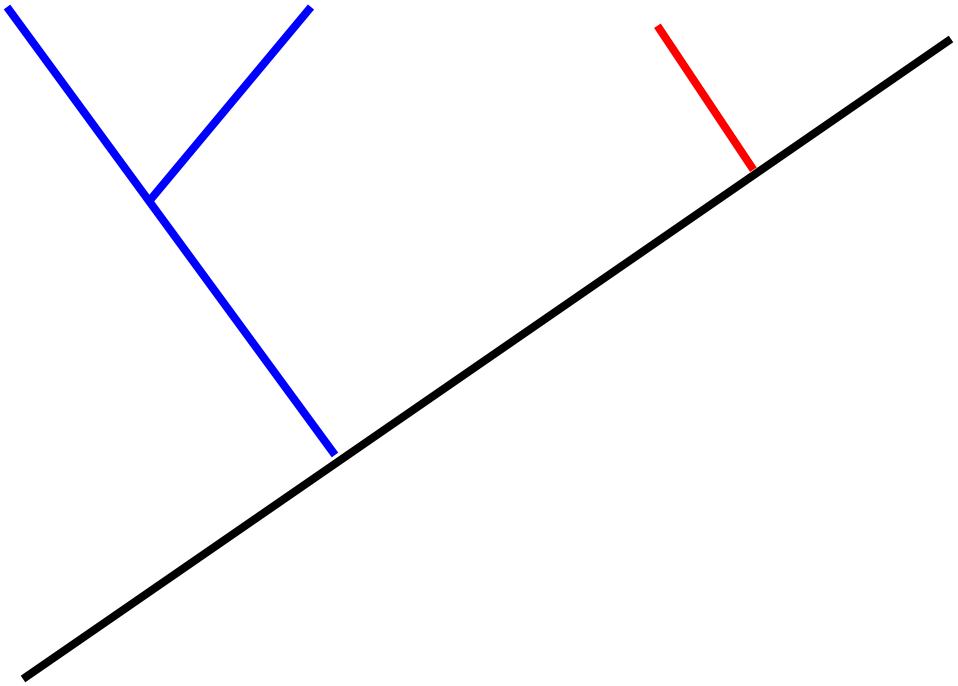
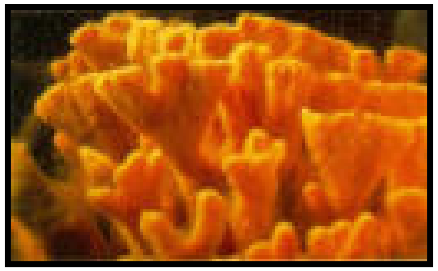
The three grades of metazoan animals

KINGDOM: **Animalia**

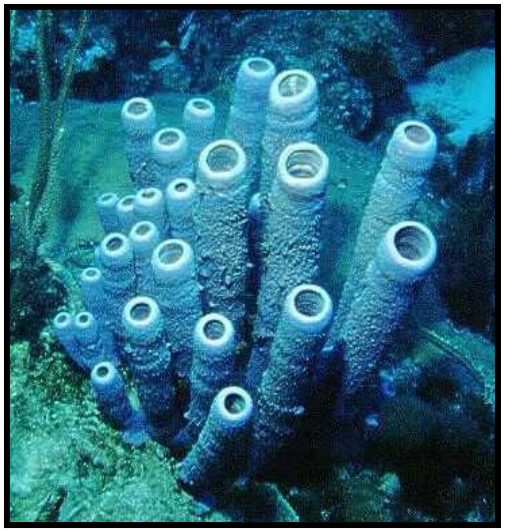
GRADE: Parazoa | Mesozoa | Eumetazoa

PHYLA: Placozoa, Porifera | Mesozoa | All other animal phyla





Phylum Porifera



the sponges

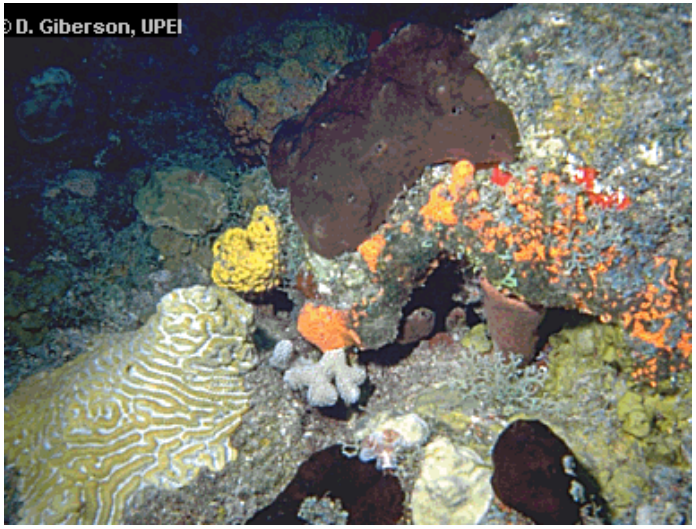
Phylum Porifera

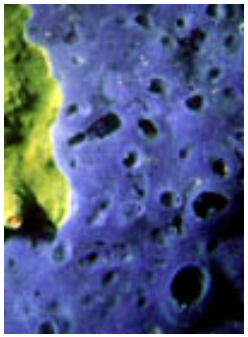
Branch Parazoa – “beside + animal”

Sponges are at the cellular level of organization and have no tissues or organs.

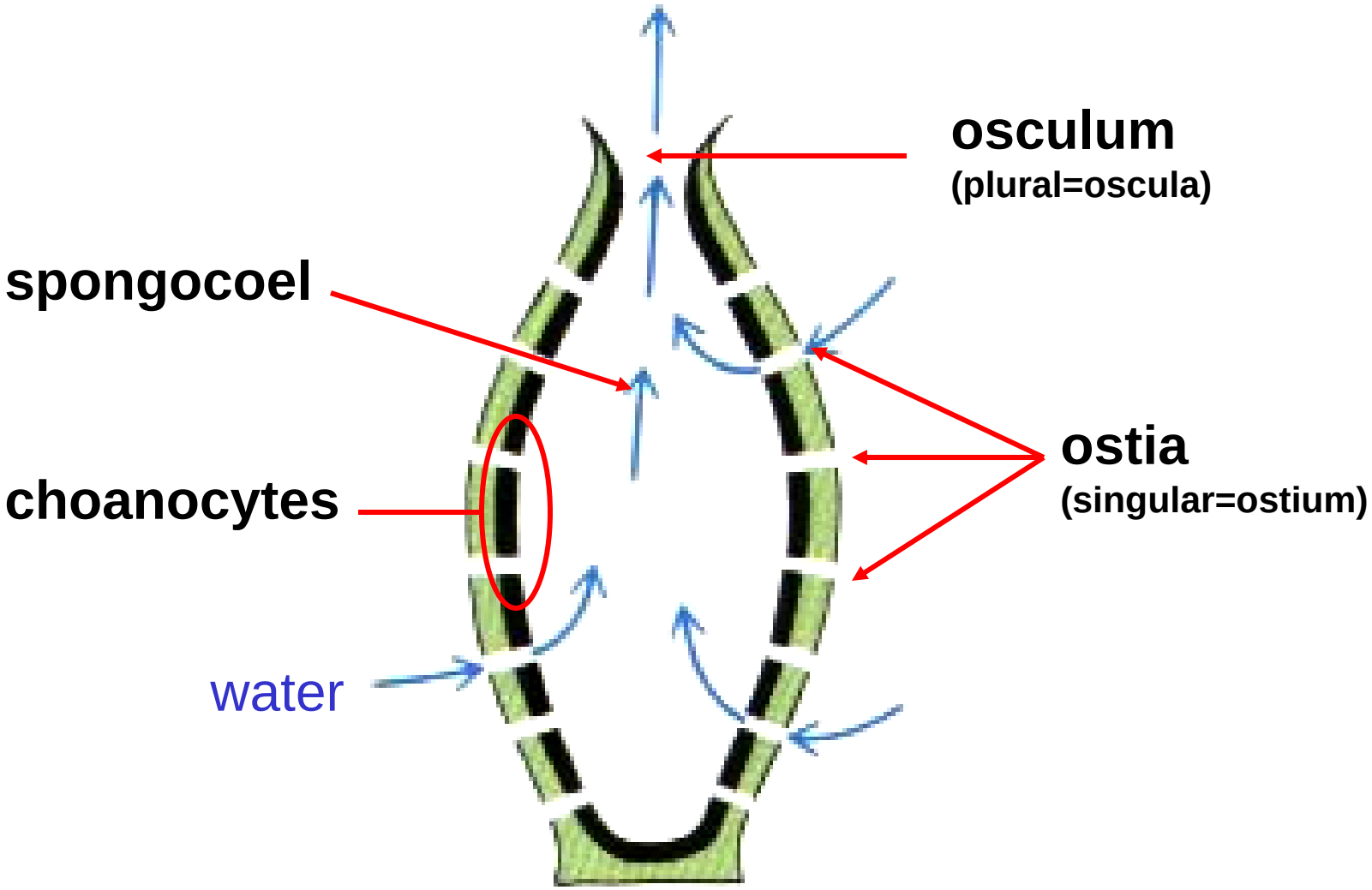
Sponges are assemblages of cells embedded in a protein matrix and supported by a skeleton of needle-like structures.

