ANNELIDA: THE METAMERIC BODY FORM

Class Polychaeta

- External Structure and Locomotion
- Feeding and the Digestive System
- Gas Exchange and Circulation
- Nervous and Sensory Functions
- Excretion
- Regeneration
- Reproduction, and Development

Class Oligochaeta

- External Structure and Locomotion
- Feeding and the Digestive System
- Gas Exchange and Circulation
- Nervous and Sensory Functions
- Excretion
- Reproduction and Development

Class Hirudinea

- External Structure and Locomotion
- Feeding and the Digestive System
- Gas Exchange and Circulation
- Nervous and Sensory Functions
- Excretion
- Reproduction and Development

Characteristics of the phylum Annelida

1. Body metameric, bilaterally symmetrical, and wormlike
2. Protostome characteristics include spiral cleavage, trochophore larvae (when larvae are present), and schizocoelous coelom formation
3. Paired, epidermal setae
4. Closed circulatory system
5. Dorsal suprapharyngeal ganglia and ventral nerve cord(s) with ganglia
6. Metanephridia (usually) or protonephridia

Metamerism and Tagmatization

- Segmental arrangement of body parts in an animal is called **metamerism**.
- Two related functions are probably the primary adaptive features of metamerism:
  - i. flexible support
  - ii. efficient locomotion.

Development of Metameric, Coelomic Spaces in Annelids

- Body cavity arises by a segmental splitting of a solid mass of mesoderm.
- Mesoderm occupies the region between ectoderm and endoderm on either side of the embryonic gut tract.
- Schizocoelous coelom formation.
- Each cavity forms a double-membraned septum on the anterior and posterior margin of each coelomic space.
- Dorsal and ventral mesenteries associated with the digestive tract.
- Muscles also develop from the mesodermal layers associated with each segment.
- A layer of circular muscles lies below the epidermis.
- A layer of longitudinal muscles, just below the circular muscles.
- Some polychaetes have oblique muscles, and the leeches have dorsoventral muscles.

