

BIOSC 041

Overview of Animal Diversity: Animal Body Plans

Reference: Chapter 32



Outline

- ❖ Definition and major characteristics of animals
- ❖ Dividing animals into groups based on:
 - Body symmetry
 - Tissues
 - Type of body cavity
 - Protostome vs deuterostome development
- ❖ Animal Phylogeny

What is an Animal?

- ❖ Scientists have identified 1.3 million living species of animals
- ❖ The definition of an animal
 - Multicellular
 - Heterotrophic eukaryotes
 - Possess tissues that develop from embryonic layers
- ❖ Common characteristics describe the group
 1. Common mode of nutrition
 2. Cell structure and specialization
 3. Reproduction and development

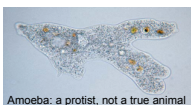
1. Characteristics of Animals: Nutrition

- ❖ Animals are **heterotrophs** ("other-eater")
 - Obtain nutrition either from other living organisms or from nonliving organic material
 - **Primary consumers** (herbivores), **secondary consumers** (eat herbivores), **tertiary consumers** (eat carnivores), and/or **detritovores** (eat detritus- decaying plants/ animals, feces)



2. Characteristics of Animals: Cell Structure and Specialization

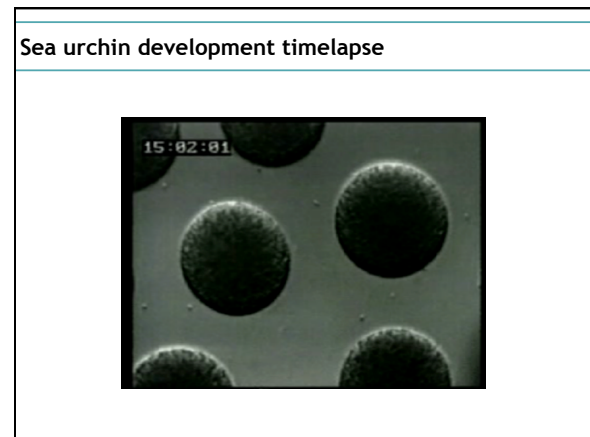
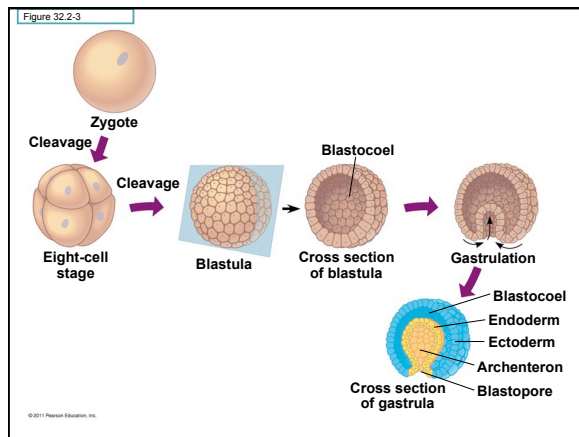
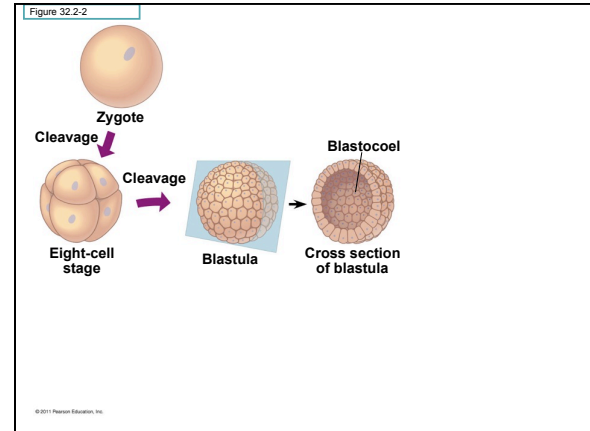
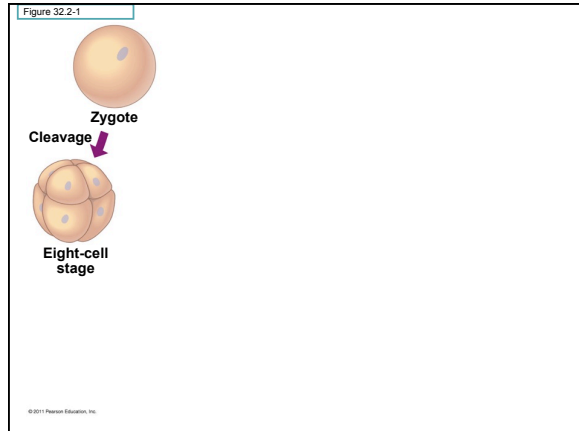
1. Animals are multicellular eukaryotes
(Note: single-celled eukaryotes with animal-like behavior are grouped as **Protists**, such as amoeba)
2. Animal cells lack cell walls
3. Bodies are held together by structural proteins like collagen
4. Bodies are organized into tissues, organs, and organ systems
 - **Tissues** are groups of cells that have a common structure, and/or function
 - Nervous tissue and muscle tissue are unique to animals