External Morphology

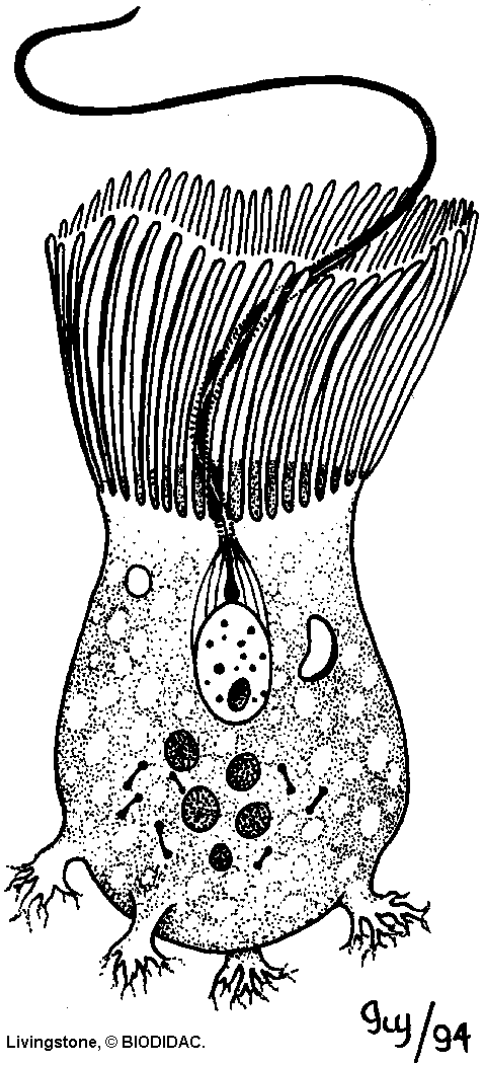




General Body Plan



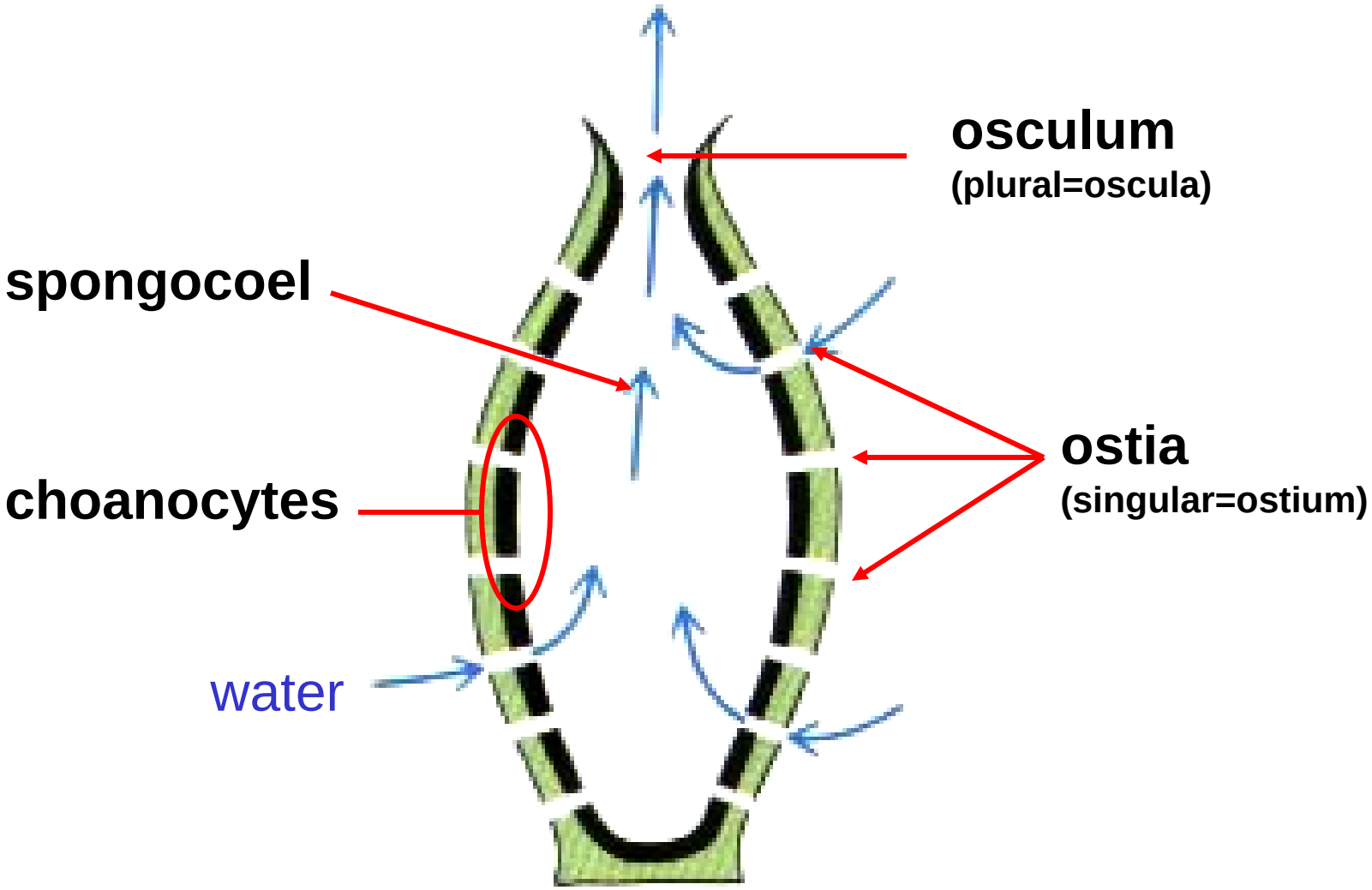
General Body Plan



Choanocytes: “collar cells”

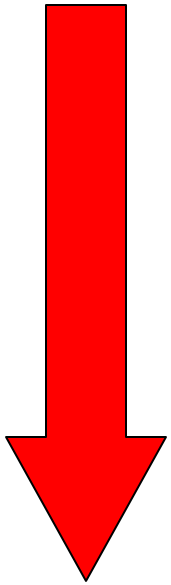
- **diagnostic of phylum Porifera**
- **consist of a long flagellum surrounded by a “collar” of microvilli**
- **functions:**
  - **-obtaining food**
  - **-creating water currents**
  - **-reproduction**

General Body Plan



3 Body Types

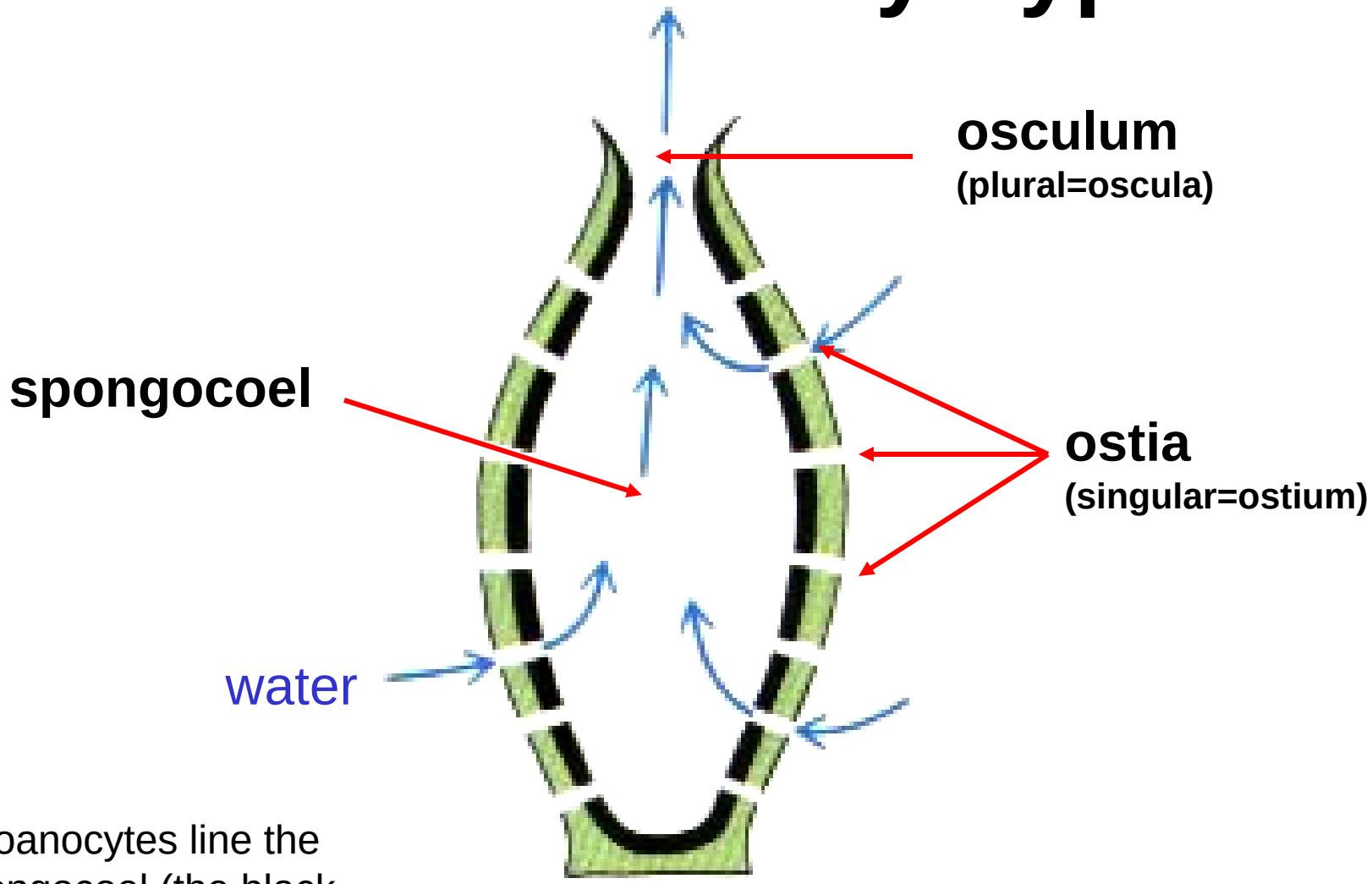
Based on the complexity of the water canals:



- **Asconoid**
- **Syconoid**
- **Leuconoid**

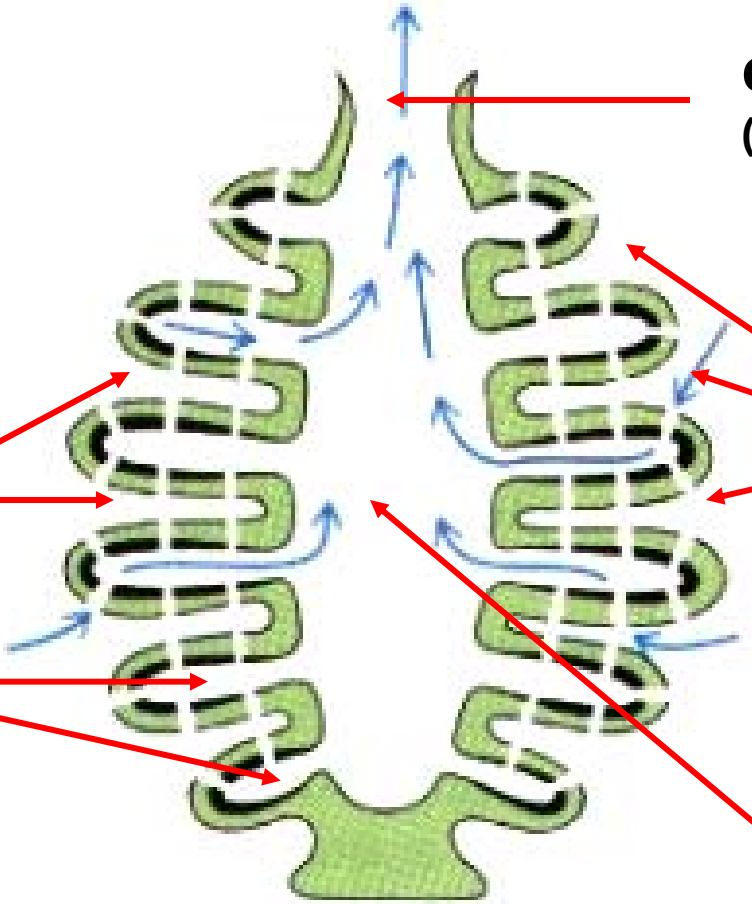
Increasing size
Increasing Surface Area :Volume

