# BIO 221
# Invertebrate Zoology I
# Spring 2010

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http://www4.nau.edu/isopod

Lecture 5

# What happens when you become larger and more complex?

# Cellularity, Revisited

## Certain Organisms Don't Exist

1. There are no 800 lb amoebas.

a. There are no single-celled squid, sea stars.

b. Why?

c. Because there are physical constraints on life.

## Physical Constraints on Life

1. Most living systems involve ionic chemistry; what molecules can do in water
2. There are physical limits on size.
3. Phylogenetic limits exist -

a. genetic variation.

b. evolutionary history.

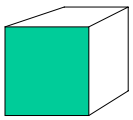
c. selection intensity.

## Physical Constraints on Life

1. Substances must enter and exit cells through the cell membrane

a. Thus, the physical relationship between surface area and volume places a limit on cell size.

## Consider a Cube



**1. With 1 cm sides:**

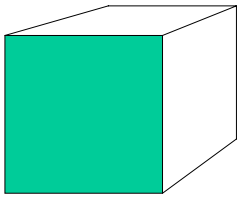
a. Each side: 1x1 = 1cm$^2$

b. Total surface area: 6(1) = 6 cm$^2$

c. Volume: base area x height = 1x1 = 1 cm$^3$

d. s.a./vol. ratio: 6/1 = 6

## Consider Another Cube



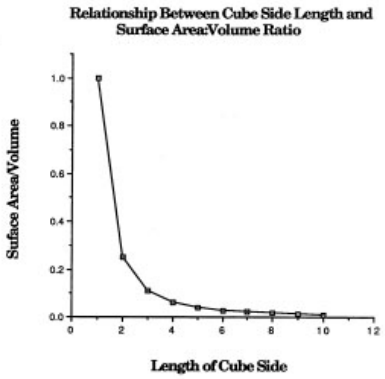
**2. With 2 cm sides:**

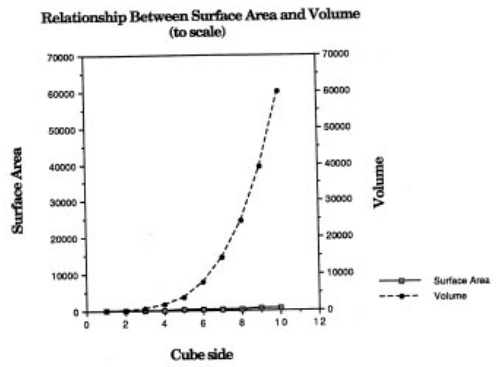
1. each side: 2x2 = 4cm$^2$

2. total surface area: 6(4) = 24 cm$^2$

3. volume: base area x height = 4x2 = 8 cm$^3$

4. s.a./vol. ratio: 24/8 = 3






# What Does It Mean?

## If You Get Larger:

1. Increasing volume->increasing cellular activity ->increased nutritional requirements, increased waste production.
2. Thus, by dividing organism into smaller parts, there is increased efficiency in materials transport.

a. Sponges absorb better than paper towels.

## If You Get More Complex:

1. Increased cell numbers, increased size = increased complexity.

a. Individual cells are ***limited*** in their ability to do different things.

b. But: ***increased*** cell numbers ***permits*** cellular specialization.

c. Increased ***efficiency*** is obtained by increased specialization.

## Venus Williams vs. the Arizona Cardinals


## If You Get More Complex:

2. Greater specialization, however, necessitates maintenance mechanisms.

a. Nerve cells aren't very good at catching their own food.

b. Required systems: those that are necessary to maintain specialized cells.

