

### 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

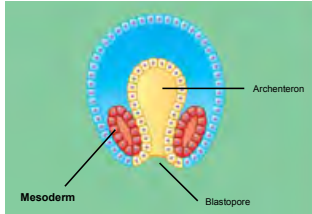


Figure 32.9b

### Triploblastic gastrulation forms three germ layers

ECTODERM	MESODERM	ENDODERM
<ul style="list-style-type: none"> <li>• Epidermis of skin and its derivatives (including sweat glands, hair follicles)</li> <li>• Epithelial lining of mouth and rectum</li> <li>• Sense receptors in epidermis</li> <li>• Cornea and lens of eye</li> <li>• Nervous system</li> <li>• Adrenal medulla</li> <li>• Tooth enamel</li> <li>• Epithelium of pineal and pituitary glands</li> </ul>	<ul style="list-style-type: none"> <li>• Notochord</li> <li>• Endoskeletal system</li> <li>• Muscular system</li> <li>• Muscular layer of stomach, intestine, etc.</li> <li>• Excretory system</li> <li>• Circulatory and lymphatic systems</li> <li>• Reproductive system (except germ cells)</li> <li>• Dermis of skin</li> <li>• Lining of body cavity</li> <li>• Adrenal cortex</li> </ul>	<ul style="list-style-type: none"> <li>• Epithelial lining of digestive tract</li> <li>• Epithelial lining of respiratory system</li> <li>• Lining of urethra, urinary bladder, and reproductive system</li> <li>• Liver</li> <li>• Pancreas</li> <li>• Thymus</li> <li>• Thyroid and parathyroid glands</li> </ul>

Figure 47.16

### Epithelial Tissue

- Continuous sheet or layers of cells with direct cell-cell junctions
- All three germ layers start as epithelia, so epithelial tissues may derive from any germ layer.

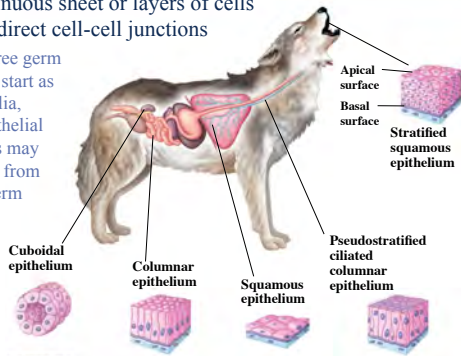
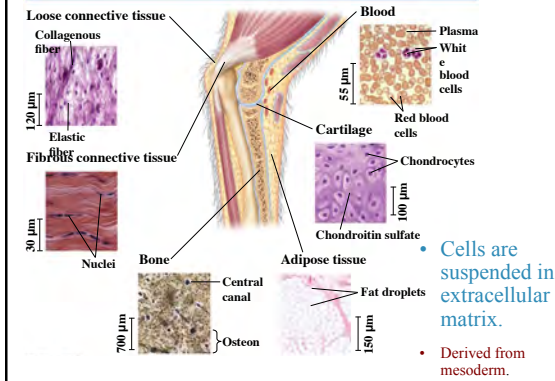


Figure 40.5

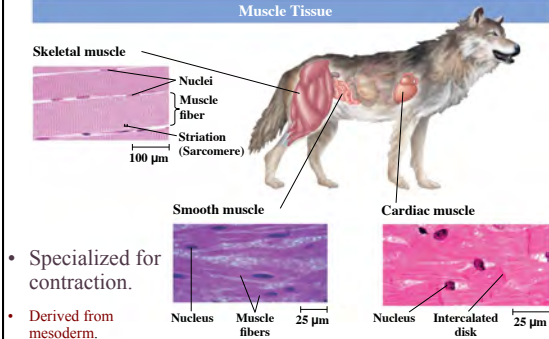
### Connective Tissue



- Cells are suspended in extracellular matrix.
- Derived from mesoderm.

Figure 40.5

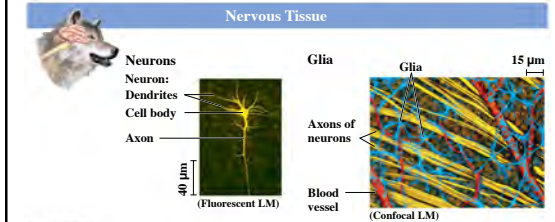
### Muscle Tissue



- Specialized for contraction.
- Derived from mesoderm.