Asconoid Body Type



Choanocytes line the spongocoel (the black shaded area)

Syconoid Body Type



osculum
(plural=oscula)

ostia
(singular=ostium)

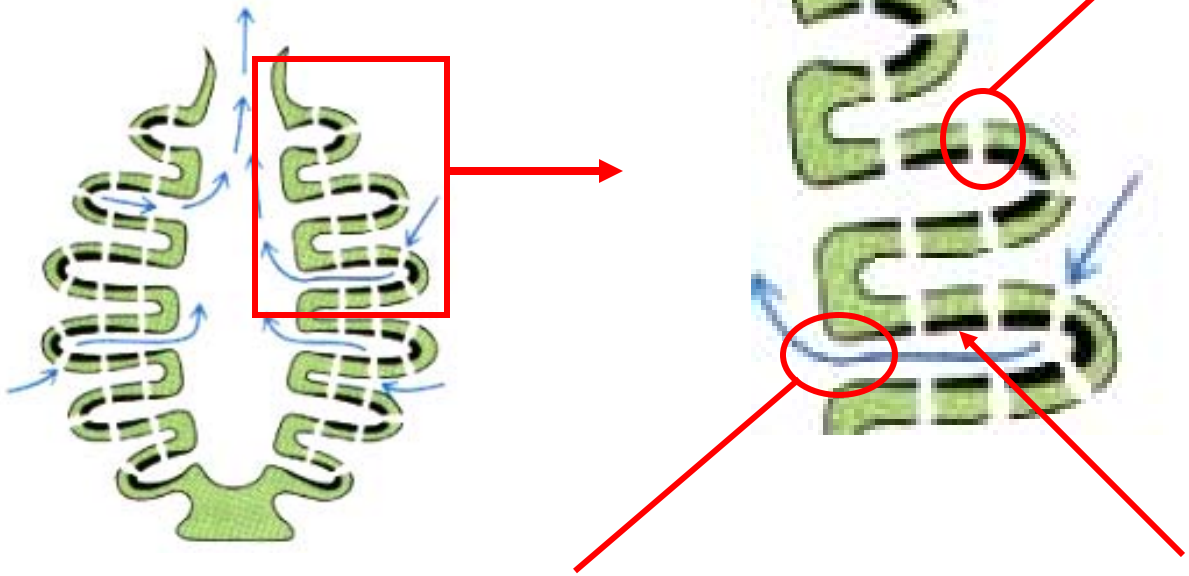
incurrent canals

radial canals

spongocoel

choanocytes line the radial canals (the black shaded area)

Syconoid Body Type

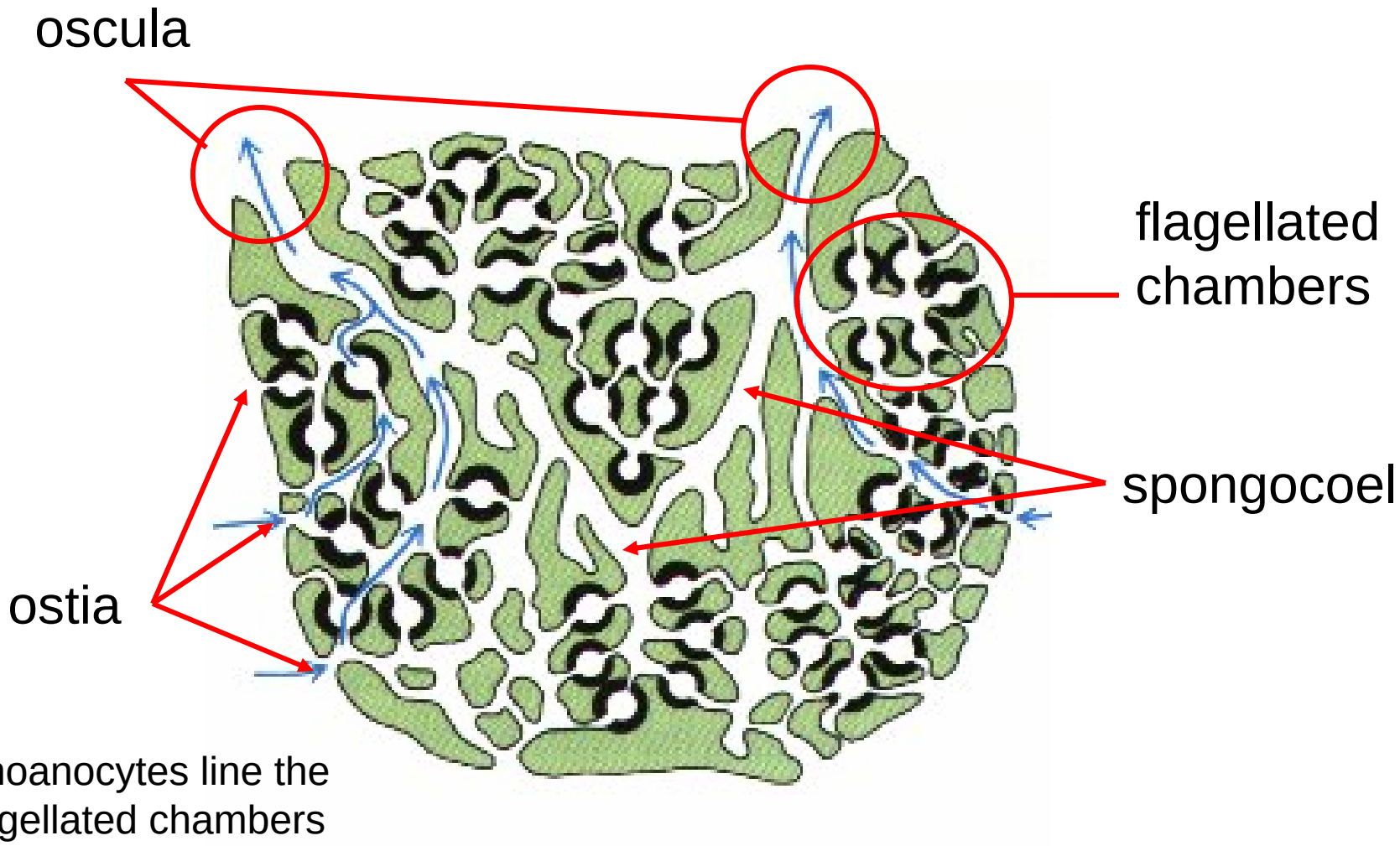


prosopyle:
opening from incurrent canal to radial canal

apopyle:
opening from radial canal to spongocoel

radial canal:
lined with choanocytes

Leuconoid Body Type

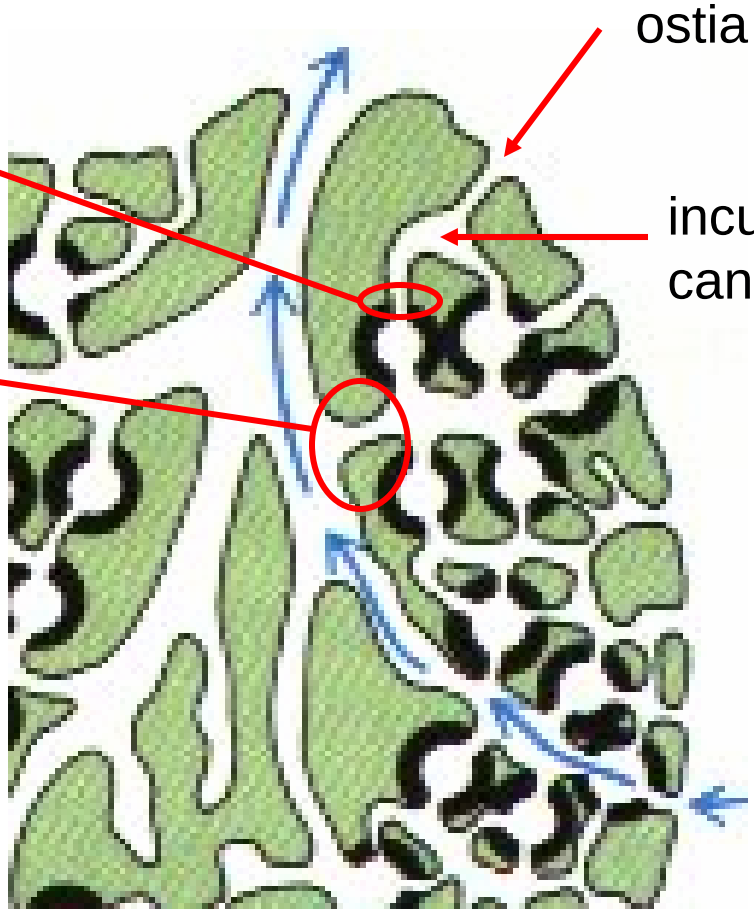


Choanocytes line the flagellated chambers (the black shaded area)

Leuconoid Body Type

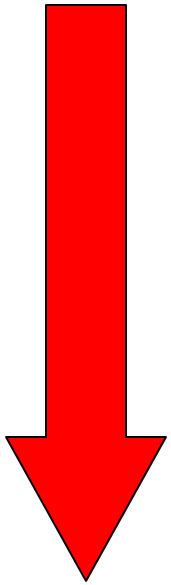
prosopyle: opening form incurrent canals to flagellated chambers

apopyle: opening form flagellated chambers to spongocoel



3 Body Types

Based on the complexity of the water canals:

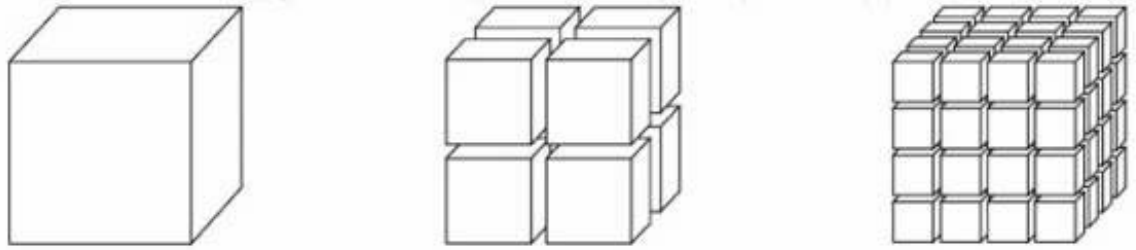


- **Asconoid**
- **Syconoid**
- **Leuconoid**

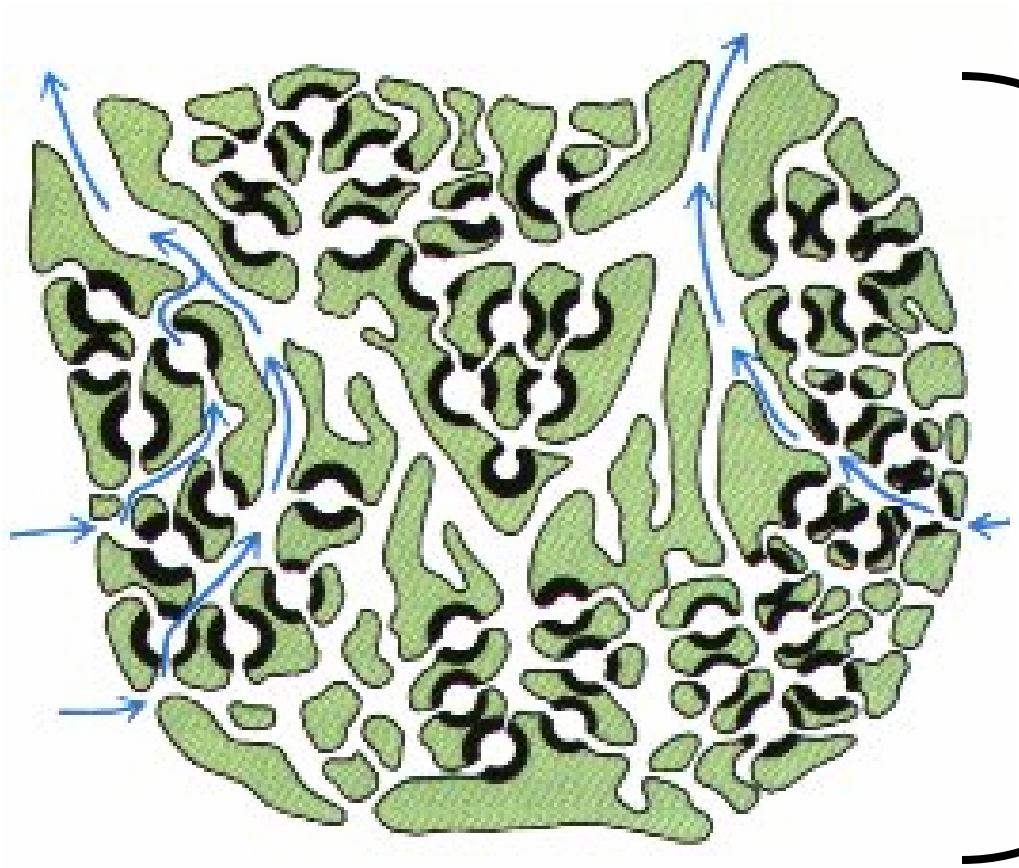
Increasing size
Increasing Surface Area :Volume

$SA = l^2 \times 6$

$V = l^3$



One 4-cm cube	Eight 2-cm cubes	Sixty-four 1-cm cubes
Surface area		
96 cm^2	192 cm^2	384 cm^2
Volume		
64 cm^3	64 cm^3	64 cm^3
Surface area: Volume per cube		
1.5:1	3:1	6:1



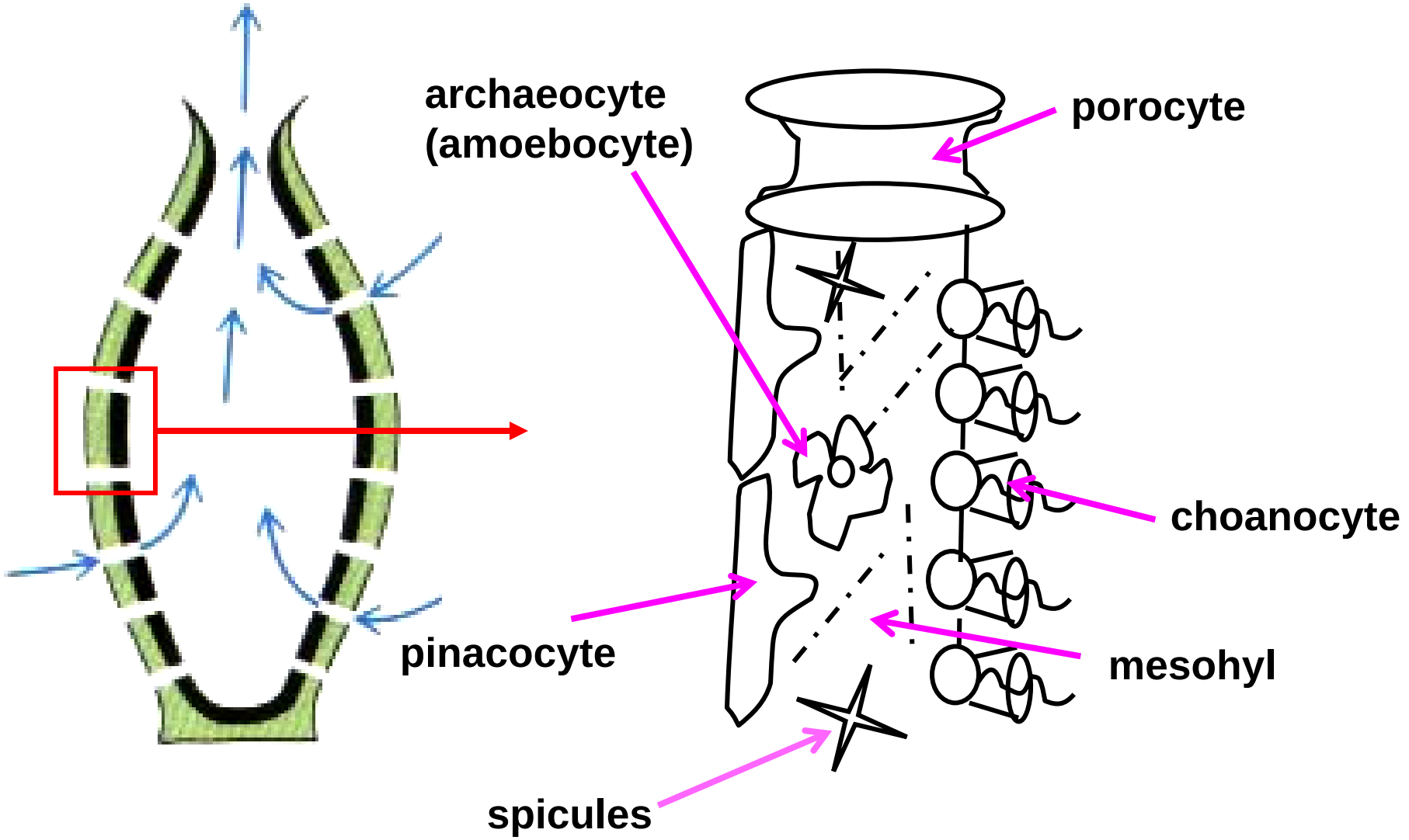
The large SA:V of leuconoid sponges

More space for choanocytes

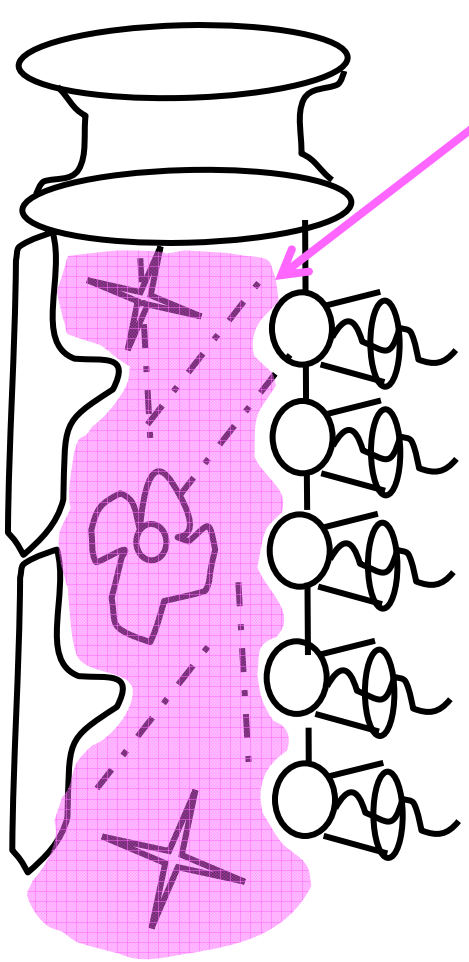
More water flow

Larger size

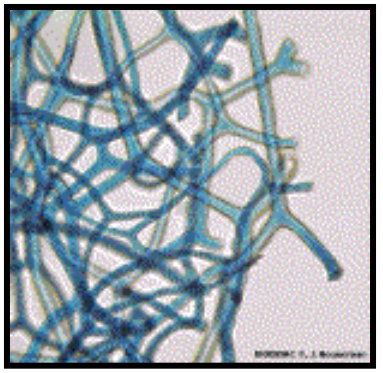
Microscopic Morphology



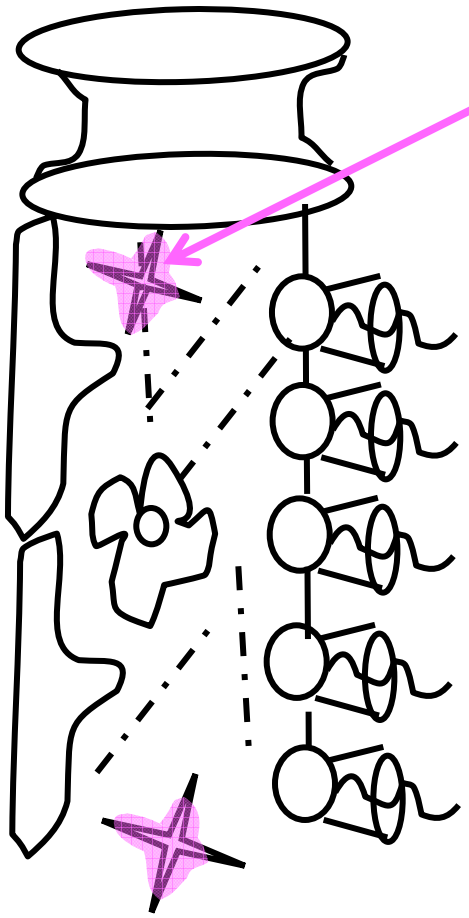
Skeletal Elements



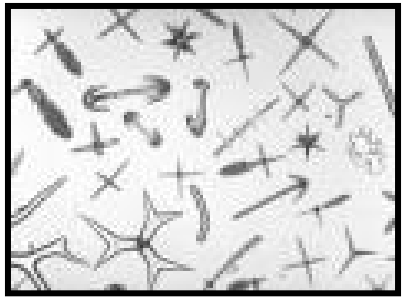
- proteinaceous matrix that contains skeletal material and certain cell types
- equivalent to the connective tissue in other organisms
- made of collagen and spongin



