Animal Complexity and Body Plans

- 34 different phyla of multicellular animals
- About 100 phyla generated during "Cambrian explosion"
- Animal body plans well-defined and established early in evolutionary history
- Many animals share a common architecture

Organization of Animal Complexity

- Unicellular organisms
  - Protozoa = single-celled organisms
  - Not classified as Animals, but "animal-like"
  - High levels of organization within the cell
  - Perform all basic functions of life
- Multicellular organisms
  - Metazoa = multi-celled organisms
  - True animals
  - Cells organized into larger units, individual cells cannot survive alone

Organization of Animal Complexity

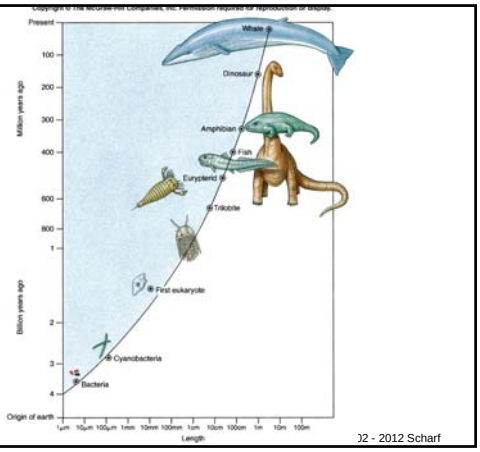
Grades or Levels of Organization

Unicellular (Protozoans)

1. Protoplasmic
   - All functions occur within cell

Multicellular (Metazoans)

2. Cellular
   - Group of cells with different functions
3. Tissue
   - Aggregation of similar cells into layers
4. Organ
   - Organization of tissues into organs
5. System
   - Organs working together to perform function



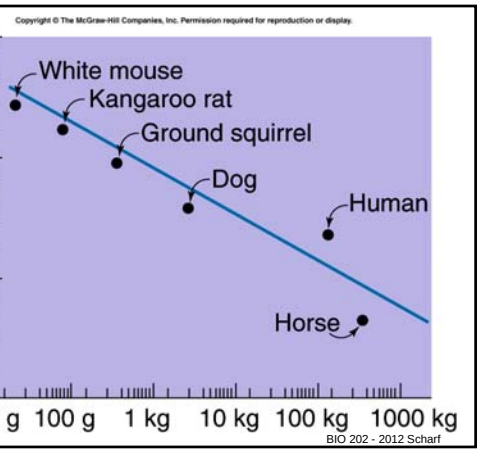
Organization of Animal Complexity

Body size

- **Complex organization promotes evolution of large body size**

Some advantages of large body size

- **Able to tolerate environmental variation**
- **Predator avoidance**
  - **Morphology**
  - **Behavior**
- **Food acquisition**
- **Metabolically efficient**
  - **Absolute energy demands higher for large animals but,**
  - **RELATIVE energy demands (per unit body weight) are LOWER**



Organization of Animal Complexity

Body size

- **Disadvantages of large body size**

Problem: surface area increases, but at a slower rate than body volume

- Surface area > as (body length)^2
- Volume > as (body length)^3

Why is it a problem?

- Physiological processes of nutrient, gas, and waste exchange often occur across surfaces

Solutions:

1. Folds in body surface
2. Development of internal transport systems

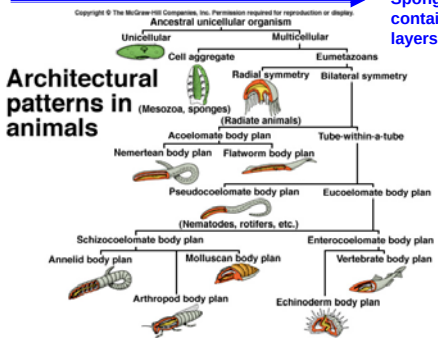
Body Plans

- **Number of animal body plans is limited**

Basic characteristics that have evolved

- Multicellular organization
- Symmetry
- Body cavity
- True coelom
- Segmentation
- Cephalization

1st Major Variation in Body Plan

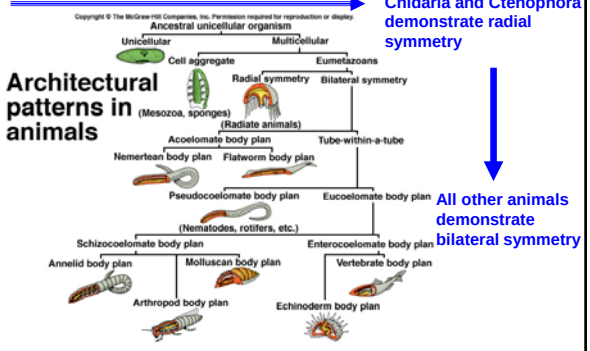


Sponges (Ph. Porifera) contain no germ layers or organs

All other animals possess true tissues

2nd Major Variation in Body Plan

Cnidaria and Ctenophora demonstrate radial symmetry



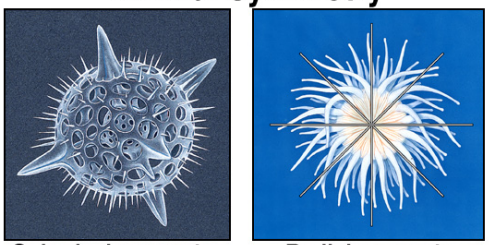
All other animals demonstrate bilateral symmetry