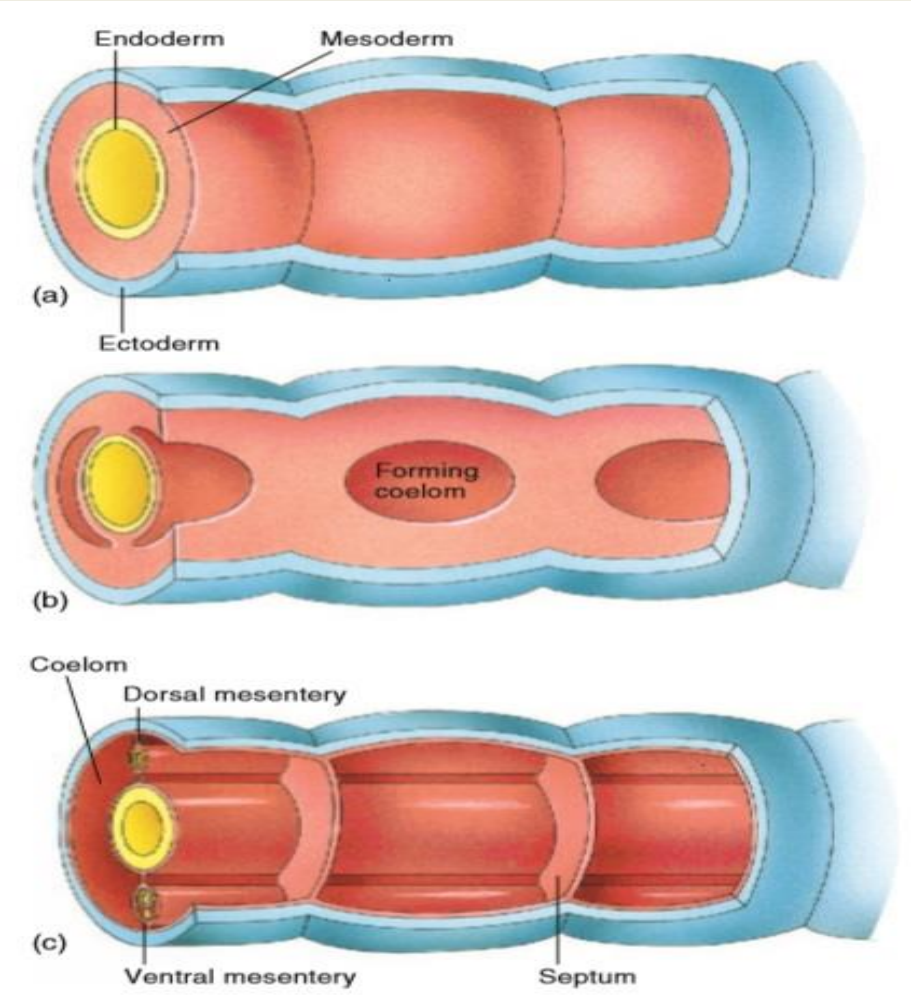

Fig: Development of Metameric, Coelomic Spaces in Annelids. (a) A solid mesodermal mass separates ectoderm and endoderm in early embryological stages. (b) Two cavities in each segment form from the mesoderm splitting on each side of the endoderm (schizocoelous coelom formation). (c) These cavities spread in all directions. Enlargement of the coelomic sacs leaves a thin layer of mesoderm applied against the outer body wall (the parietal peritoneum) and the gut tract (the visceral peritoneum), and dorsal and ventral mesenteries form. Anterior and posterior expansion of the coelom in adjacent segments forms the double-membraned septum that separates annelid metameres.

First Advantage of metamerism

- ✓ Each segment can be controlled independently of distant segments.
- ✓ Muscles can act as antagonistic pairs within a segment.
- ✓ Coelomic fluid provides a hydrostatic skeleton against which muscles operate.
- ✓ Provide the basis for swimming, crawling, and burrowing.

Second Advantage of metamerism

- ✓ It lessens the impact of injury.
- ✓ If one or a few segments are injured, adjacent segments, set off from injured segments by septa, may be able to maintain nearly normal functions.

Third Advantage of metamerism

- ✓ It permits the modification of certain regions of the body for specialized functions, such as feeding, locomotion, and reproduction.
- ✓ The specialization of body regions in a metameric animal is called **tagmatization**

Annelids and arthropods are thought to be closely related Because of :

- **Similarities in the development of metamerism.**
- **Triploblastic coelomate organization.**
- **Bilateral symmetry.**
- **Complete digestive tract.**
- **Ventral nerve cord.**

*As usual, fossil evidence documenting ancestral pathways that led from a common ancestor to the earliest representatives of these two phyla is scant.

*Annelids and arthropods may have evolved from a marine, wormlike, bilateral ancestor that possessed metameric design.

CLASSIFICATION OF THE PHYLUM ANNELIDA

Phylum Annelida (ah-nel′i-dah)

The phylum of triploblastic, coelomate animals whose members are metameric (segmented), elongate, and cylindrical or oval in cross section. Annelids have a complete digestive tract; paired, epidermal setae; and a ventral nerve cord. The phylum is traditionally divided into three classes. Cladistic analysis has resulted in other interpretations, which will be discussed later.

Class Polychaeta (pol″e-kēt′ah)

The largest annelid class; mostly marine; head with eyes and tentacles; parapodia bear numerous setae; monoecious or dioecious; development frequently involves a trochophore larval stage. *Nereis*, *Arenicola*, *Sabella*. More than 5,300 species.

Class Oligochaeta (ol″ i-go-kēt′ah)

Few setae and no parapodia; no distinct head; monoecious with direct development; primarily freshwater or terrestrial. *Lumbricus*, *Tubifex*. Over 3,000 species.

Class Hirudinea (hi′ru-din″ e-ah)

Leeches; bodies with 34 segments; each segment subdivided into annuli; anterior and posterior suckers present; monoecious with direct development; parapodia absent; setae reduced or absent. Freshwater, marine, and terrestrial. *Hirudo*. Approximately 500 species.

CLASS POLYCHAETA

General Characteristics:

- Mostly marine.
- Usually between 5 and 10 cm long.
- More than 5,300 species.
- Polychaeta is the largest of the annelid classes.
- Many live on the ocean floor, under rocks and shells, and within the crevices of coral reefs.
- Other polychaetes are burrowers and move through their substrate by peristaltic contractions of the body wall.
- Construct tubes of cemented sand grains or secreted organic materials.
- Mucus-lined tubes serve as protective retreats and feeding stations.

