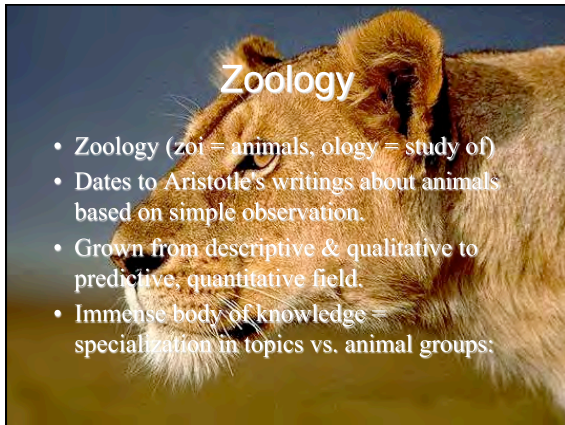
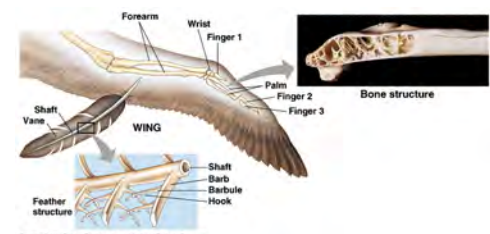


Zoology

- Zoology (zoi = animals, ology = study of)
- Dates to Aristotle's writings about animals based on simple observation.
- Grown from descriptive & qualitative to predictive, quantitative field.
- Immense body of knowledge – specialization in topics vs. animal groups:



Animal Form & Function



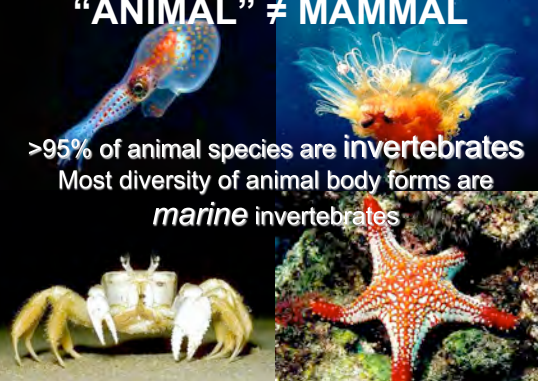
By far, most diversity of bauplane (body forms).
And most variations within bauplane.

Animals are Animated — Fascinating Behaviors

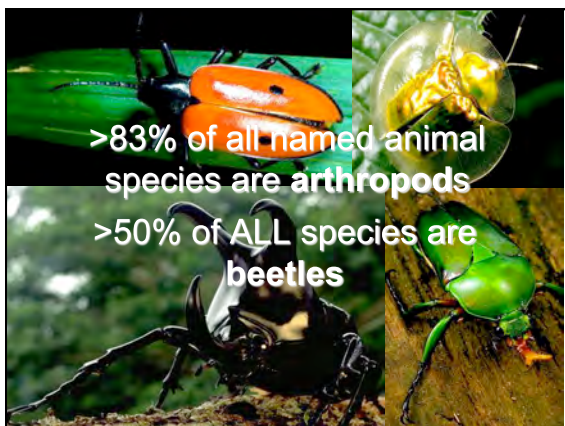


“ANIMAL” ≠ MAMMAL

>95% of animal species are invertebrates
Most diversity of animal body forms are
marine invertebrates



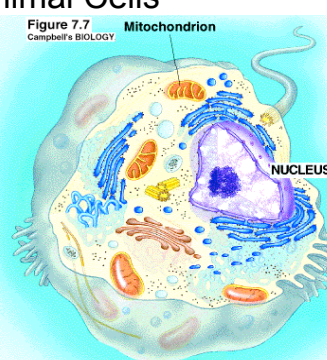
>83% of all named animal species are arthropods
>50% of ALL species are beetles




Animal Cells

Figure 7.7
Campbell's BIOLOGY

- Eukaryotic
- No cell wall
No plastids
No central vacuole
- Multicellular:
 - extensive specialization & differentiation
 - unique cell-cell junctions



Animals



Animals

- Motile
- Highly differentiated tissues
- Intercellular junctions
 - tissue-specific **cadherins**
- Extracellular protein fibers
 - **collagen**
- Diploid life cycle
- **Blastula/gastrula** embryo

Blastulation & Gastrulation

- Early embryonic development in animals

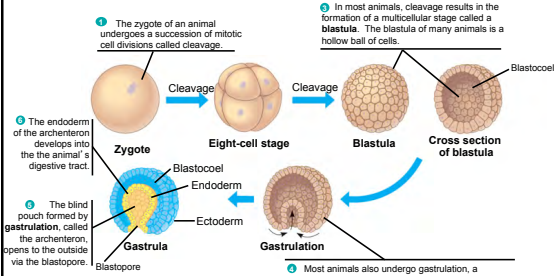


Figure 32.2

1 The zygote of an animal undergoes a succession of mitotic cell divisions called cleavage.

2 In most animals, cleavage results in the formation of a multicellular stage called a **blastula**. The blastula of many animals is a hollow ball of cells.

