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

Triploblastic gastrulation forms three germ layers

<table>
<thead>
<tr>
<th>ECTODERM</th>
<th>MESODERM</th>
<th>ENDODERM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidermis of skin and its derivatives (including sweat glands, hair follicles)</td>
<td>Notochord</td>
<td>Epithelial lining of digestive tract</td>
</tr>
<tr>
<td>Epithelial lining of mouth and nasal cavities, etc.</td>
<td>Mesenchyme</td>
<td>Epithelial lining of digestive tract</td>
</tr>
<tr>
<td>Sense receptors in epidermis</td>
<td>Circulatory and lymphatic systems</td>
<td>Epithelial lining of respiratory system</td>
</tr>
<tr>
<td>Cornea and lens of eye</td>
<td>Reproductive systems (except germ cells)</td>
<td>Epithelial lining of urinary bladder, and reproductive system</td>
</tr>
<tr>
<td>Adrenal medulla</td>
<td>Dermis of skin</td>
<td>Liver</td>
</tr>
<tr>
<td>Tooth enamel</td>
<td>Nervous system</td>
<td>Pancreas</td>
</tr>
<tr>
<td>Epithelium or pineal and pituitary glands</td>
<td>Adrenal cortex</td>
<td>Thymus</td>
</tr>
</tbody>
</table>

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.

Connective Tissue

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

Muscle Tissue

- Specialized for contraction.
- Derived from mesoderm.

Nervous Tissue

- Specialized to conduct electrochemical nerve impulses.
- Derived from ectoderm.
Bauplan: *Ger. “Life Plan” (pl: baupläne)*

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

Major patterns of baupläne

- **Diploblastic**
  - Ecdysozoa
  - Lophotrochozoa
  - Deuterostome

- **Triploblastic**
  - Protostome?

- **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

Phylum Platyhelminthes: “Flat Worms”

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

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)

Coelom

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

Bilateral symmetry with cephalization

- **Turbellarian flatworm**
Planarian anatomy – cross section

- The body of some planarians (e.g., turbellarians) is covered by a ciliated epidermis.
- Epidermal cells contain rod-shaped structures called rhabdites 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.
- Pharynx develops as an out-pocket of body wall; has similar musculature.
- Esp. in larger spp., transverse parenchyma muscles extend through the loose connective tissue (parenchyma) from the dorsal to ventral surface. Flatten body and "flap" lateral "wings."

Phylum Platyhelminthes

- ~10,000 named spp.; > half parasitic
- Turbellarians:
  - aquatic free living/predatory
- Trematodes (flukes) & Cestodes (tapeworms):
  - endoparasites

Reproduction & Regeneration

Phylum Nematoda (Nemata): "Thread-like": Round Worms

- Embryonic development:
  - Triploblastic
  - Bilateral symmetry w/ cephalization
  - No circulatory system
  - Protostome
  - Pseudocoelomate
  - Ecdysozoa
- Special features:
  - Most ubiquitous animal on earth!
Phylum Annelida: Segmented Worms

- Embryonic development:
  - Triploblastic
  - Bilateral symmetry w/ cephalization
  - Closed circulatory system
  - Protostome
  - Eucelomate
  - Lophotrochozoa

- Special features:
  - Segmentation
  - Hydrostatic skeleton

Annelida

- Body segments (metameres)
  - Head
  - Prostomium ("before mouth")
  - Peristomium ("around mouth")
  - Metameres (segments)
  - Pygidium
  - Growth zone

Eucoelomate Annelids

- Body wall (outer to inner layers):
  1. Ectoderm: simple columnar epithelium secretes a collagen cuticle
  2. Mesoderm: thin connective tissue layer
  3. Peritoneum: connective & epithelial tissue — continuous with mesenteries and outer layer of gut wall

- Gut wall (outer to inner layers):
  1. Endoderm: simple columnar epithelium

Annelida

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

Worm locomotion

- Gliding (Ciliary) Motion
  - Flatworms & larval annelids

- Peristaltic Motion
  - Requires coordination of longitudinal + circular muscles
  - Need changes in pressure

- Sinusoidal Motion
  - Roundworms & large flatworms

Heyer
Platyhelminth locomotion

- Ciliary gliding: http://vimeo.com/11416114
- Sinusoidal undulations:
  http://www.youtube.com/watch?feature=fvwp&NR=1&v=7UkZH6IgkUg

Outer Body Covering

- The body of some platyhelminthes (e.g., turbellarians) is covered by a ciliated epidermis.
- Epidermal cells contain rod-shaped structures called rhabdites 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.

Polychaete locomotion

- Video clips:
  - http://www.youtube.com/watch?v=J8TfQUM8uu4&feature=fvwrel
  - http://www.youtube.com/watch?v=b5f4bitNJoU&feature=related

- Animations:
  - http://www.biology.ualberta.ca/courses.hp/zool250/animations/Polychaete.swf

Polychaete 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

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

Aquatic oligochaete locomotion

- Segmentation direction of wave & backthrust
  - direction of swimming
  - counterclockwise

- Animations:
  - http://www.youtube.com/watch?v=oH8NMYi7qqw

Helical swimming in Lumbriculus:

- A unique form of animal locomotion

- Elapsed time (f1 to f7) = 0.2 sec
- Direction of swimming
- Backthrust