

## Porifera

Slide 1 (of 36)

sponges; sessile, filter-feeders

- ~5000 spp., ~150 in freshwater
- cellular level organization (no real tissues)
  - sort of multi-cellular colonies-blend one and cells will reform into a sponge



---

---

---

---

---

---

---

---

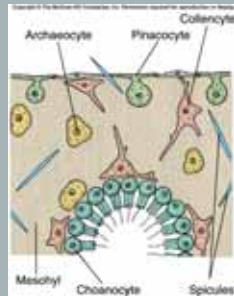
## Sponge cell types:

Slide 2 (of 36)

Cells loosely arranged in matrix called mesohyl

Mesohyl = collagen matrix

- the middle non-cellular layer between inner and outer layers



---

---

---

---

---

---

---

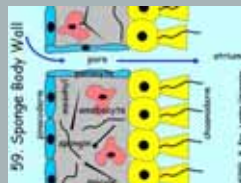
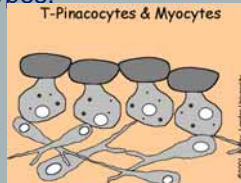
---

## Sponge cell types:

Slide 3 (of 36)

Pinacocytes – form pinacoderm-most tissue-like

- Thin, flat, cover exterior and some interior surface
- some T-shaped, extending into mesohyl
- somewhat contractile, adjust surface area
- Myocytes -- contractile pinocytes usu. around oscula or pores
  - high concentrations of microfilaments and microtubules
  - similar to muscle cells in other animals
  - fusiform with filopods



---

---

---

---

---

---

---

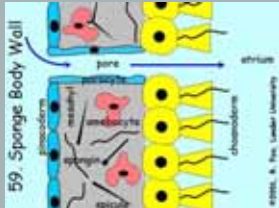
---

### Sponge cell types:

Slide 3 (of 36)

**Porocytes: tubular cells that make up the pores**

- originate as a squamous pinacocyte that rolls into a tube
- perforation or infolding of cell.
- cross the mesohyl from exterior to atrium




---

---

---

---

---

---

---

---

---

---

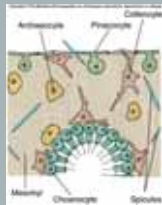
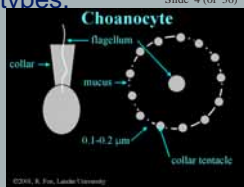
### Sponge cell types:

Slide 4 (of 36)

**Choanocyte – collar cell. all identical**

**very similar to protists-choanoflagellates**

- inner layer of body wall lining spongocoel
- collar faces inside of sponge and moves water using one
- flagellum surrounded by this collar of microvilli
- collar is a ring of 20-30 microvilli known as collar tentacles
- each has a core of microfilaments
- tentacles about 0.1-0.2 mm apart
- adjacent tentacles connected by glycoprotein mucus




---

---

---

---

---

---

---

---

---

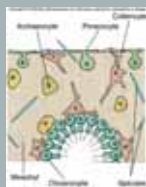
---

### Sponge cell types:

Slide 5 (of 36)

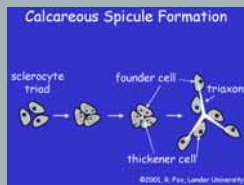
**Archeocytes**

- Amoeboid - mobile
- Phagocytic - a sort of immune system
- Totipotent – forms all other types of cells
- Lophocytes (mobile) and collencytes (attached)
  - attached by cytoplasmic threads
  - produce collagen



**Sclerocyte**

- produces spongin or spicules
- cells may cluster together and secrete spicules center then divide & radiate out to form ray




---

---

---

---

---

---

---

---

---

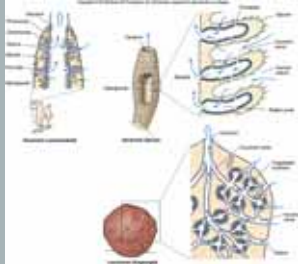
---

**Pores:**

### Sponge structure

Slide 6 (of 36)

- Ostia (small pores) allow flow into spongocoel
  - incurrent canals
- osculum or oscula – large opening(s)
  - excurrent canals
- interior space is the spongocoel or atrium



---

---

---

---

---

---

---

---

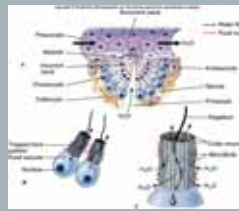
### Sponge feeding

Slide 7 (of 36)

Indiscriminate filtering at dermal pore-prosopyle, by protoplasmic strands in incurrent canals or microvilli of choanocytes.

**Phagocytosis**

- Some cells do not phagocytose, others, especially mobile archaeocytes
- mineral particles are carried to excurrent canals and exocytosed
- organic particles are shared with other cells
- 1x10cm sponge can filter 22 liters (5 gal) of water each day



---

---

---

---

---

---

---

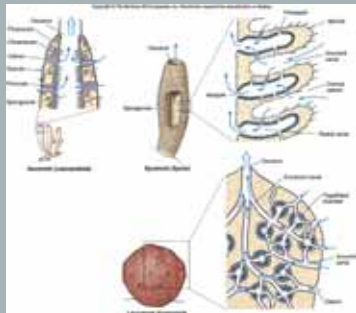
---

### Sponge structure

Slide 8 (of 36)

three types of canal systems:  
**Asconoid, Syconoid, and Leuconoid**

- also differences in body shapes
- Asconoid and syconoid are vase-like, radially symmetrical



---

---

---

---

---

---

---

---

### Sponge structure Asconoid

flagellated spongocoel  
a simple tube  
perforated by pores

- open internal part of the tube : spongocoel (or atrium)
  - lined by choanoderm
  - single osculum.
  - porocytes connect the atrium with the environment
  - only a few small sponges
  - size limited – S/V ratio
  - atrium is limited to about 1 mm diameter by the water-moving power of the choanoderm




---

---

---

---

---

---

---

---

---

---

### Sponge structure Syconoid

Slide 10 (of 36)

tubular body with a single osculum

To overcome size limitation:

- Folding: increase choanoderm surface area & decrease atrium-
  - water mvmt. more efficient
  - creates incurrent and radial canals
  - Spongocoel - pinocytes,
  - prosopyles, apopyles, incurrent canals –pino- or porocytes
  - radial canals – choanocytes
  - atrium up to about 1 cm




---

---

---

---

---

---

---

---

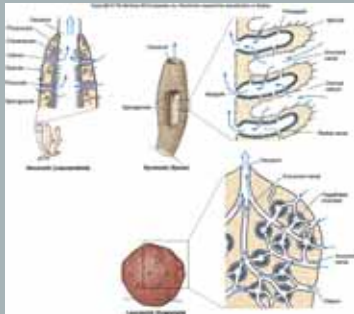
---

---

### Syconoid water flow

Slide 11 (of 36)

- outside → ostium → incurrent canal → prosopyle → choanocyte chamber → apopyle → atrium → osculum




---

---

---

---

---

---

---

---

---

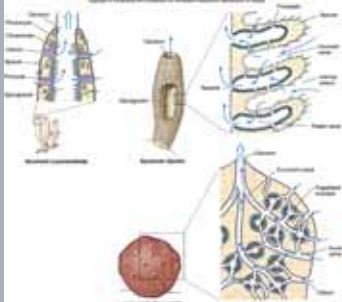
---

## Leuconid

Slide 12 (of 36)

leuconoid: shaped kind of like a rock/lump, unsymmetrical

- the largest and most complex sponges.
- mesohyl proliferates, flagellated chambers proliferate
- Canals lead to numerous small chambers lined with flagellated cells.



---

---

---

---

---

---

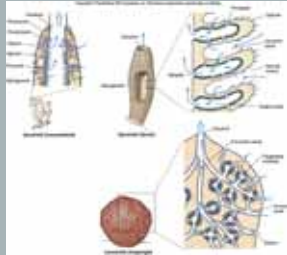
---

---

## Leuconoid water flow

Slide 13 (of 36)

Water moves through the canals, into these chambers, and out via a central canal and osculum. incurrent canals diminish in diameter, excurrent canals increase  
ostium → incurrent canal → choanocyte chamber → excurrent canal → osculum



---

---

---

---

---

---

---

---

## Evidence for basal status

Slide 14 (of 36)

earliest multicellular life was sponge like, perhaps.  
earliest known multicelled animal fossils are sponges from China that roughly 600myo

relatedness to choanoflagellates

- sRNA evidence
- cell similarities
  - all metazoans, sponges, and choanoflagellates have 2 basal bodies at right angles
  - monocoliated cells are widespread among metazoans



Proterosporgia (protist)



---

---

---

---

---

---

---

---

## Sexual Reproduction

Slide 15 (of 36)

gonochoristic or hermaphrodite, mostly hermaphrodite  
no organized gonads  
cross fertilization assumed to be the rule  
fertilization is internal in the mesohyl.  
most sponges are viviparous and release larvae

---

---

---

---

---

---

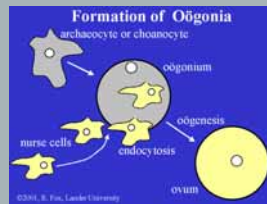
---

---

## Oögenesis

Slide 16 (of 36)

archaeocytes (usually) or choanocyte become oögonia  
nurse cells (archaeocytes) with food reserves stream to the oögonium and are phagocytized  
food reserves are incorporated in the oögonium  
a follicle forms around the oögonium  
oögonium begins meiosis (completed after fertilization)