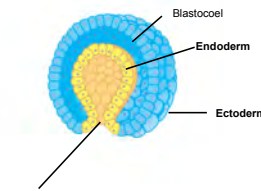
3 The endoderm of the archenteron develops into the animal's digestive tract.

4 The blind pouch formed by **gastrulation**, called the archenteron, opens to the outside via the blastopore.

5 Most animals also undergo gastrulation, a rearrangement of the embryo in which one end of the embryo folds inward, expands, and eventually fills the blastocoel, producing layers of embryonic tissues: the **ectoderm** (outer layer) and the **endoderm** (inner layer).

Primary embryonic germ layers

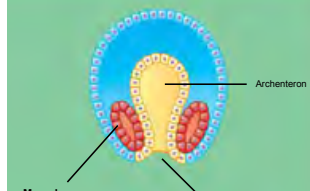
- **Diploblastic**: two germ layers
 - **Ectoderm**: develops into epidermal & neural tissues
 - **Endoderm**: develops into feeding tissues
 - Blastocoel: becomes filled with acellular **mesogleia**



Examples: Porifera & Cnidaria

Primary embryonic germ layers

- **Triploblastic**: three germ layers
 - **Ectoderm**: develops into epidermal & neural tissues
 - **Endoderm**: develops into gut & accessory organs
 - **Mesoderm** — displaces blastocoel: develops into muscle, endoskeleton, & connective tissues




Examples: everything else

Figure 32.9b

Body Symmetry

- **Asymmetry**
 - Determined by environmental constraints — Encrusting
- **Radial symmetry**

Radial symmetry. The parts of a radial animal, such as a sea anemone (phylum Cnidaria), radiate from the center. Any imaginary slice through the central axis divides the animal into mirror images.



- Body orientation has two recognizable sides: **oral** (with mouth) & **aboral** (opposite side from mouth)

Body Symmetry

- **Asymmetry**
 - Determined by environmental constraints — Encrusting
- **Radial symmetry**
- **Bilateral symmetry**

Bilateral symmetry. A bilateral animal, such as a lobster (phylum Arthropoda), has a left side and a right side. Only one imaginary cut divides the animal into mirror-image halves.

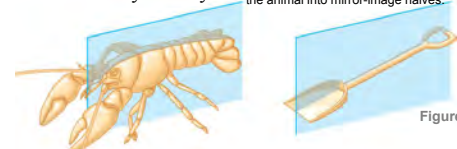


Figure 32.7b

- Body orientation has two recognizable **lateral** sides (right/left); **anterior** (front); **posterior** (rear); **dorsal** (back); & **ventral** (belly) dimensions.
- Generally accompanied by **cephalization**: localization of sensory and central nervous centers to the anterior (head)

Animals

Variations in Gastrulation: Digestive tract

- **Gastrovascular cavity** (blind gut)
 - Blastopore remains only orifice to gut
- **Protostome** (“mouth first”) development
 - The blastopore becomes the mouth
 - Secondary invagination to form anus
- **Deuterostome** (“mouth second”) development
 - The blastopore becomes the anus
 - Secondary invagination to form mouth

The diagrams illustrate three types of digestive tracts:

- Gastrovascular Cavity:** A single opening at the top labeled 'Mouth' leads into a central cavity. Below the cavity, the opening is labeled 'Mouth develops from blastopore.'
- Protostome:** A central 'Digestive tube' is shown. The top opening is 'Mouth' and the bottom opening is 'Anus'. Below, it says 'Mouth develops from blastopore.'
- Deuterostome:** A central 'Digestive tube' is shown. The top opening is 'Anus' and the bottom opening is 'Mouth'. Below, it says 'Anus develops from blastopore.'

	Protostome development (examples: molluscs, annelids)	Deuterostome development (examples: echinoderms, chordates)
(a) Cleavage	Eight-cell stage Spiral and determinate	Eight-cell stage Radial and indeterminate
(b) Coelom formation	Archenteron Coelom Mesoderm Blastopore Solid masses of mesoderm split and form coelom.	Archenteron Coelom Blastopore Mesoderm Folds of archenteron form coelom.
(c) Fate of the blastopore	Anus Digestive tube Mouth Mouth develops from blastopore.	Mouth Digestive tube Anus Anus develops from blastopore.