EXTERNAL STRUCTURE AND LOCOMOTION

Parapodia

- Lateral extensions called parapodia.
- Chitinous rods support the parapodia.
- Numerous setae project from the parapodia, giving them their class name.

Fig: Class Polychaeta. External structure of *Nereis virens*. Note the numerous parapodia.

Setae

- Setae are bristles secreted from invaginations of the distal ends of parapodia.
- They aid locomotion by digging into the substrate.
- Hold a worm in its burrow or tube

Prostomium

- The prostomium is a lobe that projects dorsally and anteriorly to the mouth.
- Contains numerous sensory structures.
- Eyes, antennae, palps, and ciliated pits or grooves, called nuchal organs.

Peristomium

- The first body segment, the peristomium.
- Surrounds the mouth and bears sensory tentacles or cirri.

Epidermis

- Consists of a single layer of columnar cells.
- Secrete a protective, nonliving cuticle.
- Some polychaetes have epidermal glands that secrete luminescent compounds.

LOCOMOTION

- When longitudinal muscles on one side of a segment contract, the parapodial muscles on that side also contract, stiffening the parapodium and protruding the setae for the power stroke.
- As a polychaete changes from a slow crawl to swimming, the period and amplitude of undulatory waves increase.
- Burrowing polychaetes push their way through sand and mud by contractions of the body wall or by eating their way through the substrate.
- Polychaetes digest organic matter in the substrate and eliminate absorbed and undigestible materials via the anus.