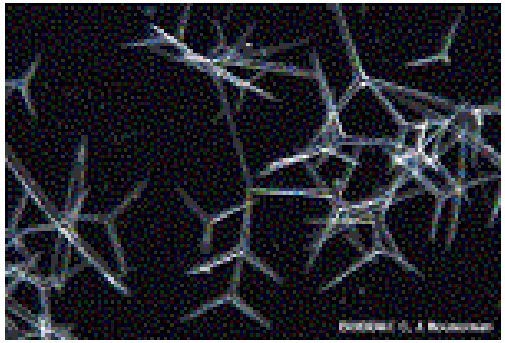
Skeletal Elements

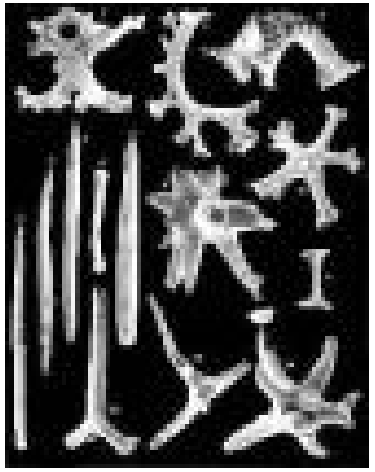


Spicules

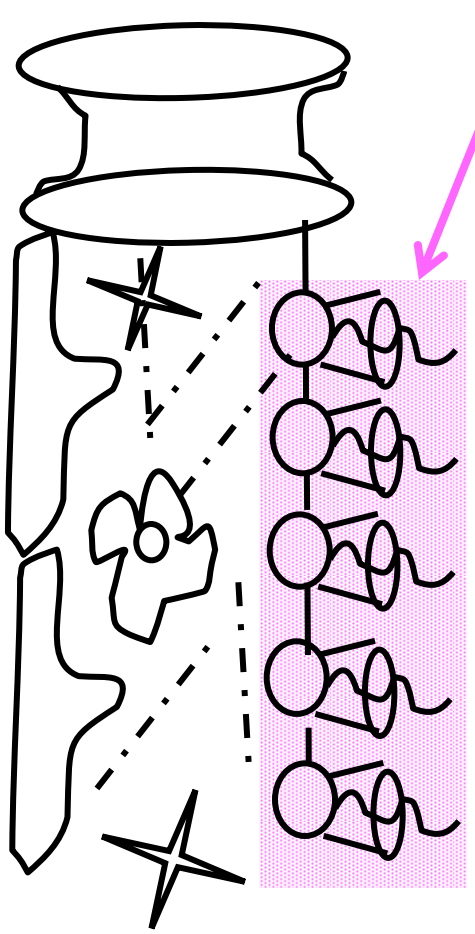


- **made of calcium carbonate or silica**
- **often used in taxonomic identification**



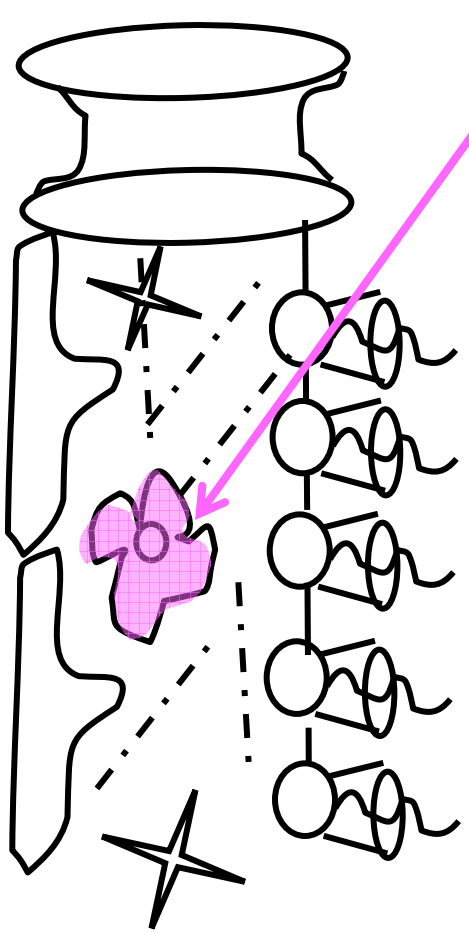


Cell Types



- diagnostic of phylum Porifera
- consist of a long flagellum surrounded by a “collar” of microvilli
- functions:
  - -obtaining food
  - -creating water currents
  - -reproduction

Cell Types

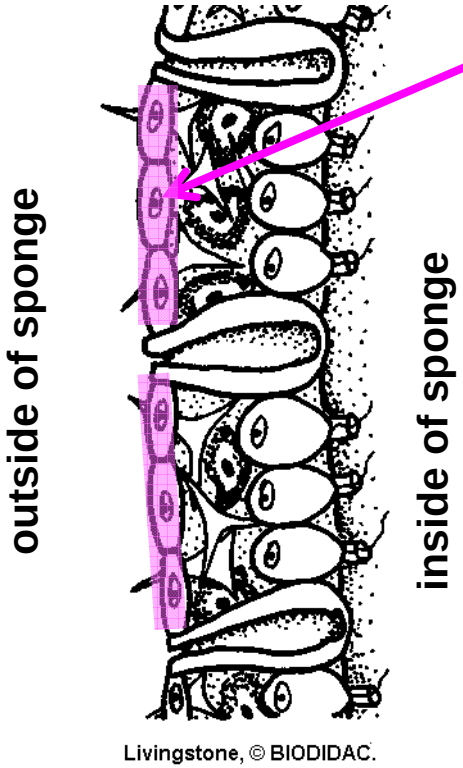


Archaeocytes

- **also called “amoebocytes”**
- **found throughout mesohyl**
- **totipotent → can differentiate into any other type of cell**
- **functions:**
  - **digestion through phagocytosis**
  - **make spicules**
  - **reproduction**

Cell Types

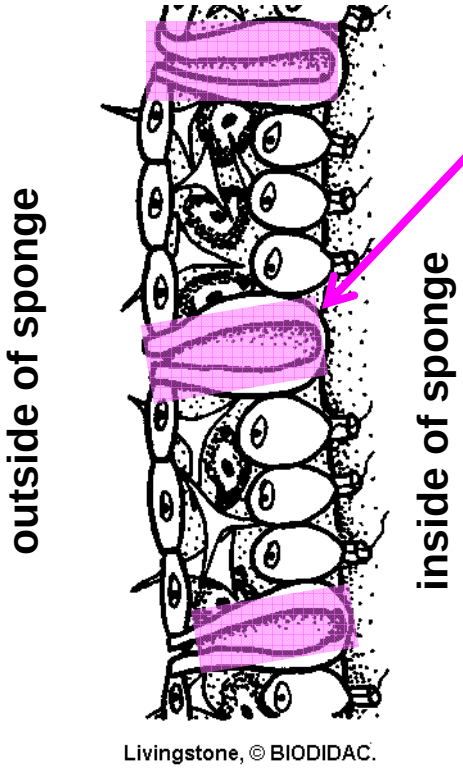
Pinacocytes



- **line the exterior surface of the sponge**
- **functions:**
  - **some can regulate water flow by moving (open/close ostia)**

Cell Types

Porocytes



- found in asconoid sponges
- form tubes in the body wall where water can pass through
- functions:
  - allow water flow

Physiology

Feeding

- **Sessile filter-feeders**

Digestion

- **Intracellular**

Gas exchange

- **Simple diffusion**

Excretion (nitrogenous waste removal)

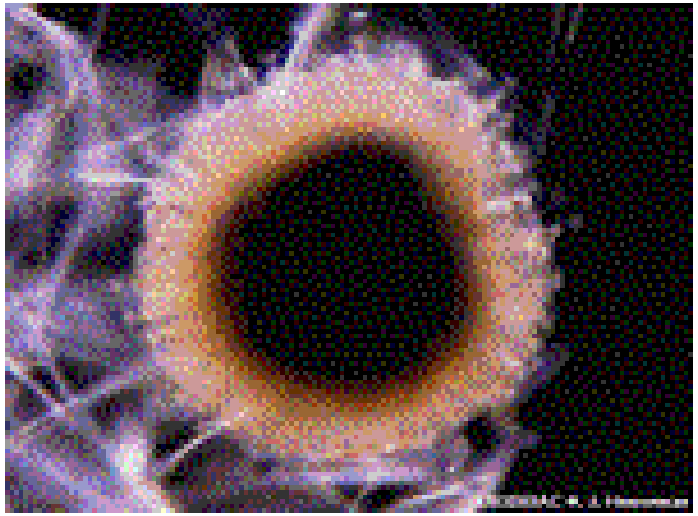
- **Simple diffusion**

Physiology

Reproduction

1. **Asexual**
   - **fragmentation**
   - **budding**
   - **regeneration**
   - **gemmules**

Physiology



Gemmules:

-in freshwater sponges only

–resistant mass of archaeocytes that are produced in unfavorable conditions

–when the environment is favorable, they will develop into sponges

Physiology

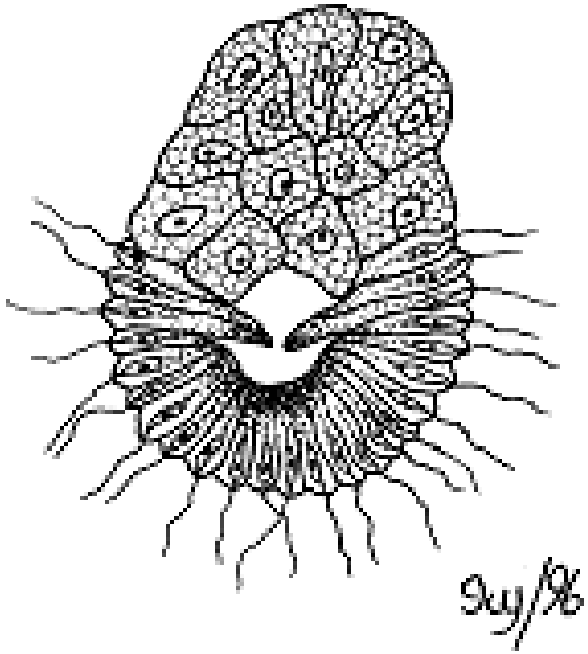
Reproduction

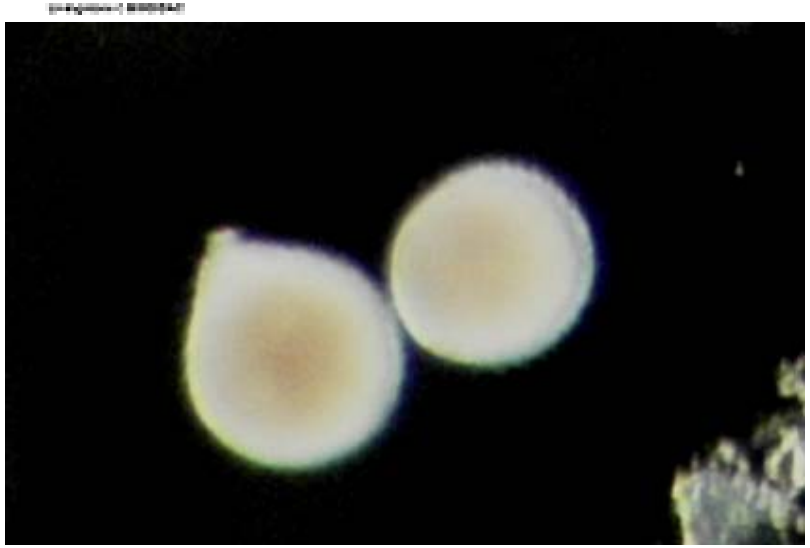
2. Sexual

usually monoecious

(a single individual produces both male and female gametes; both sexes are within one individual)