Figure 40.5

### Nervous Tissue

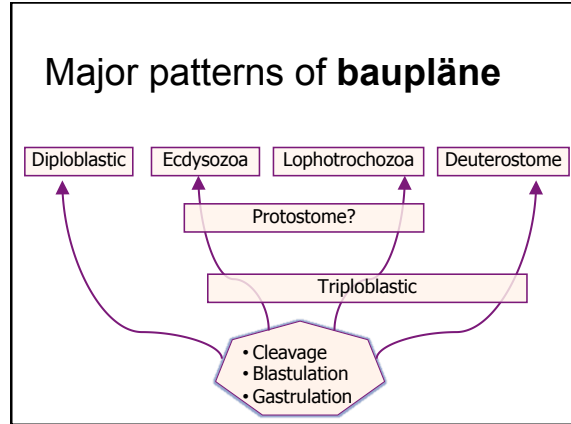


- Specialized to conduct electrochemical nerve impulses.
- Derived from ectoderm.

Figure 40.5

**Bauplan:**  
 Ger. "Life Plan" (*pl*: baupläne)

The arrangement, pattern, and development of tissues, organs, and systems unique to a particular type of **organism**.



**Larval Development**

Protostomal development occurs in two distinct animal groups

- **Lophotrochozoa:** have ciliated larval stages
  - Usually with a distinct larval stage called a **trochophore**
- **Ecdysozoa:** have no ciliated tissues
  - All stages have a chitinous cuticle
  - Growth requires **ecdysis** (molting)

Figure 32.12 ecdysis

Figure 32.13 trochophore larva

**Coelom**

- Formation of body cavities allows movement of organs within the body, esp. gut expansion & motility

- **Acoelomate:** no body cavity
- **Pseudocoelomate:** cavity between endoderm & mesoderm
- **Eucoelomate:** cavity within mesoderm