Amoeba: a protist, not a true animal

3. Characteristics of Animals: Reproduction and Development

- ❖ Most animals reproduce sexually, with the diploid stage dominating the life cycle
- ❖ Development occurs in specific stages
 1. Fertilization to form **zygote**
 2. Zygote undergoes rapid cell division called **cleavage**
 3. Cleavage leads to formation of a multicellular, hollow **blastula** (ex: whitefish blastula slides from lab, with cells undergoing rapid mitosis)
 4. The blastula undergoes **gastrulation**, forming a **gastrula** with different layers of **embryonic tissues**



3. Characteristics of Animals: Reproduction and Development, cont'd

- ❖ Many animals have at least one larval stage
 - A **larva** (pl. **larvae**) is sexually immature and morphologically distinct from the adult
 - It eventually undergoes **metamorphosis** (physical development)
 - A **juvenile** resembles an adult, but is not yet sexually mature

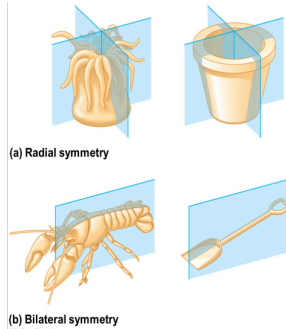


Animal "body plans"

- ❖ Animals may be categorized according to **body plan**- a set of morphological and developmental traits shared by a group:
 - Type of symmetry
 - Certain types of tissues
 - Type of body cavity
 - Protostome vs deuterostome development
- ❖ Animal body plans have evolved over time
 - Many reflect ancient innovations - traits that have been **conserved** over evolutionary time
 - Gastrulation is under molecular control by **Hox genes**
 - Most animals (and only animals) have **Hox genes** that regulate the development of body form
 - the **Hox** family of genes has been highly conserved

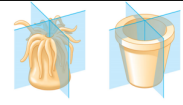
Body Plan: Symmetry

- ❖ Animals can be categorized according to the symmetry of their bodies, or lack of it
- 1. No Symmetry
- 2. **Radial Symmetry**
- 3. **Bilateral Symmetry**



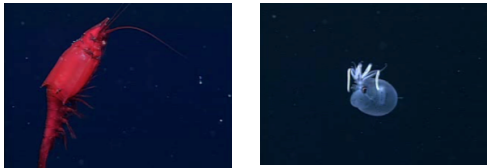
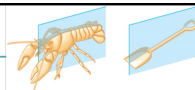
Body Plan: Radial Symmetry

- ❖ Body has one, vertical axis
 - no front and back, or left and right
- ❖ Radial animals are often sessile (fixed in place) or planktonic (drifting or weakly swimming)



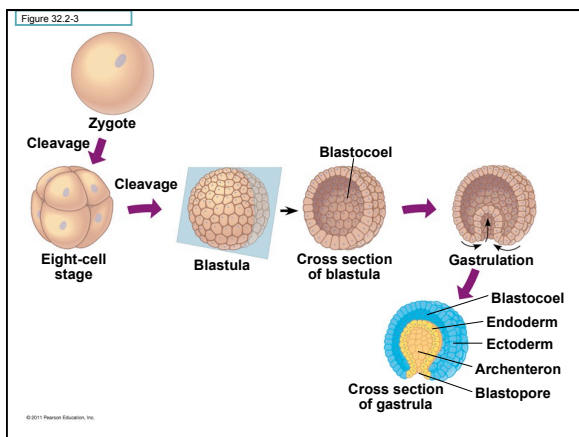
Body Plan: Bilateral Symmetry

- ❖ Two-sided symmetry is called **bilateral symmetry**
- ❖ Bilaterally symmetrical (bilaterian) animals have
 - A **dorsal** (top) side and a **ventral** (bottom) side
 - A right and left side
 - **Anterior** (head) and **posterior** (tail) ends
 - **Cephalization**, the development of a head



