and form a new organism. The buds may remain attached to the parent, or they may detach and settle down nearby to form a separate organism. Sponges also reproduce sexually when specialized gametocyte cells produce sperm and eggs. Sponges undergo synchronous spawning and eject sperm and egg cells into the water. If gametes (sex cells; either sperm or egg) from the same species meet, they form a larval sponge. After a period of planktonic drifting, the larva settles to a suitable location on the bottom and grows into an adult sponge. The drifting larval stage means that sponges can colonize new locations, even though as adults they remain attached in a sessile lifestyle.

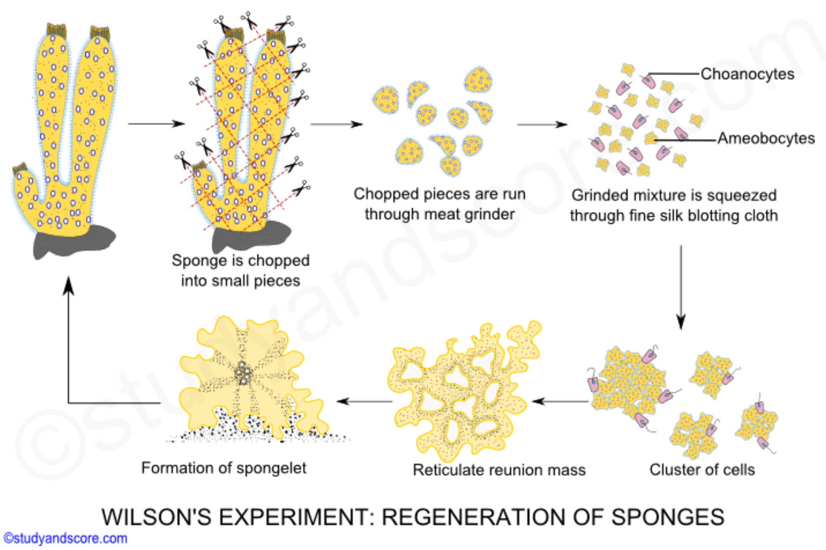
Freshwater sponges can live in areas that are subject to cyclical wet and dry periods. They have a special strategy to help them deal with these harsh conditions.

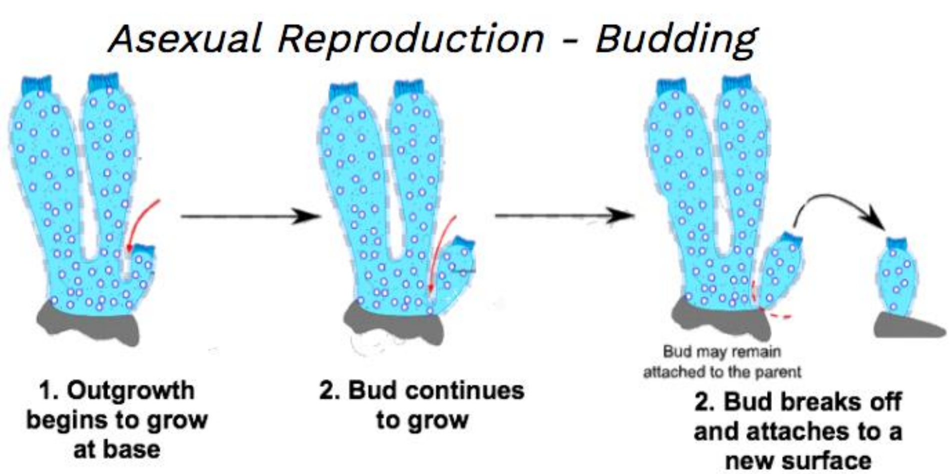
Freshwater sponges can produce a "resting" stage called a gemmule. A gemmule is a small, encysted bud that can tolerate being dried out for a long period of time. When the gemmule is exposed to water, it can resume development as a sponge. Organisms that can undergo a phase where they are dormant to survive harsh conditions are said to be in cryptobiosis (from the root words crypto meaning hidden and bio meaning life), because they do not appear to be living. In reality, these organisms are in a state of suspended animation.

Asexual

Sponges have three asexual methods of reproduction: fragmentation; by budding; and by producing gemmules. Fragments of sponges may be detached by currents or waves. They use the mobility of their pinacocytes and choanocytes and reshaping of the mesohyl to re-attach themselves to a suitable surface and then rebuild themselves as small but functional sponges over the course of several days. The same capabilities enable sponges that have been squeezed through a fine cloth to regenerate. A sponge fragment can only regenerate if it contains both collencytes to produce mesohyl and archeocytes to produce all the other cell types. A very few species reproduce by budding.