# Tissue Organization

## Cellular Associations

1. Multicellular animals may consist of loosely organized groups of cells

a. little specialization

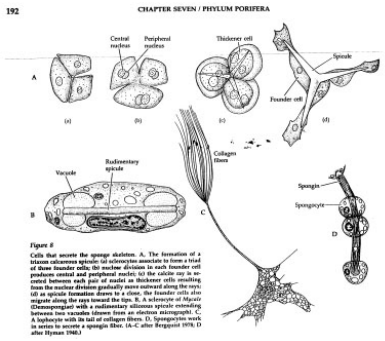
b. little integration among functional groups of cells

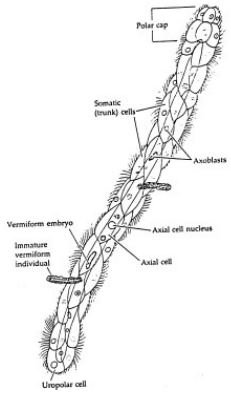
2. Examples:

a. Sponges

b. Mesozoa - linearly arranged clusters of cells.

## Porifera






# Mesozoa

## True Tissues

1. Cells arranged as functional units.

a. Specialization of structure and function.

b. Usually arranged in systems and organs.

2. Arrangement is often laid down early in development.

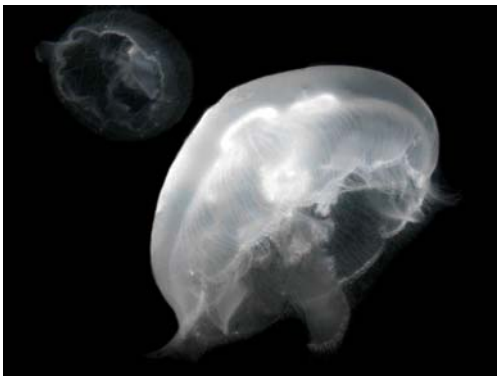
## Diploblastic Arrangement

1. ***Epidermis*** - outer layer
2. ***Gasterodermis*** - inner, digestive layer
3. ***Mesenchyme*** - middle layer of cells, but no true mesoderm

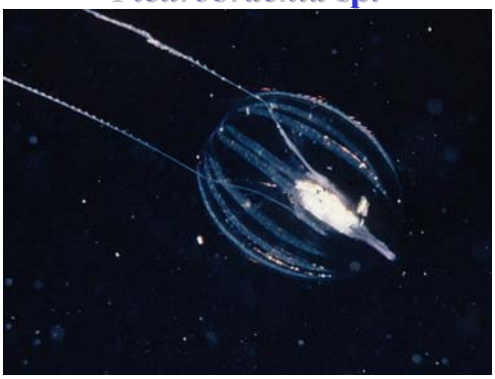
b. Examples:

1. cnidarians, ctenophores

## *Aurelia aurita*



## *Pleurobrachia* sp.



## Triploblastic Arrangement

1. **Epidermis** - outer layer, derived from embryonic ectoderm.
2. **Endodermis** - digestive layer, derived from endoderm
3. **Mesodermis** - inner muscle, organ layers, derived from mesoderm

*Notoplana acticola*

# Body Symmetry

# How ARE Organisms Arranged?

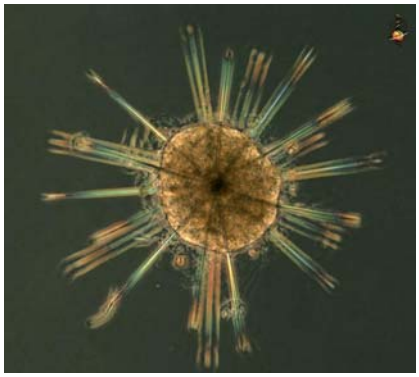
## Spherical

1. Body of the organism is arranged so that any plane can cut it into equal parts
2. Relatively few examples in Metazoa except early in development
3. Protozoa

a. Radiolaria

b. multicellular algae: *Volvox*

*Astrolithium* sp.



## Irregular

1. Body of organism is arranged so that no plane cuts it into equal parts.
2. Examples:

a. amoebae

b. sponges

3. Neither spherically nor irregularly symmetrical organisms have polarity

*Mayorella* sp.