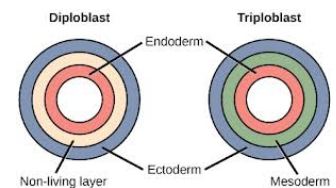
Animal Body Plans: Embryonic Tissues

- ❖ Animal body plans also vary according to the type and organization of the animal's **tissues**
 - Collections of specialized cells isolated from other tissues by membranous layers
- ❖ During development, **three primary germ layers** give rise to the tissues and organs of the animal embryo
 - **Ectoderm**
 - "Outer" germ layer covering the embryo's surface
 - **Mesoderm**
 - "Middle" layer
 - **Endoderm**
 - "Inner" germ layer
 - Lines the developing digestive tube, called the **archenteron**



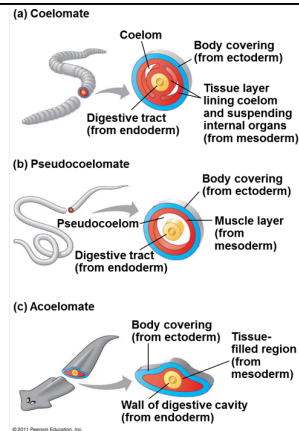
Animal Body Plans: Embryonic Tissues

- ❖ Sponges (Porifera) and a few other groups lack true tissues
- ❖ **Diploblastic** animals have **ectoderm** and **endoderm**
 - no mesoderm
 - include jellyfish and comb jellies
- ❖ **Triploblastic** animals also have **mesoderm** layer; these include all **bilaterians**
 - These include flatworms, arthropods, vertebrates, and others



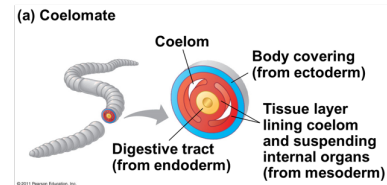
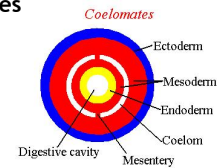
Animal Body Plans: Body Cavities

- ❖ Animals can be classified on the basis of presence/absence of a true body cavity, or **coelom**



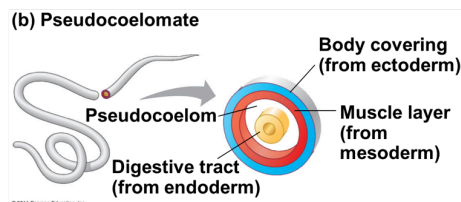
Animal Body Plans: Coelomates

- ❖ **Coelomates**
 - Possess a true coelom
 - Derived from mesoderm
 - Enveloped by mesentery



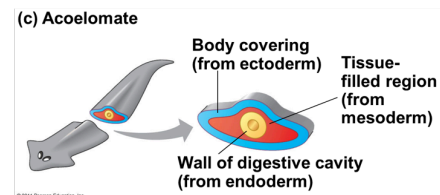
Animal Body Plans: Pseudocoelomates

- ❖ **Pseudocoelom**
 - A body cavity derived from the mesoderm and endoderm
- ❖ Triploblastic animals that possess a pseudocoelom are called **pseudocoelomates**



Animal Body Plans: Acoelomates

- ❖ Triploblastic animals that lack a body cavity are called **acoelomates**

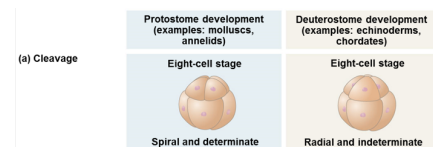


Animal Body Plans: Protostome vs. Deuterostome Development

- ❖ **Protostome** = "first mouth"
- ❖ **Deuterostome** = "second mouth"
- ❖ Based on the
 - Type of cleavage during early development
 - Formation of coelom
 - Fate of the blastopore