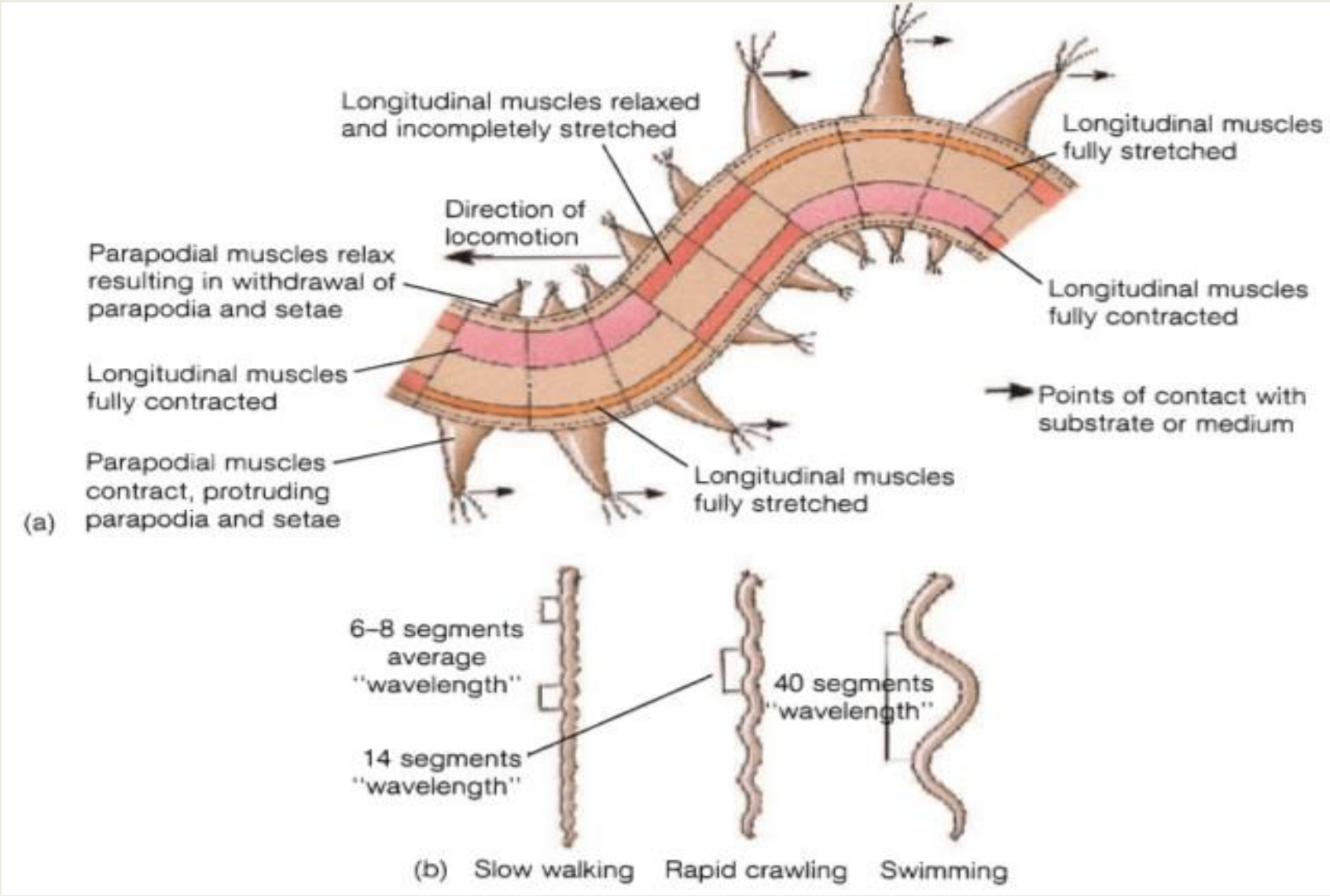

Fig: Polychaete Locomotion. (a) Dorsal view of a primitive polychaete, showing the antagonism of longitudinal muscles on opposite sides of the body and the resultant protrusion and movement of parapodia. (b) Both the period and amplitude of locomotor waves increase as a polychaete changes from a "slow walk" to a swimming mode

FEEDING AND THE DIGESTIVE SYSTEM

- The digestive tract is a straight tube.
- The anterior region of the digestive tract is modified into a proboscis
- When the proboscis is everted, paired jaws are opened and may be used for seizing prey.
- Some polychaetes have poison glands at the base of the jaw.
- Other polychaetes are herbivores and scavengers and use jaws for tearing food.
- Deposit-feeding polychaetes extract organic matter from the marine sediments they ingest.
- The digestive tract consists of a pharynx, a storage sac, called a crop; a grinding gizzard and a long, straight intestine.

FEEDING AND THE DIGESTIVE SYSTEM

Predatory polychaetes

- May not leave their burrow or coral crevice.
- The worm quickly extends its anterior portion, everts the proboscis, and pulls the prey back into the burrow.

herbivores and scavengers

- use jaws for tearing food

Deposit-feeding polychaetes

- Extract organic matter from the marine sediments.
- The digestive tract consists of a pharynx that, when everted, forms the proboscis; a storage sac, called a crop; a grinding gizzard; and a long, straight intestine

sedentary and tube-dwelling polychaetes

- usually lack a proboscis but possess other specialized feeding structures.

FEEDING AND THE DIGESTIVE SYSTEM

❖ **Fanworms:**

- Tube dwellers
- possess radioles that form a funnel-shaped fan
- Cilia on the radioles circulate water through the fan, trapping food particles.
- Trapped particles are carried along a food groove at the axis of the radiole.

❖ **Chaetopterus:**

- Another filter feeder
- Chaetopterus, lives in a U-shaped tube.
- Secretes a mucous bag that collects food particles, which may be as small as 1 µm.
- The parapodia of segments 14 through 16 are modified into fans that create filtration currents. When full, the entire mucous bag is ingested

GAS EXCHANGE AND CIRCULATION

- Respiratory gases of most annelids simply **diffuse** across the body wall.
- **Parapodial gills** further increase the surface area for gas exchange.
- **Closed** circulatory system.
- **Respiratory pigments** usually dissolved in the plasma.
- Blood may be colorless, green, or red, depending on the respiratory pigment.
- **Dorsal aorta** that lies just above the digestive tract and propels blood from rear to front
- **Ventral aorta** that lies ventral to the digestive tract and propels blood from front to rear.
- Two or three sets of **segmental vessels** that receive blood from the ventral aorta and break into capillary beds in the gut and body wall.
- **Capillaries** coalesce again into segmental vessels that deliver blood to the dorsal aorta.