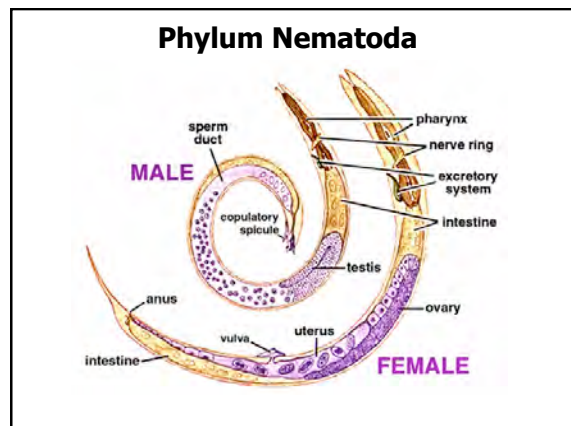
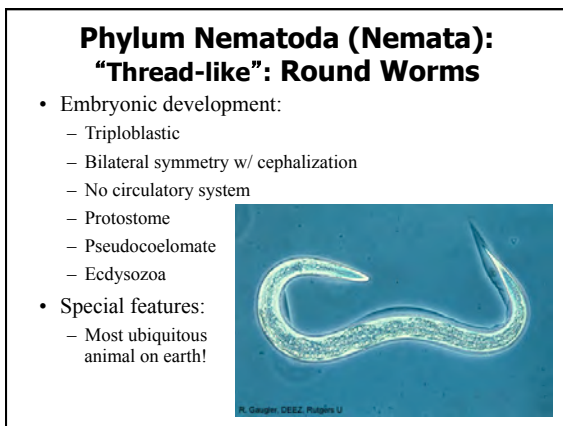
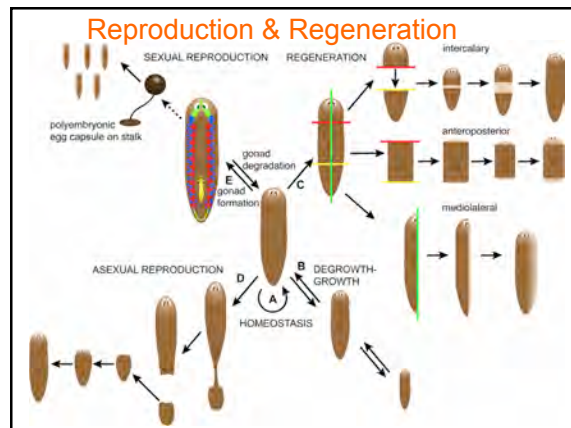
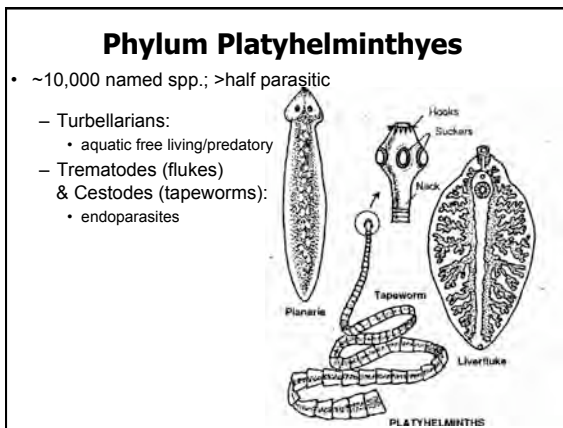
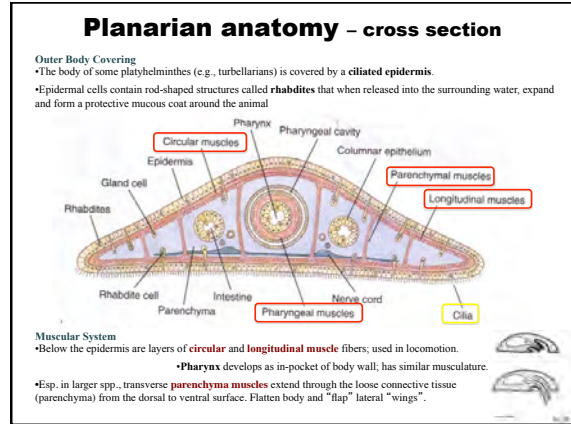
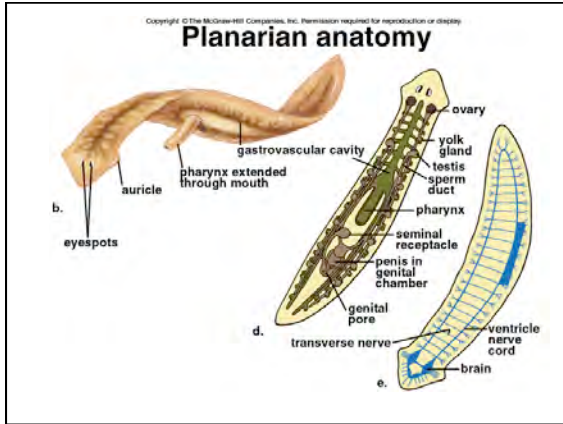
Figure 32.8

**Phylum Platyhelminthes: "Flat Worms"**

- Embryonic development:
  - Triploblastic
  - Bilateral symmetry w/ cephalization
  - No circulatory system
  - Gastrovascular cavity
  - Acoelomate
- Special features:
  - Dorso-ventrally flattened