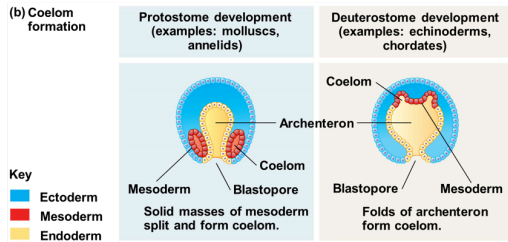
Animal Body Plans: Protostome vs. Deuterostome Cleavage

- ❖ **Protostome development**
 - Cleavage is spiral and determinate
- ❖ **Deuterostome development**
 - Cleavage is radial and indeterminate
 - Each cell in the early stages of cleavage retains the capacity to develop into a complete embryo
 - Indeterminate cleavage makes possible identical twins, and embryonic stem cells



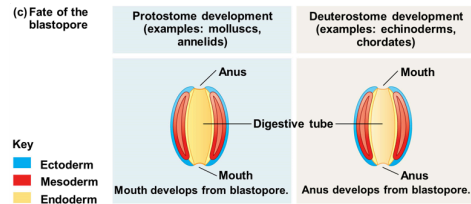
Animal Body Plans: Protostome vs. Deuterostome Coelom Formation

- ❖ In protostome development, the splitting of solid masses of mesoderm forms the coelom
- ❖ In deuterostome development, the mesoderm buds from the wall of the archenteron to form the coelom



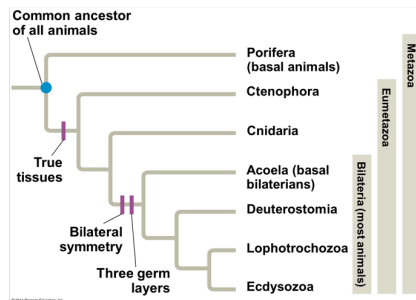
Animal Body Plans: Protostome vs. Deuterostome Fate of the Blastopore

- ❖ The **blastopore** forms during gastrulation and connects the archenteron to the exterior of the gastrula
- ❖ In protostome development, blastopore → mouth
- ❖ In deuterostome development, blastopore → anus
 - A second opening forms the mouth ("second" mouth)

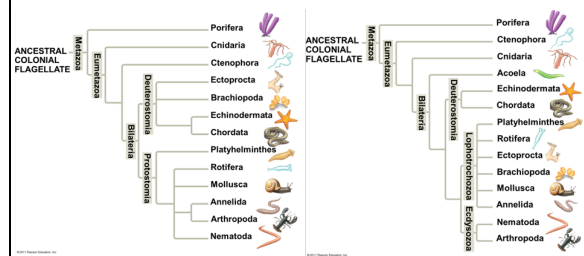


New views of animal phylogeny are emerging from molecular data

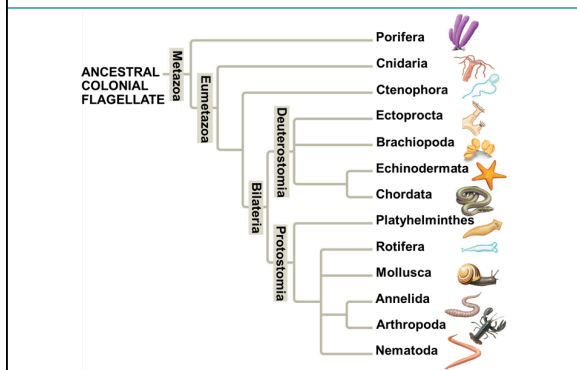
- ❖ Zoologists recognize about three dozen animal phyla
- ❖ Phylogenies now combine morphological, molecular, and fossil data