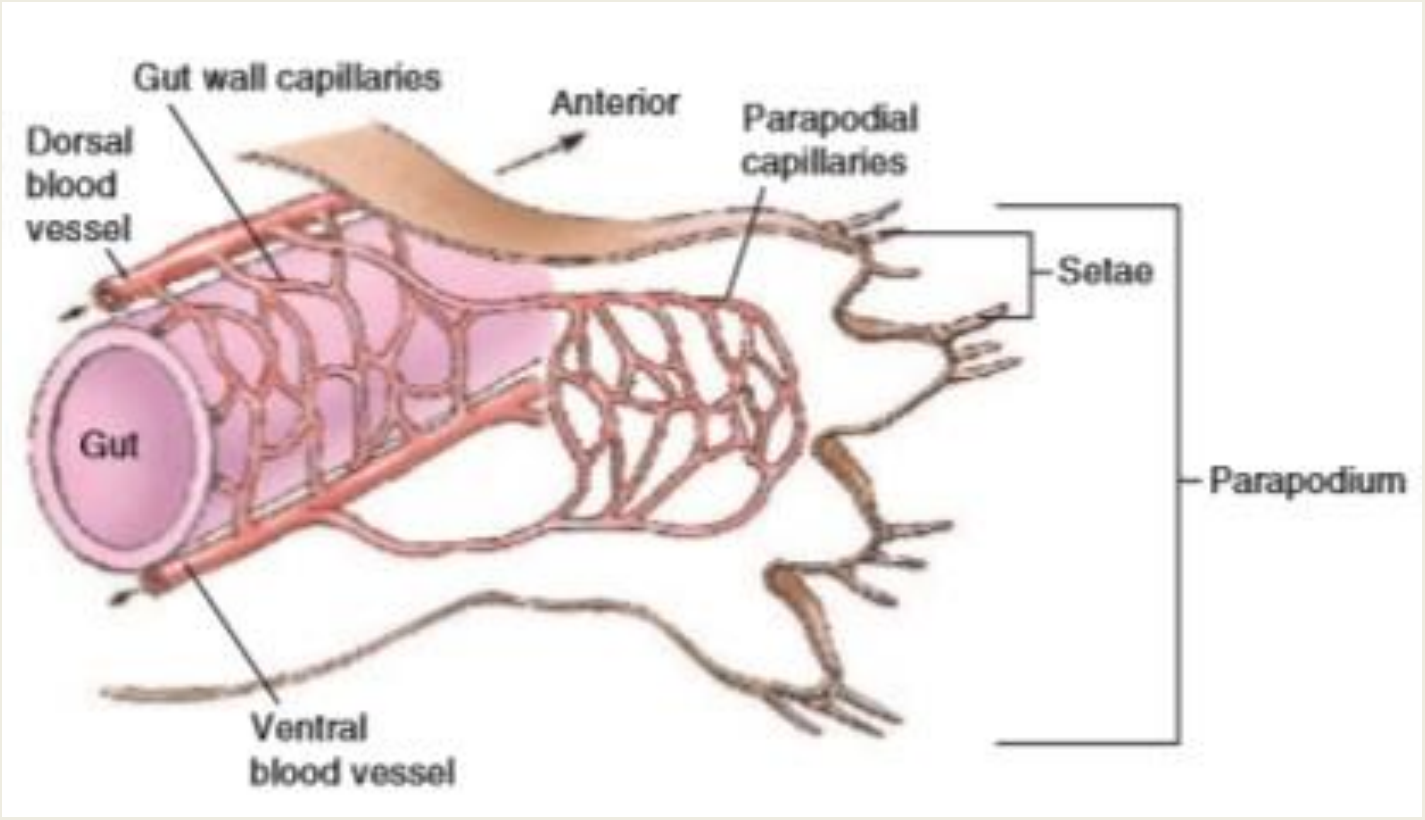

Fig: Circulatory System of a Polychaete. Cross section through the body and a parapodium. In the closed circulatory system shown here, blood passes posterior to anterior in the dorsal vessel and anterior to posterior in the ventral vessel. Capillary beds interconnect dorsal and ventral vessels.