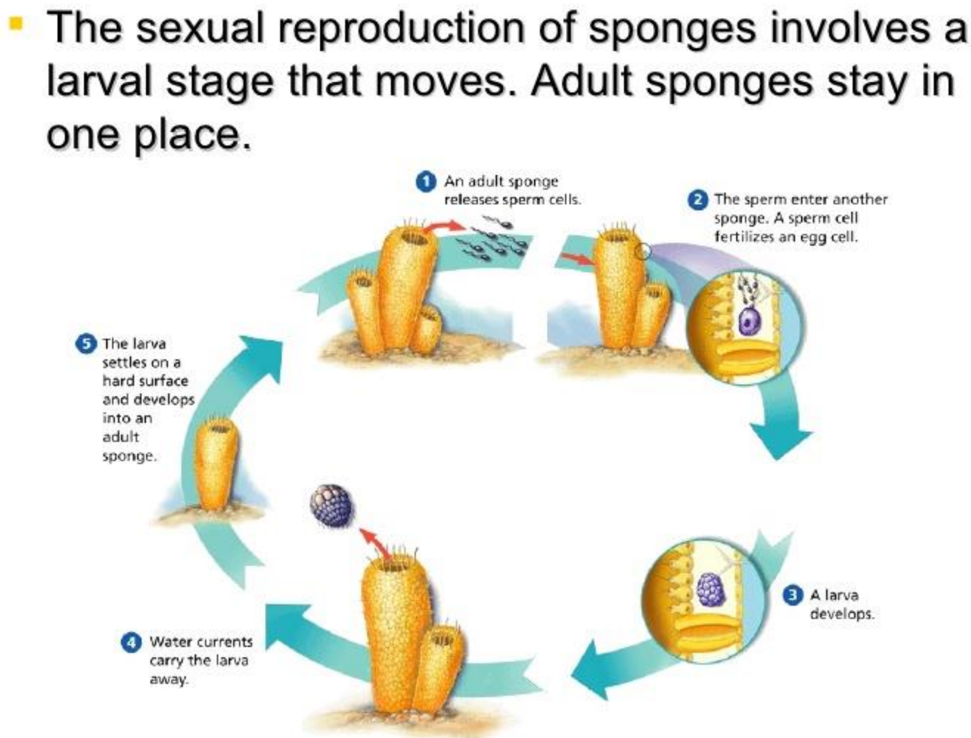
Gemmules are "survival pods" which a few marine sponges and many freshwater species produce by the thousands when dying and which some, mainly freshwater species, regularly produce in autumn. Spongocytes make gemmules by wrapping shells of spongin, often reinforced with spicules, round clusters of archeocytes that are full of nutrients. Freshwater gemmules may also include phytosynthesizing symbionts. The gemmules then become dormant, and in this state can survive cold, drying out, lack of oxygen and extreme variations in salinity. Freshwater gemmules often do not revive until the temperature drops, stays cold for a few months and then reaches a near-"normal" level. When a gemmule germinates, the archeocytes round the outside of the cluster transform into pinacocytes, a membrane over a pore in the shell bursts, the cluster of cells slowly emerges, and most of the remaining archeocytes transform into other cell types needed to make a functioning sponge. Gemmules from the same species but different individuals can join forces to form one sponge. Some gemmules are retained within the parent sponge, and in spring it can be difficult to tell whether an old sponge has revived or been "recolonized" by its own gemmules.

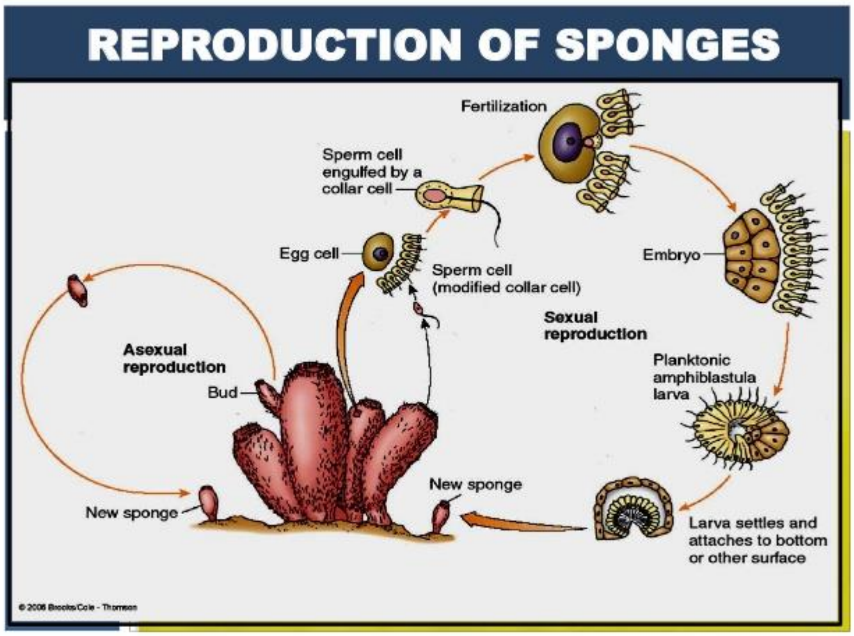




Sexual

Most sponges are hermaphrodites (function as both sexes simultaneously), although sponges have no gonads (reproductive organs). Sperm are produced by choanocytes or entire choanocyte chambers that sink into the mesohyl and form spermatic cysts while eggs are formed by transformation of archeocytes, or of choanocytes in some species. Each egg generally acquires a yolk by consuming "nurse cells". During spawning, sperm burst out of their cysts and are expelled via the osculum. If they contact another sponge of the same species, the water flow carries them to choanocytes that engulf them but, instead of digesting them, metamorphose to an ameboid form and carry the sperm through the mesohyl to eggs, which in most cases engulf the carrier and its cargo. A few species release fertilized eggs into the water, but most retain the eggs until they hatch. There are four types of larvae, but all are balls of cells with an outer layer of cells whose flagellae or cilia enable the larvae to move. After swimming for a few days the larvae sink and crawl until they find a place to settle. Most of the cells transform into archeocytes and then into the types appropriate for their locations in a miniature adult sponge.





Life cycle

Sponges in temperate regions live for at most a few years, but some tropical species and perhaps some deep-ocean ones may live for 200 years or more. Some calcified demosponges grow by only 0.2 mm (0.0079 in) per year and, if that rate is constant, specimens 1 m (3.3 ft) wide must be about 5,000 years old. Some sponges start sexual reproduction when only a few weeks old, while others wait until they are several years old.