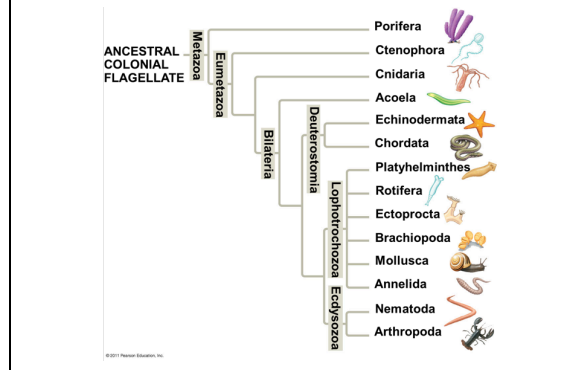
Two competing hypotheses for animal evolution



One hypothesis of animal phylogeny is based mainly on morphological and developmental comparisons

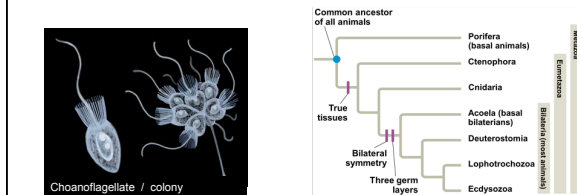


One hypothesis of animal phylogeny is based mainly on molecular data



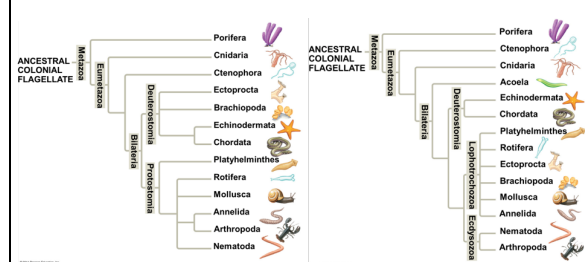
Points of Agreement

1. All animals share a common ancestor (most likely a colonial flagellate similar to choanoflagellates)
2. Sponges are **basal** animals
3. **Eumetazoa** is a clade of animals with true tissues
4. Most animal phyla belong to the clade **Bilateria**
5. Chordates and some other phyla belong to the clade **Deuterostomia**



Progress in Resolving Bilaterian Relationships

- ❖ The morphology-based tree divides bilaterians into two clades: Deuterostomes and Protostomes
- ❖ In contrast, recent molecular studies indicate three bilaterian clades: Deuterostomia, Ecdysozoa, and Lophotrochozoa



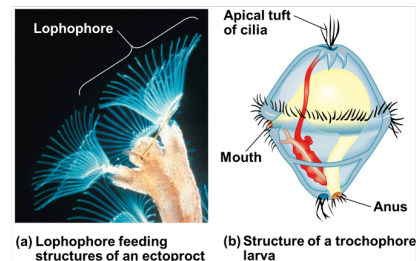
Progress in Resolving Bilaterian Relationships

- ❖ **Ecdysozoans**
 - Secrete **exoskeleton - cuticle**
 - Shed the exoskeletons through a process called **ecdysis** (moulting)
- ❖ Important to note that some taxa not included in this clade also moult (ex: snakes)



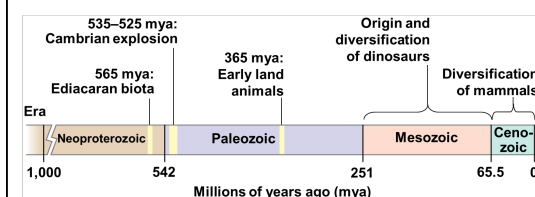
Progress in Resolving Bilaterian Relationships

- ❖ Some lophotrochozoans have a feeding structure called a **lophophore**
- ❖ Others go through a distinct developmental stage called the **trochophore larva**



History of animals spans > half a billion years

- ❖ Includes a great diversity of living species, even greater diversity of extinct ones
- ❖ Common ancestor of living animals may have lived between 675 and 800 million years ago
 - This ancestor may have resembled modern choanoflagellates, protists that are the closest living relatives of animals



Summary

- ❖ Animals are multicellular, heterotrophic eukaryotes with tissues that develop from embryonic layers
- ❖ Animals can be characterized by “body plans”
 - Symmetry
 - Tissue formation
 - Body cavity
 - Protostome vs deuterostome development
- ❖ Views of animal phylogeny continue to be shaped by new molecular and morphological data
- ❖ Consensus is that all animals share a common ancestor, 675-800 mya, similar to a choanoflagellate (sponges are made up of choanocytes)