*Mycale loveni*

## Radial

1. Body is arranged along a longitudinal axis (varying in length).

a. Often with oral, aboral ends

b. Polarity is established

2. Planes drawn parallel to the longitudinal axis divide the animal into equal halves.

3. Often associated with sessile feeding.

*Haliplanella luciae*

*Pachycerianthus fimbriatus*

## Biradial

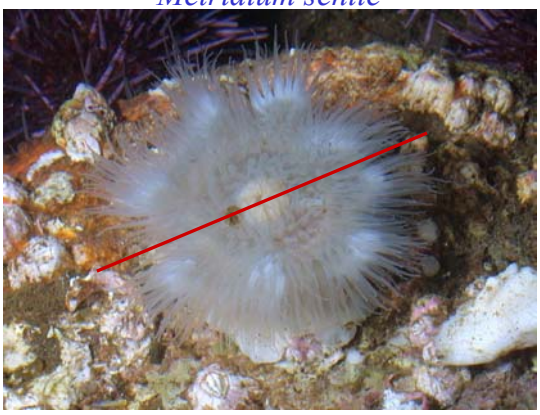
1. Similar to radial symmetry except that only two planes will cut the animal into equal halves.

a. Usually some secondary specialization on feeding arrangement

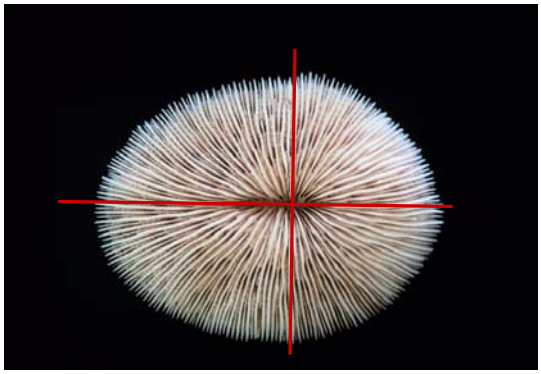
2. There can be more involved versions of this.

a. triradial, pentaradial, etc.

*Metridium senile*



*Fungia scutaria*



## Bilateral

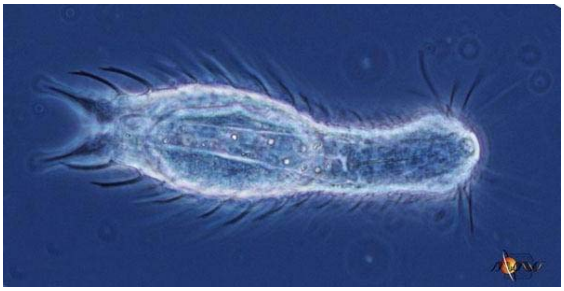
1. A single plane divides the body into equal halves.
2. often with other functional surfaces.

a. dorsal, ventral, lateral.

b. anterior, posterior.

3. Usually locomotory specialization
4. Often associated with cephalization (association of nervous tissue in anterior end).

*Chaetonotus* sp.