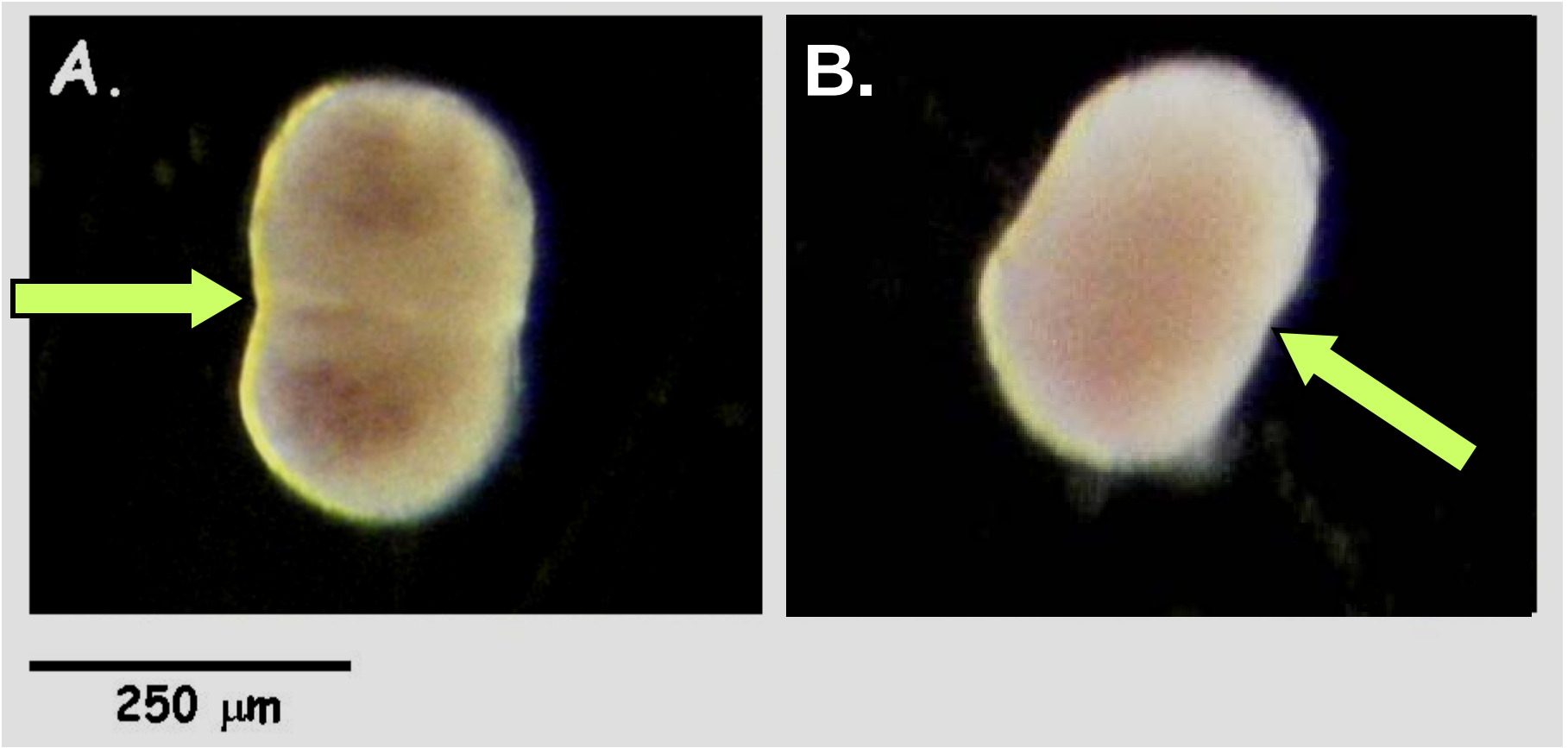
- **sperm are released into the water and eggs are retained within the sponge**
- **motile larvae are produced**

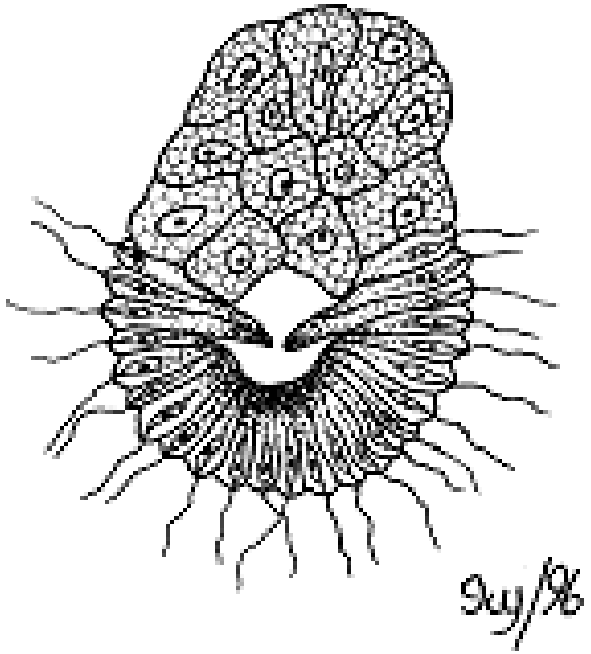


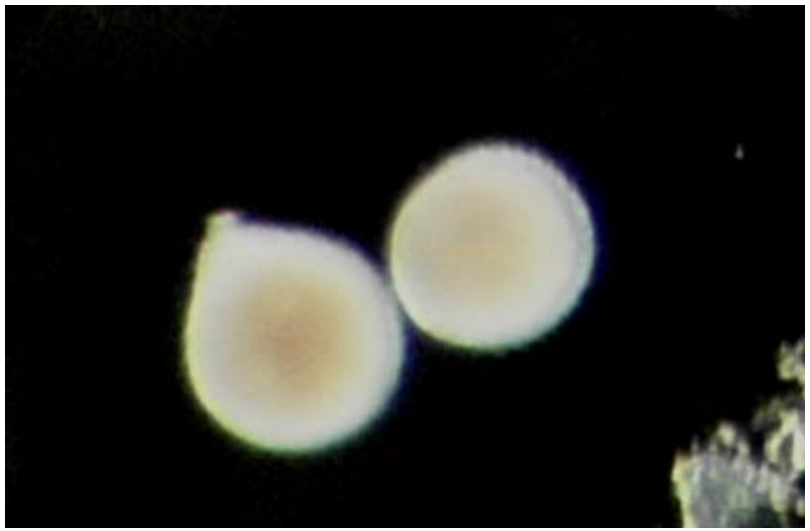


Some sponge larvae crawl along the bottom, whereas others are free swimming.

Some free-swimming larvae are capable of fusing with others!







Larvae eventually settle and metamorphose into adults

Ecology

- most sponges are marine (~5000 species) but there are ~150 freshwater sponge species
- Sponges are found at all depths but certain species are restricted to particular depths due to how their spicules are formed
- There are few sponge predators because they usually contain distasteful toxins
- Some predators (e.g. sea slugs) sequester these sponge toxins which in turn deters their own predators

Ecology

Symbiosis –

the living together of 2 different species in an intimate relationship

Types of symbiotic relationships:

- **Mutualism= both partners benefit**
- **Commensalism= 1 partner benefits, 1 partner is unaffected**
- **Parasitism= 1 partner benefits, 1 partner is harmed**

There are examples of all 3 of these types of symbiotic relationships occurring in Sponges

Ecology

Mutualism –

- certain ‘endosymbiotic’ bacteria and algae living within the sponge provide additional food for the sponge while the sponge provides a place for the bacteria and algae to grow

• some crabs will attach a piece of sponge to their body to use as camouflage and to deter predators while the sponge gets to move around

Ecology

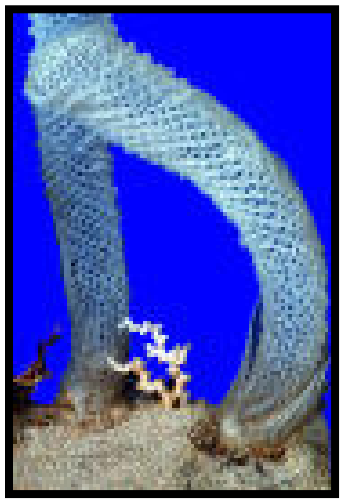
Commensalism –

- many different species live within sponges and receive food and shelter benefits but do nothing for the sponge

  e.g. 15cm² piece of sponge in California was found to house 100 different species of plants + animals

  e.g.Venus's Flower basket

  a pair of shrimp live their entire lives within 1 sponge



Ecology

Parasitism –

- **boring sponges are parasites on certain corals because they bore into the calcium carbonate base of the coral for protection and kill part of the coral in the process**

FSU Research on Sponges: Dr. Janie Wulff

wulff@bio.fsu.edu

Smithsonian Institution field station at Carrie Bow Cay

The sponge communities of reefs and mangrove islands are very different. What factors are responsible for this difference?

1. Abiotic factors: Light, turbidity, nutrients, substrate, physical disturbance…

2. Biotic factors: competition, predation, parasitism…

The sponge communities of reefs and mangrove islands are very different. What factors are responsible for this difference?

1. Abiotic factors: Light, turbidity, nutrients, substrate, physical disturbance…

2. Biotic factors: competition, predation, parasitism…

Determining which of these is more important is difficult because reefs and mangroves differ in abiotic and biotic factors.

What factors determine the diversity of sponges in a habitat?

What factors determine the diversity of sponges in a habitat?

Twin Cays

Pelican Cay

-Species composition: there are 167 species in both habitats combined, but 78 % of the species are found in only one of the two locations.

What factors determine the diversity of sponges in a habitat?

Twin Cays

- Sponges grow on mangrove roots
- Sponge diversity is typical of mangrove stands throughout the Western Atlantic

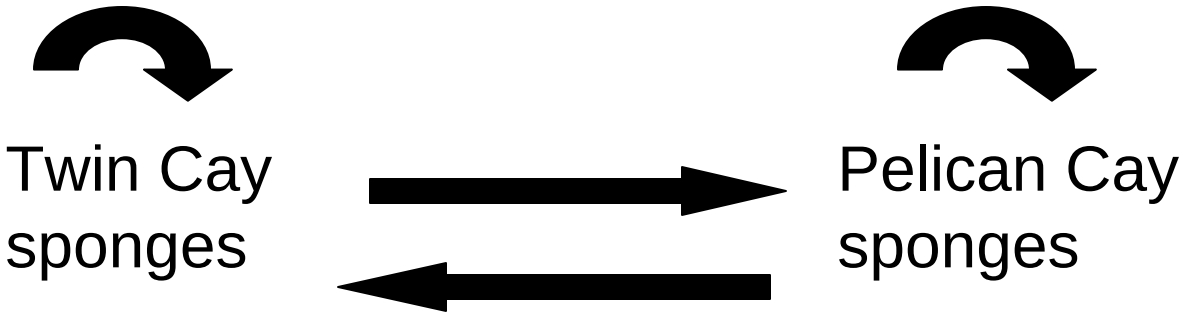
What factors determine the diversity of sponges in a habitat?