Key: Ectoderm (blue), Mesoderm (red), Endoderm (yellow)

Figure 32.10

Organ Systems

The diagram shows an animal body with various systems:

- External environment:** Mouth (intake of Food, CO₂, O₂), Anus (excretion of Unabsorbed matter (feces)).
- Internal systems:** Digestive system (Heart, Intestinal fluid), Circulatory system (Heart, Interstitial fluid), Respiratory system (Cells), Excretory system (Metabolic waste products (urine)).
- Scale bars:** 0.5 cm (overall body), 50 μm (digestive system), 10 μm (excretory system).

Figure 40.4

Circulatory & Respiratory Systems

The diagram shows a cross-section of a two-cell layer organism. It has a central 'Gastrovascular cavity' where 'Diffusion' occurs. The outer layer is labeled 'Mouth' and 'Diffusion'.

Figure 40.3b (b) Two cell layers

Circulatory Systems

- Ciliated Body Cavity
- Open Circulatory System
- Closed Circulatory System

The diagrams illustrate:

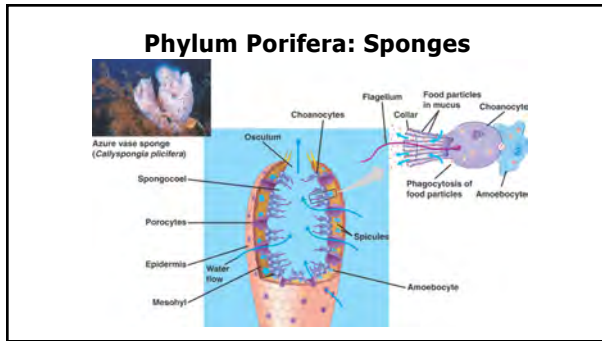
- Open Circulatory System (Insect):** Shows a 'Tubular heart' at the top, 'Lateral hearts' on the sides, and 'Hemocoel' (open body cavity) at the bottom. The 'Gastrovascular cavity' is at the top, with 'Pharynx' and 'Mouth'.
- Closed Circulatory System (Earthworm):** Shows a 'Dorsal blood vessel' at the top and a 'Ventral blood vessel' at the bottom, connected by 'Lateral hearts'.

Uncertain Systematics

Figure 32.10: Cladogram based on certain morphological and developmental characters. It shows relationships between groups like Porifera, Radiata, Deuterostomia, Protostomia, Bilateria, Eumetazoa, Metazoa, and Hypothetical Ancestor.

Figure 32.11: Cladogram based on certain molecular and other developmental characters. It shows relationships between groups like Porifera, Radiata, Deuterostomia, Lophotrochozoa, Ecdysozoa, Bilateria, Eumetazoa, and Hypothetical Ancestor.

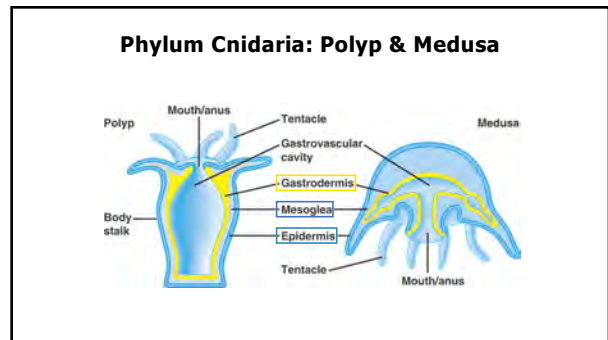
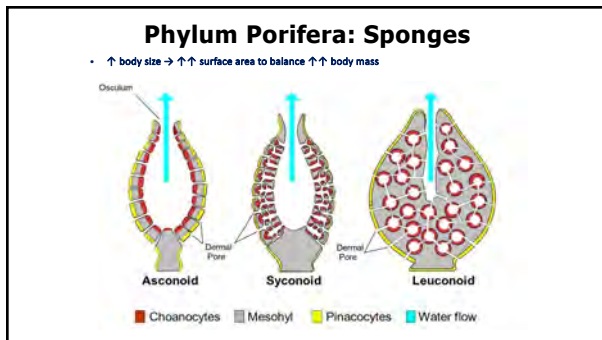
- No fossil record — all phyla appear simultaneously (“Cambrian explosion”)
- Morphological, embryological, and molecular characters all yield contradictory patterns



Phylum Porifera: Sponges

- Embryonic development:
 - Diploblastic
 - Radial symmetry → may become asymmetrical
 - No coelom
 - acellular mesogleia between endoderm and ectoderm
 - Gut → filter chamber (**spongocoel**)
 - intracellular digestion
 - Flagellated larvae
 - Circulatory systems:
 - Flagellated* spongocoel
 - Cell-mediated: amoebocytes
- Special features:
 - Choanocytes
 - Amoebocytes
 - Spicules
 - *Flagellated tissue