*Urechis caupo*

# Body Cavity Arrangement

## Acoelomates

1. Possess no body cavity
2. Instead, parenchyma tissue and muscles.
3. Examples:

a. Platyhelminthes

b. Nemerteans

*Bipalium kewense*

*Opisthorchis sinensis*

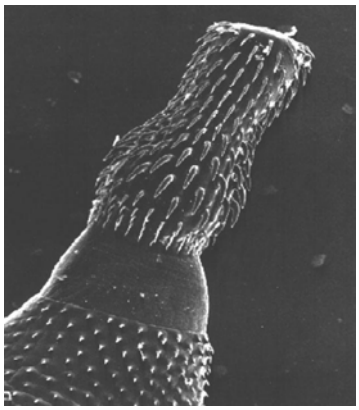
**An Antarctic nemertean**

## Pseudocoelomates

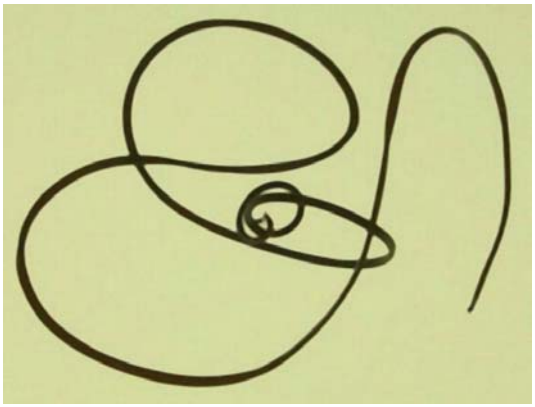
1. Possess a body cavity,
2. Fluid filled pseudocoel; organs supported by hydrostatic pressure.
3. Lack mesenteries
4. Examples:

a. Blastocoelomate (Ascelminth) phyla

***Corynosoma*** **sp.**



A horsehair worm



*Pycnophyes greenlandicus*

## Eucoelomates

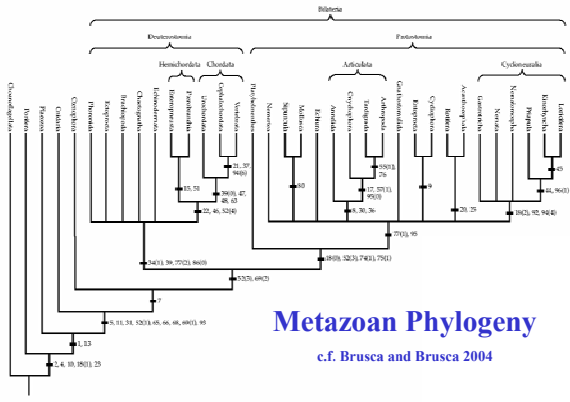
1. Possess a body cavity
2. Not fluid filled or under pressure
3. Organs supported by mesenteries
4. Examples:

a. all other phyla

*Opisthopus transversus*

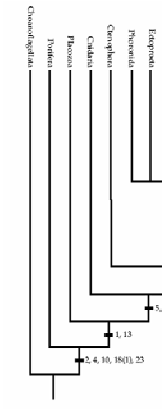
*Florometra serratissima*

# Lower Metazoan Phylogeny




**Metazoan Phylogeny**

c.f. Brusca and Brusca 2004




## Lower Metazoan Clades:

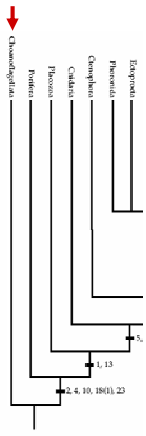
Choanoflagellata

Porifera

Placozoa

Cnidaria

Ctenophora




## Lower Metazoan Clades:

**Choanoflagellata**

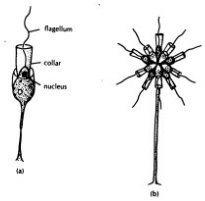
Porifera

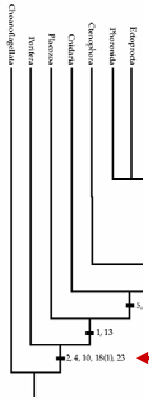
Placozoa

Cnidaria

Ctenophora

## Choanoflagellates




## Lower Metazoan Clades:

**Choanoflagellata**

**Porifera**

Placozoa

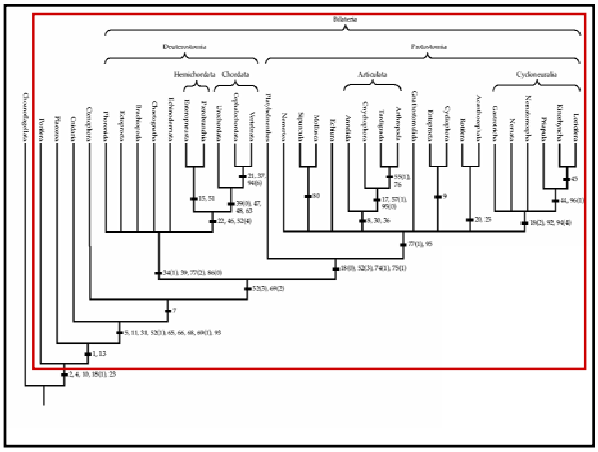
Cnidaria

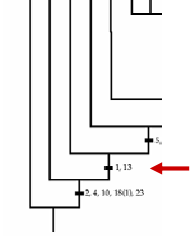
Ctenophora

# Porifera and Metazoa

a. Are distinct from choanoflagellates by:

2. Multicellularity
4. Epithelial tight junctions
10. Collagen fibers in body
18(1). Development w/"radial" cleavage.
23. Spermatozoa




## Lower Metazoan Clades:

Choanoflagellata

**Porifera**

**Placozoa**

Cnidaria

Ctenophora

# Porifera

**a. Are distinct from the Placozoa by:**

Have collar cells (absent in Metazoa)

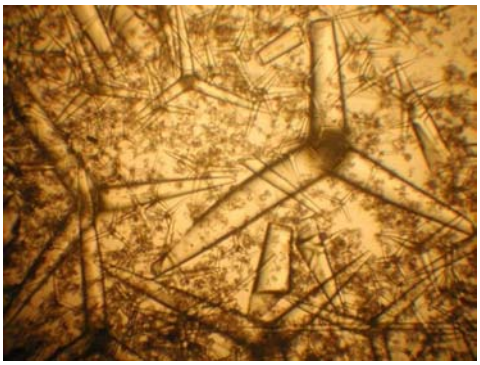
Lack striated ciliary rootlets (present in Metazoa)

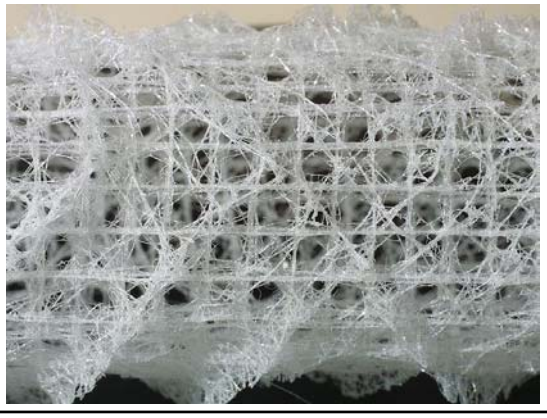
**b. Also have the following apomorphies**

1. Aquiferous system
2. Layered construction
3. Spicules

03.03B Barrel sponges

## Sponge Spicules



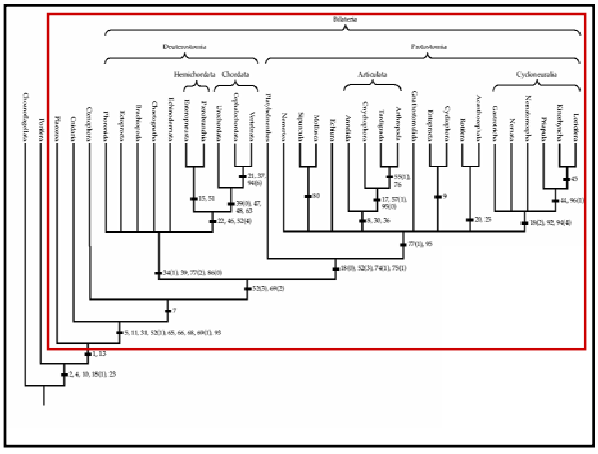


# Placozoa and other Metazoa

This clade includes all animals (multicellular heterotrophs)

a. Synapomorphies:

1. Absence of collar cells
13. Striated ciliary rootlets




*Tricoplax adhaerens*

*Tricoplax adhaerens*