Pelican Cay

- **Sponges grow on mangrove roots**
- **Sponge diversity is typical of shallow coral reefs**

Why do these two similar habitats have such different sponge communities ?

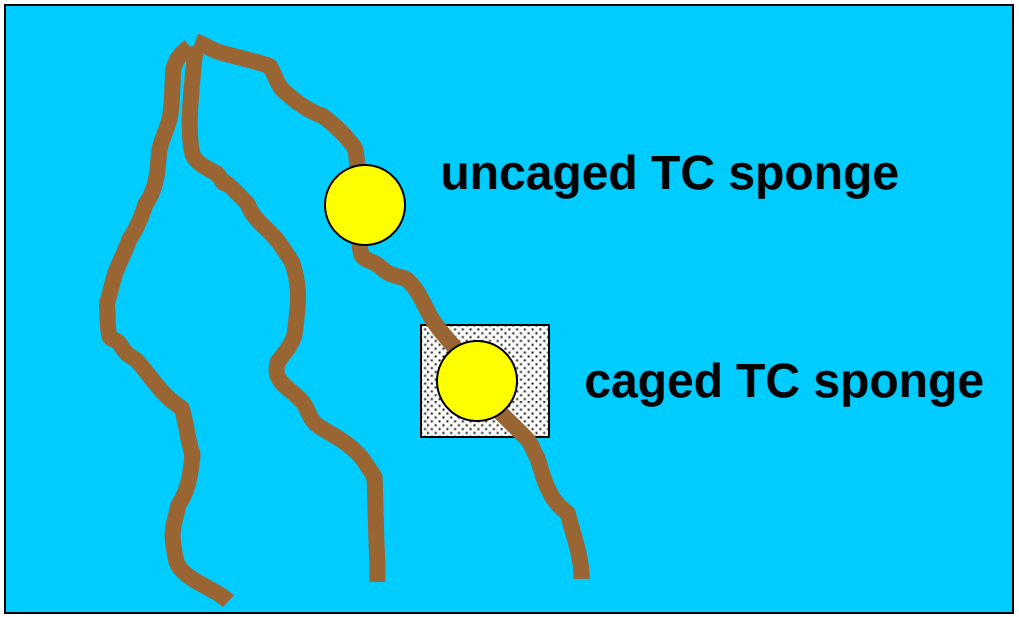
Transplant experiments: small pieces of sponge from each habitat were attached to mangrove roots in the native and non native habitat



Why do these two similar habitats have such different sponge communities ?

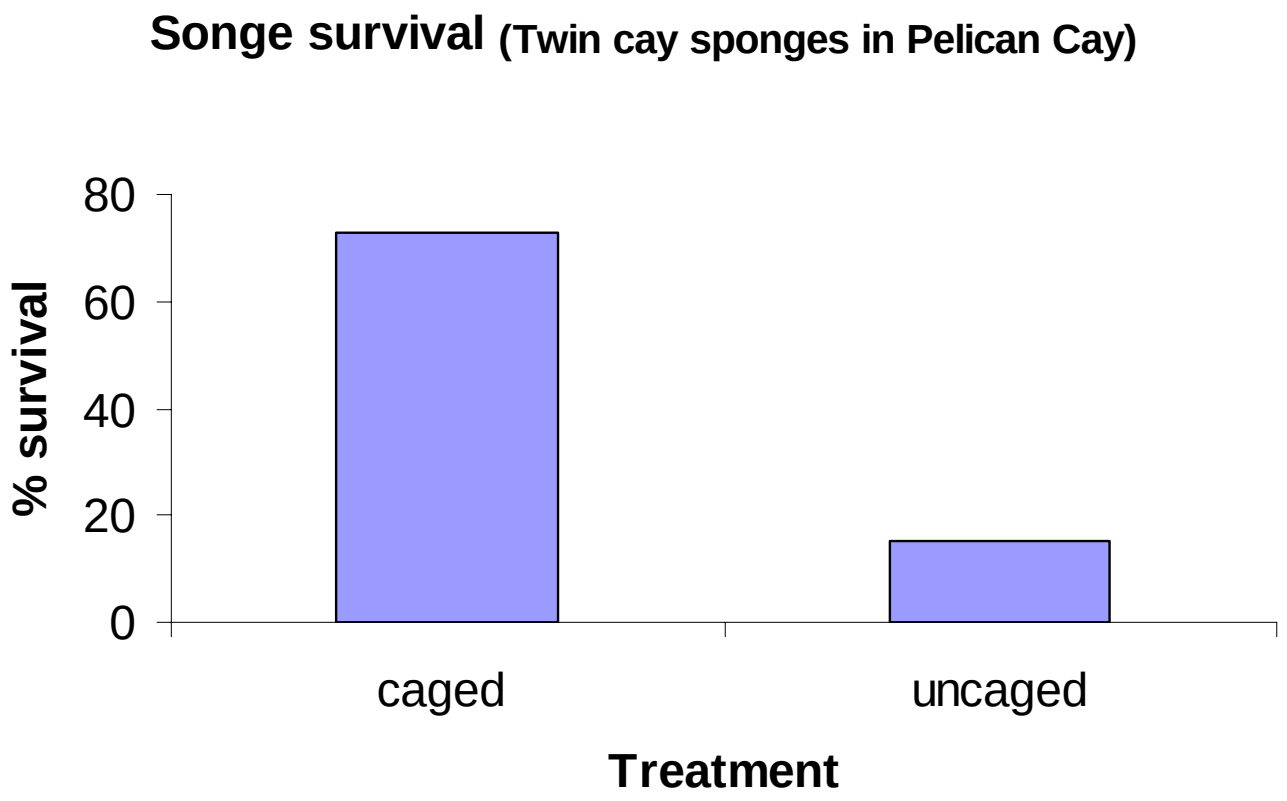
Transplant experiments:

1. Caging experiments: the role of predation



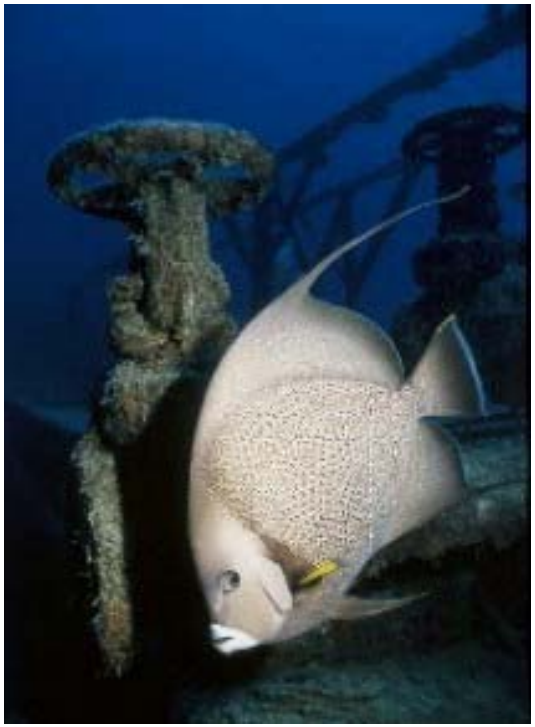
Twin Cay sponges transplanted in Pelican Cay

Competition Results:



Competition Results:

Sponge predators in Pelican Cay:



Gray angelfish

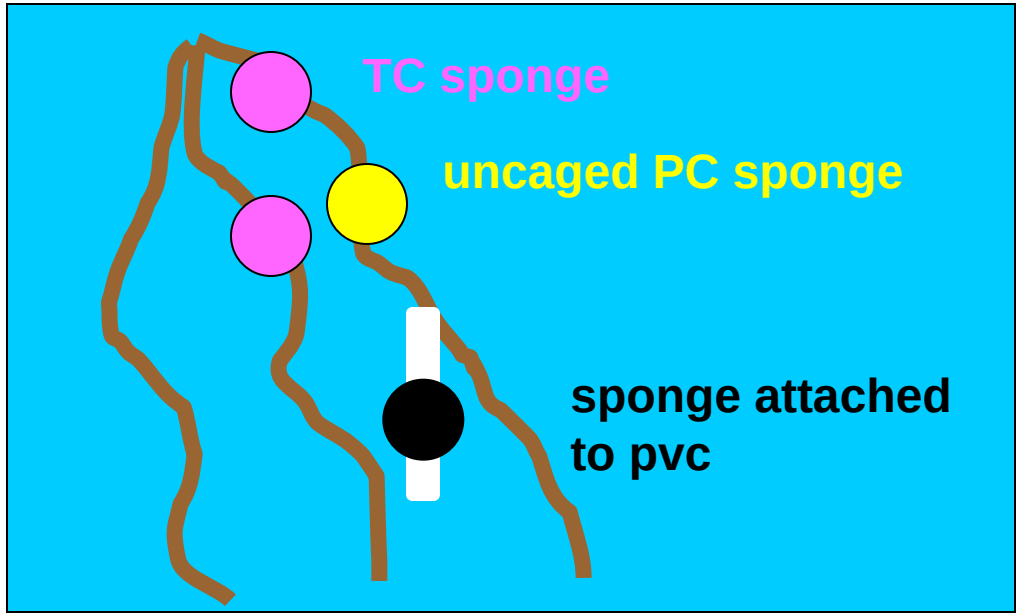
Redband parrotfish

These spongivores are also present on reefs.

Why do these two similar habitats have such different sponge communities ?