---

---

---

---

---

---

---

---

## spermatogenesis

Slide 17 (of 36)

occurs in spermatic cysts surrounded by follicle cells  
sperm develop from choanocytes  
mature spermatozoa are released into the exhalant canal and ejected from the osculum



---

---

---

---

---

---

---

---

## Fertilization

Slide 18 (of 36)

sperm enter the inhalent canal

- phagocytized by a choanocyte
- loses collar and flagellum to become an amoeboid carrier cell
- carrier cell travels to an oöcyte and delivers the sperm
- oviparous - zygote is released into the exhalent current (unusual)
- viviparous zygote is brooded to become a larva and then released

---

---

---

---

---

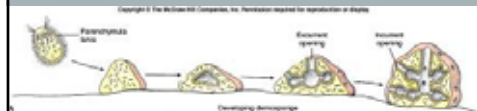
---

---

---

## Development

Holoblastic (no nutrients; all cells part of division)  
a larva (blastula) forms  
larva of most sponges is an stereoblastula (solid mass of cells) known as a parenchymella  
(some are hollow amphiblastulas)  
Covered in flagella



---

---

---

---

---

---

---

---

## Development

Slide 20 (of 36)

inside are the ancestors of all unflagellated cells  
parenchymella leaves the parent via the exhalent flow  
settles and undergoes gastrulation  
external flagellated cells ingress to the interior and become choanocytes  
the unflagellated cells become all other cells  
Morphogenesis in leuconoid larvae (from asconoid through syconoid to leuconoid forms)

---

---

---

---

---

---

---

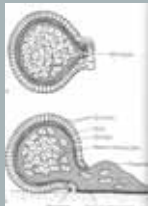
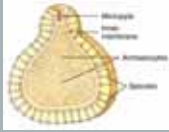
---

## Asexual reproduction

### 1) budding

### 2) Gemmules (Spongillidae)

- spongocytes accumulate around archaeocytes and produce a spongin capsule
- nurse cells migrate to the aggregation and are phagocytized by archaeocytes
- sclerocytes secrete spicules in the capsule
- the sponge degenerates leaving the gemmules to overwinter
- under favorable conditions the archeocytes (thesocytes) become metabolically active and hydrolyze reserves



---

---

---

---

---

---

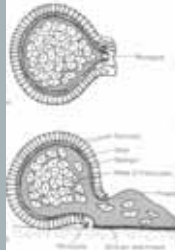
---

---

## Gemmule reaggregation

Slide 22 (of 36)

- hydrolysis produces an opening in the capsule (micropyle)
- a pioneer cohort of archeocytes exits the gemmule
- and become pinacocytes and collencytes which establish the framework and covering of a new sponge
- a second wave of archeocytes exits and differentiates into choanocytes
- a third wave of colonists migrate to the new sponge and remain totipotent archeocytes



Larvae of different species may fuse when settling

---

---

---

---

---

---

---

---

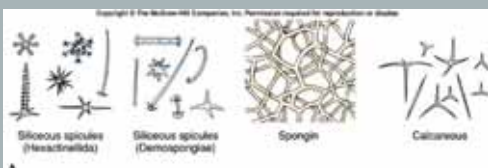
## Sponge 'skeleton'

Slide 23 (of 36)

collagen

spicules

- calcareous or siliceous, depending on the group of sponges



---

---

---

---

---

---

---

---

## Spicule form is a basis for taxonomy Slide 24 (of 36)

### Shape

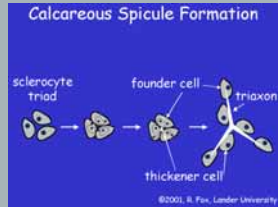
**Monaxon** Single rod or ray  
with ends – pointed,  
knobbed, hooked

**Triaxons** – 3 rays

**Tetraxons** – 4 rays

**Hexaxons** – 6 rays

**Polyaxons** – many rays  
(burr, ray, or star-shaped)




---

---

---

---

---

---

---

---

---

---

## Spicule form is a basis for taxonomy -- Size and arrangement Slide 25 (of 36)

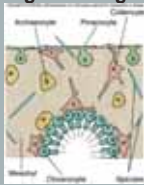
**Megascleres**-spicules that  
provide chief support