Animal Symmetry

Correspondence in size or shape on two sides of a plane

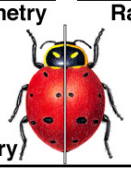
1. **Radial**
   - Cnidarians, Ctenophores, some sponges, and sea urchins
   - Usually sessile, free floating animals
   - Can interact with environment from all sides
2. **Bilateral**
   - Major evolutionary advance
   - Well suited for forward movement

Animal symmetry

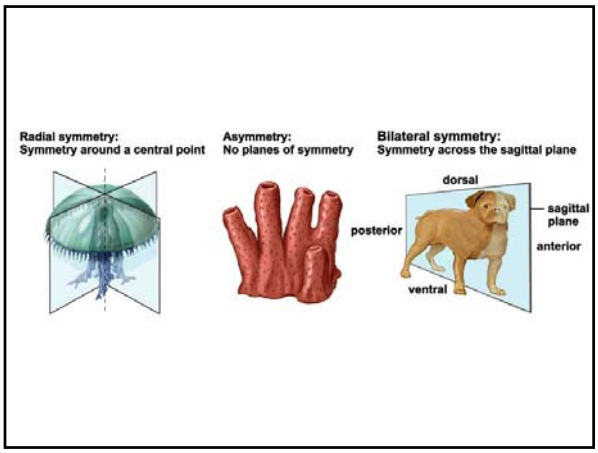


Spherical symmetry

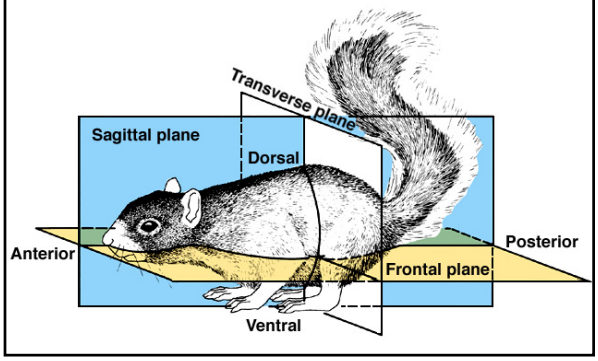
Radial symmetry



Bilateral symmetry

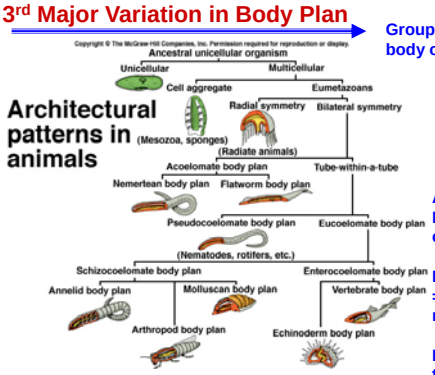


Planes of animal symmetry



3rd Major Variation in Body Plan

Grouped by type of body cavity or coelom



Acoelomates = No body cavity

Pseudocoelomates = body cavity but not a true coelom

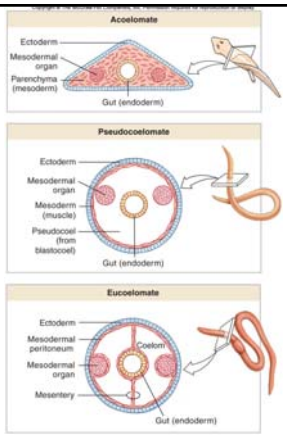
Eucoelomates = true coelom

Why is the evolution of a body cavity important?

- Tube-within-a-tube allows greater flexibility
- Space for organs
- Exposes more cells to surface exchange

What are the differences?

1. Acoelomates
   - No body cavity – space filled with parenchyma
2. Pseudocoelomates
   - Have body cavity but not a true coelom since it's not derived from mesoderm
3. Eucoelomates
   - Possess true coelom that is derived from mesoderm

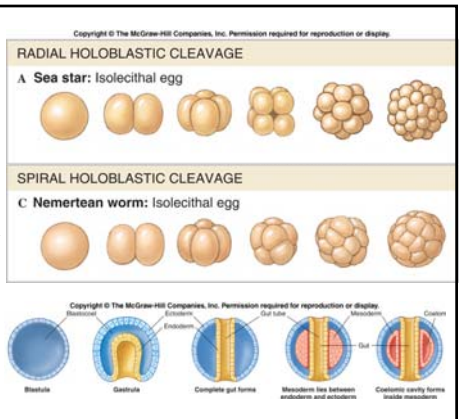


Two main types of cell cleavage:

Radial →

Spiral →

Generalized sequence of development →



Body plans

Two major body plans:

1) **Deuterostome ("2nd mouth") animals**
   - Radial cleavage
   - Blastopore becomes anus
   - Echinoderms, Hemichordates, and Chordates
   - All are true eucoelomates

2) **Protostome ("1st mouth") animals**
   - Spiral cleavage
   - Blastopore becomes mouth
   - Includes acoelomates, pseudocoelomates, and eucoelomates
   - Two major subgroups: **Ecdysozoa** and **Lophotrochozoa**

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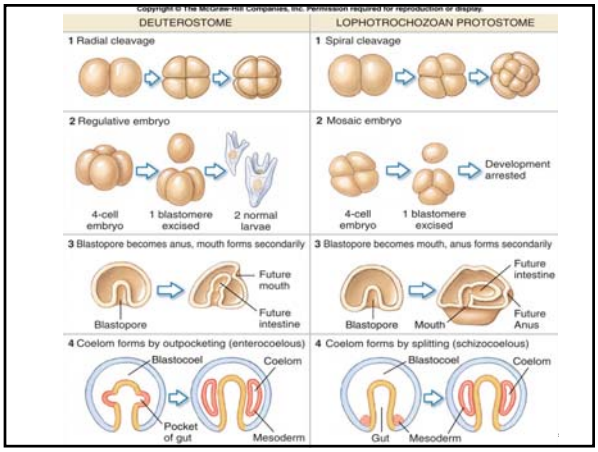

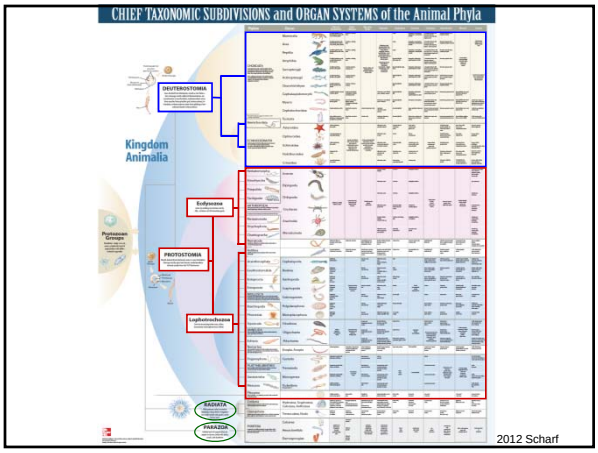

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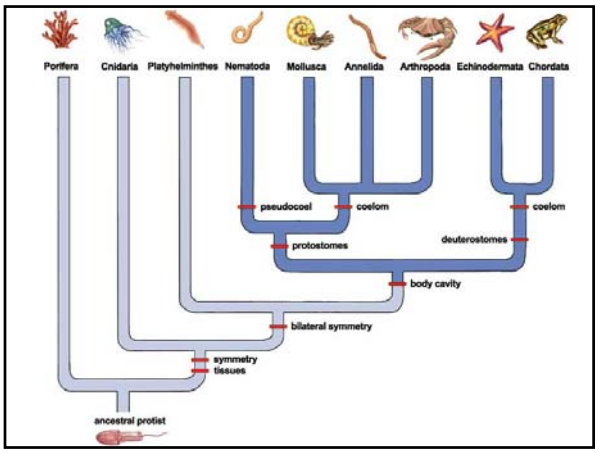
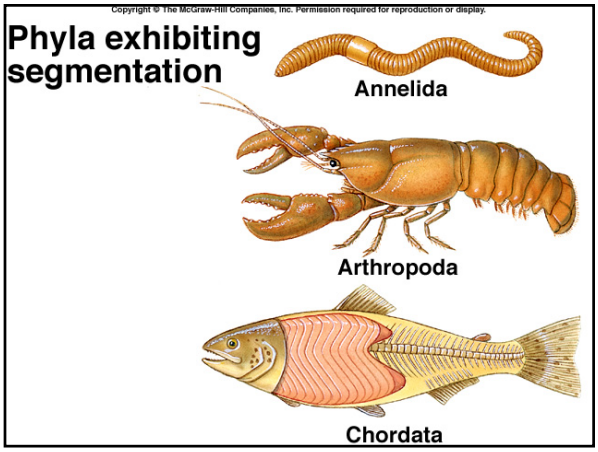

Porifera
Cnidaria
Platyhelminthes
Nematoda
Mollusca
Annelida
Arthropoda
Echinodermata
Chordata
pseudocoel
coelom
coelom
protostomes
deuterostomes
body cavity
bilateral symmetry
symmetry
tissues
ancestral protist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Phyla exhibiting segmentation
Annelida
Arthropoda
Chordata