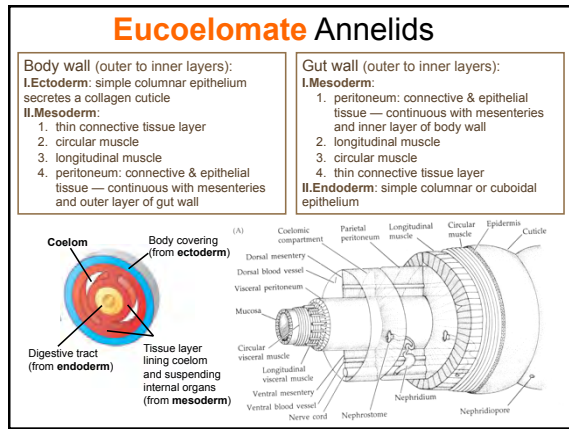
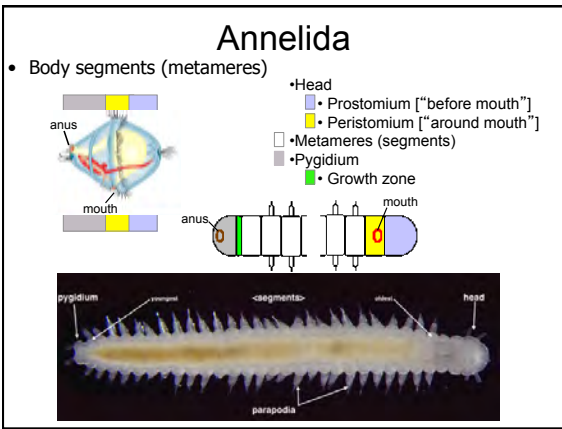
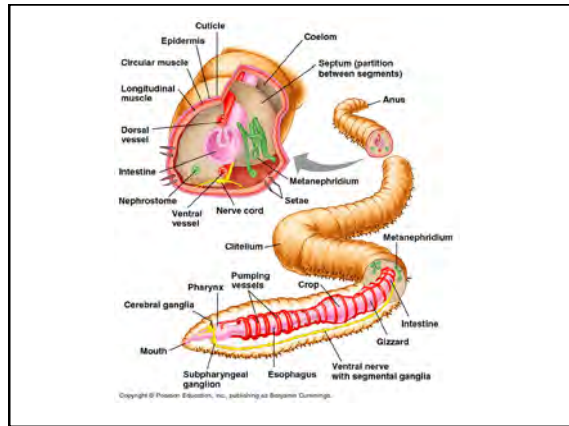
**Bilateral symmetry with cephalization**

- Turbellarian flatworm




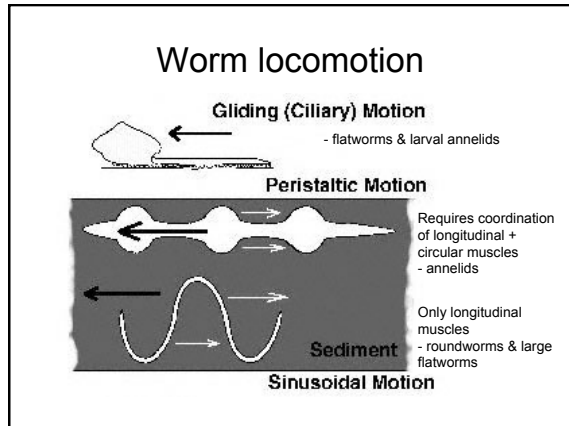
### Phylum Annelida: Segmented Worms

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

### Annelida

- 2 Classes
  - Polychaeta – bristle worms ~12,000 spp.
  - Clitellata – earthworms & leeches ~ 5,000 spp.

### Platyhelminth locomotion

**Outer Body Covering**

- The body of some platyhelminths (e.g., turbellarians) is covered by a ciliated epidermis
- Epidermal cells contain rod-shaped structures called *rhopalia* that when released into the surrounding water, expand and form a protective mucous coat around the animal

**Muscular System**

- Below the epidermis are layers of circular and longitudinal muscle fibers; used in locomotion

- Ciliary gliding: <http://vimeo.com/11416114>
- Sinusoidal undulations: <http://www.youtube.com/watch?feature=fvwp&NR=1&v=7UkZHDlujUc>

### THRUST FORCES DURING SINUSOIDAL SWIMMING

NOTE: waves may be D/V or L/R in orientation.

### Polychaete locomotion

- Video clips
  - <http://www.youtube.com/watch?v=J8TfQUM8uu4&feature=fvrel>
  - <http://www.youtube.com/watch?v=b5f4bitNJoU&feature=related>
- Animations:
  - <http://www.biology.ualberta.ca/Polychaete.swf>

Polychaeta locomotion: shows the alternate contraction of the longitudinal muscles to form the wedge shape that results in the zig zag walking.

### Earthworm locomotion

#### Peristaltic movement

- Contracted longitudinal muscle
- Contracted circular muscle

### Earthworm locomotion

- Animations:
  - <http://www.biology.ualberta.ca/courses.hp/zool250/animations/Earthworm.swf>
  - <http://www.youtube.com/watch?v=oH8NMYi7qqw>

### Aquatic oligochaete locomotion

Segmentation → variation of sinusoidal: Helical swimming in *Lumbriculus*: A unique form of animal locomotion

ccw = counterclockwise  
cw = clockwise  
elapsed time (f1 → f7) = 0.2 sec  
2 mm