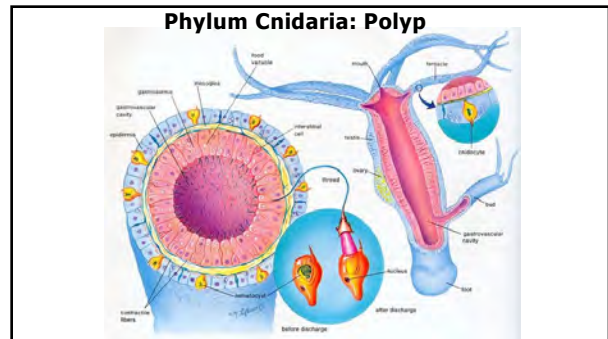
A small diagram of a sponge cross-section, similar to the one in the previous slide, showing the internal structure and feeding process.

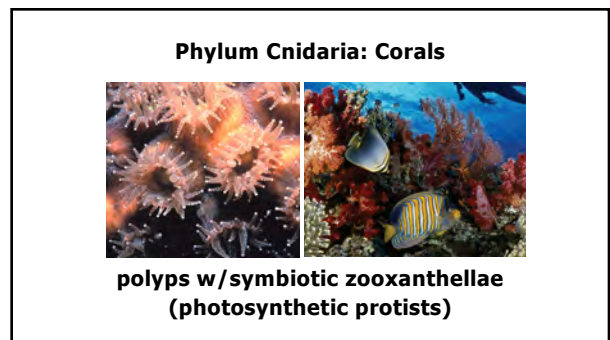
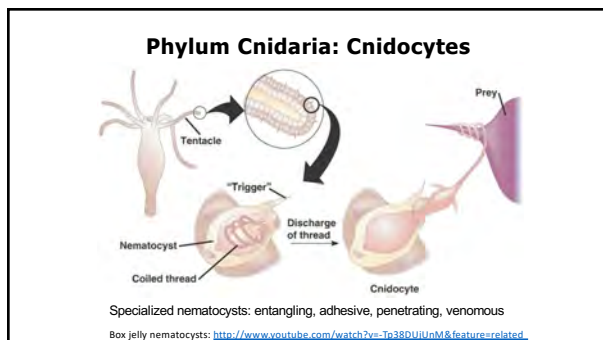
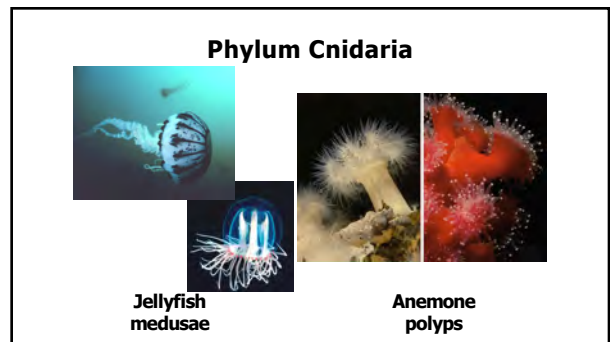
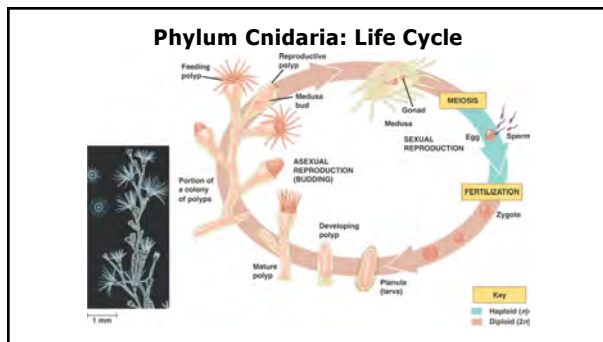


Phylum Cnidaria: Polyp & Medusa

- Embryonic development:
 - Diploblastic
 - Radial symmetry
 - No coelom
 - acellular mesogleia
 - Ciliated / contractile gastrovascular cavity
 - Ciliated **planula** larvae
- Special features:
 - Polyps & medusas
 - Ciliated myoepithelia
 - Cnidocytes w/ nematocysts

A small diagram showing a Polyp and a Medusa, similar to the one in the previous slide, with labels for Mouth/anus, Tentacle, Gastrovascular cavity, Gastrodermis, Mesoglea, Epidermis, Body stalk, and Tentacle.





Phylum Annelida: Segmented Worms

- Embryonic development:
 - Triploblastic
 - Bilateral symmetry w/ cephalization
 - Closed vascular circulatory system
 - Protostome
 - Eucoelomate
 - Lophotrochozoa
- Special features:
 - Segmentation
 - Hydrostatic skeleton