**Microscleres**

Throughout mesohyl & poking  
through pinacoderm

Interlocking and/or fused

Variably arranged throughout  
body




---

---

---

---

---

---

---

---

---

---

## Sponge Classes Slide 27 (of 36)

divided into classes on the type of spicules

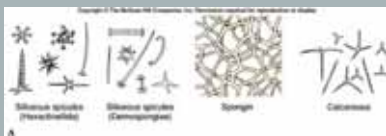
- bony (Calcarea) most primitive
  - asconoid, synconoid based and leuconoid members.
  - mon-, tr-, tetra

glass (Hexactenellida) leuconoid

spongin (Demospongiae) leuconoid 90% of modern  
sponges

- network of collagen fibers

mixture (the Sclerospongiae)




---

---

---

---

---

---

---

---

---

---

## Class Calcarea

Slide 28 (of 36)

Spicules - Mon-, tri-, or tetraxon shapes  
Calcium carbonate, No spongin

Structure and habitat

- Small (<10 cm)
- Occupy shallow water
- Cosmopolitan
- All 3 body types



---

---

---

---

---

---

---

---

## Hexactenellida

Slide 29 (of 36)

glass sponges, syconoid forms  
body composed of syncytial tissue (trabecular reticulum)

- instead of pinacoderm,
- largest, continual syncytial tissue in the metazoa
- bilayered
- surrounds thin collagenous mesohyl
  - typical sponge cells plus choanoblasts
  - very much like an organ
    - flagellated chamber that acts as a pump
    - particles trapped between layers of reticulum
    - reticulum takes up via phagocytosis

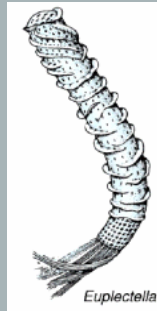
Individualized cup, urns or vase shape

Lattice – siliceous w/ sieve plate over osculum

Spicules – hexaxons

Basal spicules w/ tufts for soft sediment

Deep water (200 meters-abyss) / Cosmopolitan w/ more in Antarctic



---

---

---

---

---

---

---

---

## Class Demospongiae – most common form, leuconoid forms

Slide 31 (of 36)

Spicules - Tri- or tetraxon

Along with spongin

Structure and habitat

Brightly colored (amebocytes w/ pigment)

Shape reflects habitat & resources available

- Encrusting on vertical surfaces or in crevices
- Tubular (w/ branching) on limited substrates (conserves space)
- Shallow to deep water

Algal symbionts- non-motile zooxanthella or cyanobacters in mesohyl or amebocytes



---

---

---

---

---

---

---


---

Slide 32 (of 36)

### Class Demospongiae – examples


**Boring sponges (Cliona)**

- Perforates shells or corals
- Amebocytes excavate chips of material
- Sponge fills tunnels (yellow or red on surface)
- Breaks down shells and corals (pock-marked shells along Atlantic coast)
- Important in calcium cycling




**Spongiidae –**

- bath sponges, no spicules only spongin
- Spongiillidae – freshwater forms



**Encrusting green forms (Zoochlorella in amebocytes)**




---

---

---

---

---

---

---

---


---

---

Slide 33 (of 36)

### Class Sclerospongiae – Leuconoid forms

**Small group**  
**found in grottos or coral tunnels**  
**Internal siliceous spicules & spongin**  
**External calcareous portion**




---

---

---

---

---

---

---

---

---

---

Slide 34 (of 36)

### Other interesting facts

**Many species contain toxic substances**

- predation and competition

**Certain other marine animals take advantage of this characteristic of sponges by placing adult sponges on their bodies**

**Some chemicals have pharmaceutical effects**

- respiratory, cardiovascular, gastrointestinal, anti-inflammatory, antitumor, and antibiotic activities.

**Euplectella (Hex.)- newly discovered uses involving fiber optics**

**some shown to move a few cm per day**

---

---

---

---

---

---

---

---

---

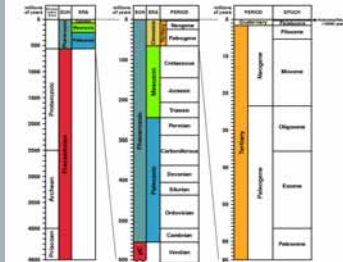
---

## Sponge history and evolution Slide 35 (of 36)

The fossil record of sponges dates back to the Precambrian era. (?)

Greatest development

- Devonian period (500-400 mya)
- Cretaceous period (135-65 mya)




---



---



---



---



---



---



---



---

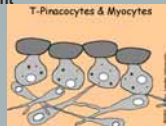
## Cellular signaling Slide 36 (of 36)

no nervous system but messenger chemicals are present in mesohyl

- amoebocytes carry these messages around
- electrical discharge between adjacent cells

**Myocytes**

- concentrated around oscula and major water canals
- filopods touch other myocytes and pinacocytes
- apparently function as neurons as well as muscles
- sponges are capable of coordinated myocyte responses
  - no action potentials or synapses known but acetylcholine and cholinesterase are present




---



---



---



---



---



---



---



---