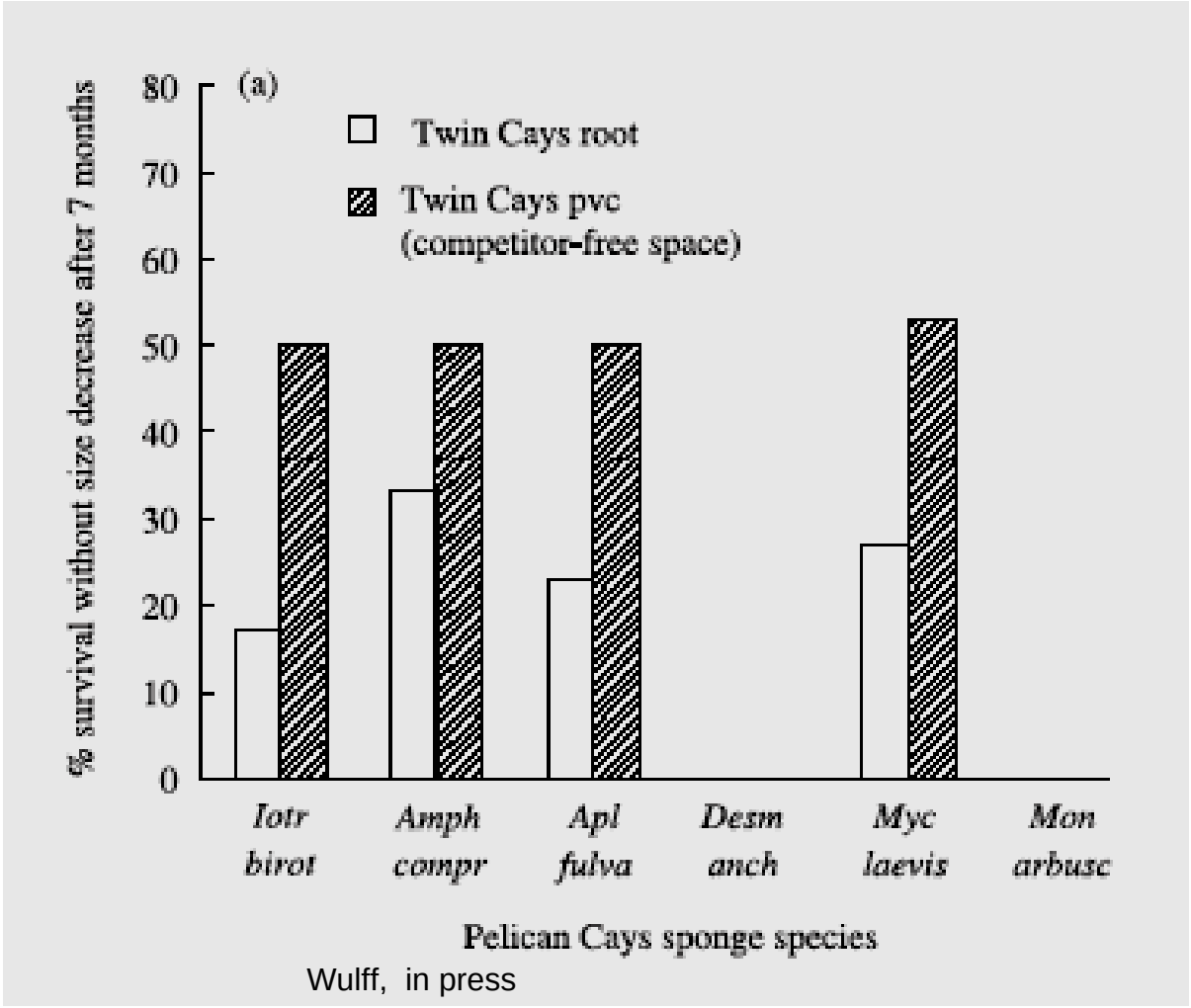
Transplant experiments:

1. Caging experiments: the role of predation
2. Competitor free space: the role of competition



Pelican Cay sponges transplanted in Twin Cays

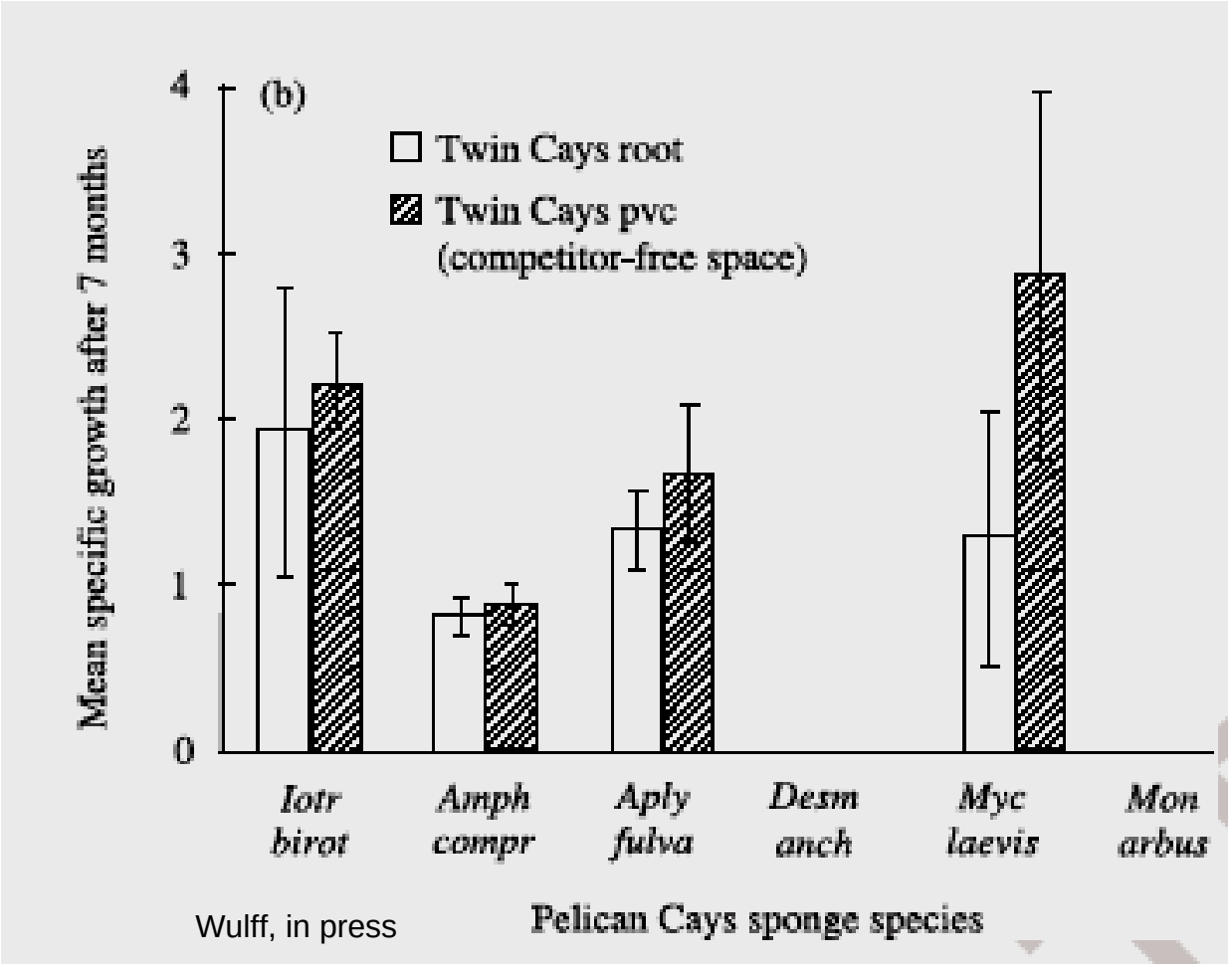
Competition Results:



Wulff, in press

Sponges in competitor free space have higher survival

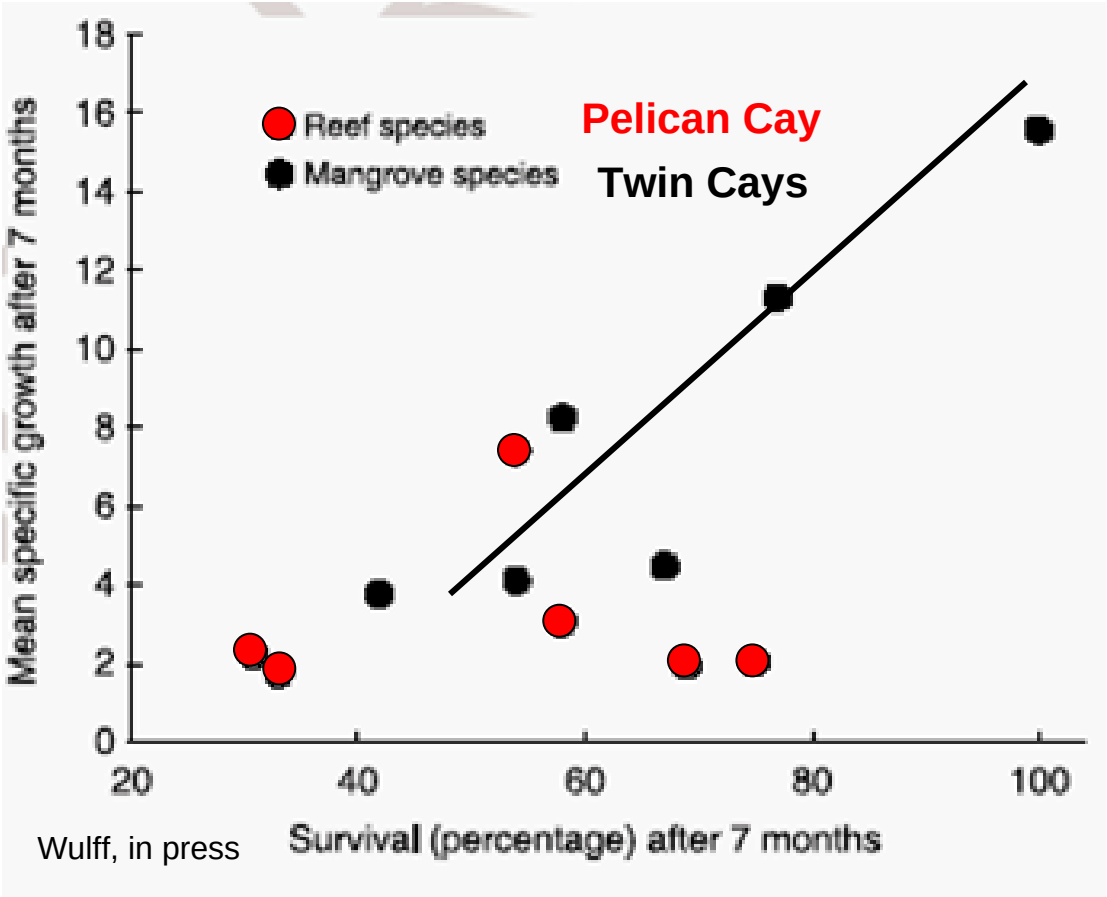
Competition Results:



Wulff, in press

Sponges in competitor free space tend to grow more

Competition Results:



Wulff, in press

There is a positive relationship between growth and survival in Twin Cays, but not in Pelican Cay

The sponge communities of reefs and mangrove islands are very different. What factors are responsible for this difference?

Dr. Wulff's research suggests that biotic factors (predation and competition) are important :

- Competition plays a more important role in determining sponge diversity in mangrove habitats.
- Predation plays a more important role in determining sponge diversity in coral reef habitats.

The sponge communities of reefs and mangrove islands are very different. What factors are responsible for this difference?

Dr. Wulff's research also suggests that there maybe a trade-off between competitive ability and predator defense: