ZOOLOGY – SEGMENTED WORMS (Phylum Annelida)

I. Compared and Contrasted to Phylum Mollusca.

A. They are like the molluscs in that they…
1. are eucoelomate animals.
2. have specialized sense organs.
3. have a closed circulatory system like the cephalopods.
4. are considered closely related to mollusks and primitive arthropods by most biologists.

B. They are more complex than the molluscs in that they…
1. show primitive metamerism.
2. have fleshy parapodia (suggesting paired appendages of more complex animals).

II. Characteristics of Phylum Annelida (the segmented worms)

A. Phylum Annelida includes about 15,000 species of segmented worms (2/3 of which are _____ worms).
1. **Class Polychaeta** - mainly _____ and usually _____.
2. **Class Clitellata –** the earthworms & their relatives & the leeches that have a clitellum used for reproduction.
a. **Class Oligochaeta** - mostly _____ or _____, some are parasitic, a few are marine or live in brackish water.
b. **Class Hirudinea** - _____ have developed both parasitic and predatory adaptations.
1) mainly in freshwater, a few are marine.

B. Annelids are true coelomates

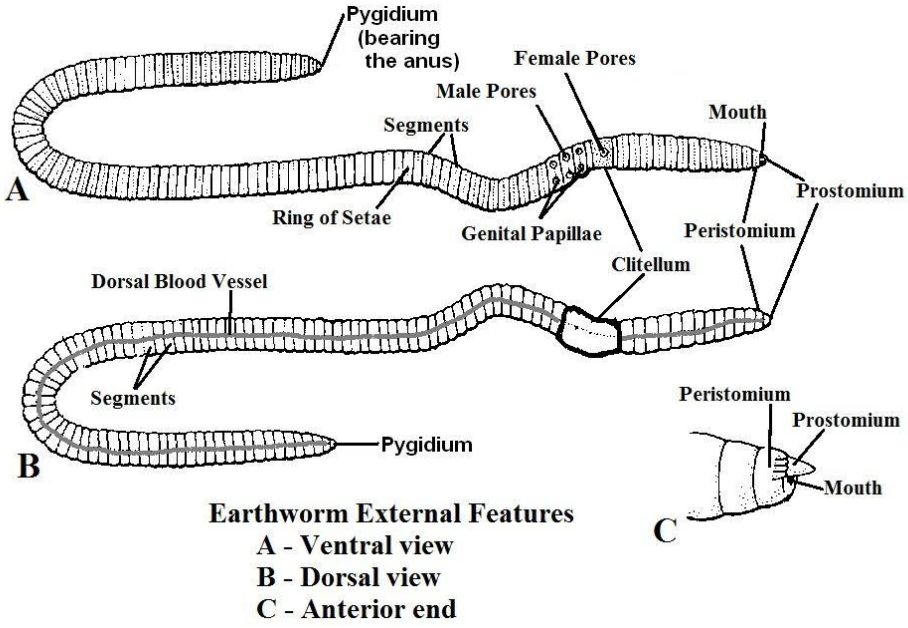
C. The nervous system is more centralized and the circulatory system is more complex than in other worms.

D. Segmentation
1. _____ would increase burrowing efficiency; this would favor evolution of the nervous system.
2. Body segments are marked by circular grooves called _____.
3. Metamerism is the repetition of organs in segments called metameres or _____.
4. Walls, called _____, separate segments.

E. Except for leeches, annelids have tiny chitinous bristles called _____.
1. Short setae anchor a segment in an earthworm so it prevents slipping backward.

2. Long setae help aquatic worms swim.

III. Body Plan of Annelids



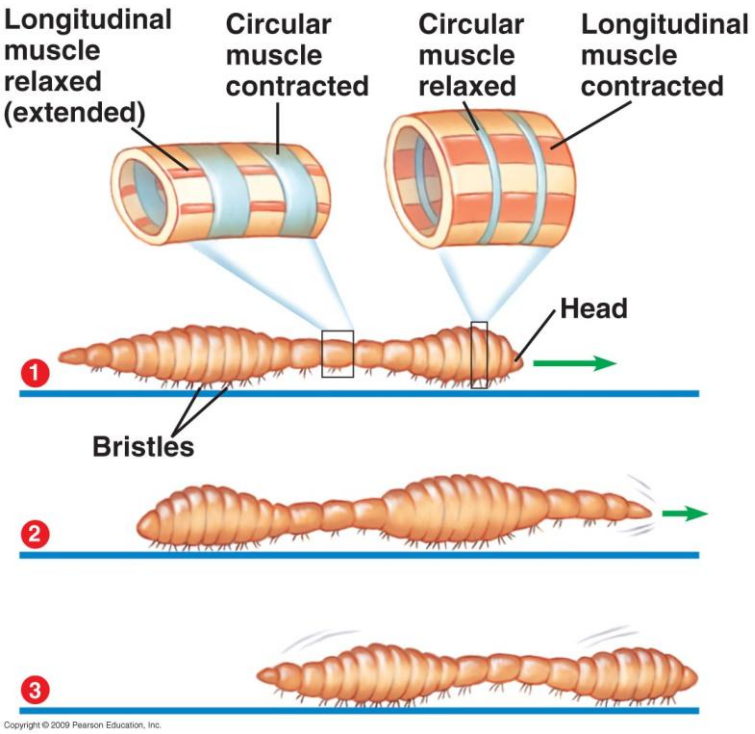
Earthworm External Features
A - Ventral view
B - Dorsal view
C - Anterior end

A. Body Wall

1. The anterior tip is the _____;
2. The terminal portion bearing the anus is the _____.
    a. new metameres form just in front of the pygidium; thus the newest segments are at the posterior.
3. Strong circular and longitudinal muscles underlie the body wall.
4. The surface is covered with an epidermis and a thin outer layer of non-chitinous _____.

B. Coelom

1. The coelom develops embryonically as a split in _____ on each side of the gut
2. _____ (mesodermal epithelium) lines the body wall and forms dorsal and ventral mesenteries.
    a. Peritonea of adjacent segments meet to form the septa.
    b. The gut and longitudinal blood vessels extend through the septa.
3. Hydrostatic Skeleton
    a. Except in leeches, the _____ is filled with fluid and serves as a hydrostatic skeleton.
    b. The fluid volume remains constant, therefore contraction of longitudinal muscles causes the body to _____ and _____.
    c. Contraction of _____ muscles causes the body to narrow and lengthen.
    d. Alternate waves of contraction, or _____, allow efficient burrowing.
    e. Swimming annelids use undulatory movements.



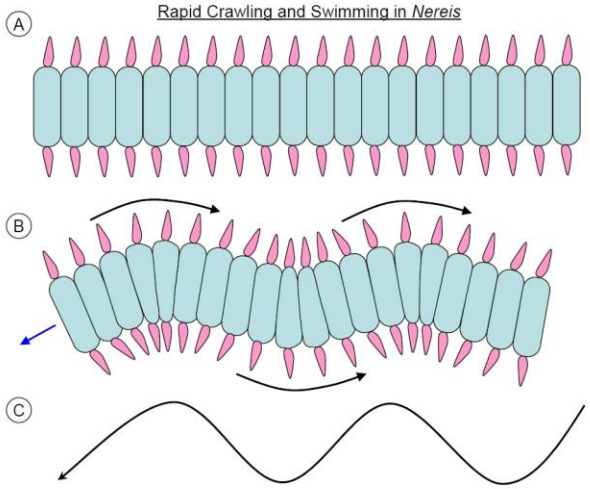
IV. Classes

A. Class Polychaeta - the largest class of annelids with more than 10,000 species, mostly marine, varying from 1 mm to 3 meters long.

1. Polychaetes have paired appendages called _____ that are on most segments.
    a. Parapodia help crawl, swim, and anchor the worm in a tube.
    b. Usually the parapodia are the chief _____ organ although the worm may also possess gills.
2. They have no clitellum.
3. Polychaetes are an important part of marine food chains.
4. Sedentary polychaetes are mainly _____.
    a. Sedentary polychaetes feed on suspended particles or particles in sediment.
5. Errant polychaetes may be free-moving, burrow or crawl.
    a. Errant polychaetes are _____ or _____.
6. Nervous System and Sense Organs
    a. Dorsal cerebral ganglia connect to subpharyngeal ganglia by a circumpharyngeal commissure.
    b. A double ventral nerve cord runs the length of the worm with ganglia in each metamere.
    c. Sense organs include ….
        1) eyes - vary from simple eyespots to well-developed image resolving eyes similar to mollusk eyes.
        2) _____ organs - ciliated sensory pits that are probably chemoreceptive
        3) _____ - Some burrowing and tube-building polychaetes use statocysts to orient their body

7. Reproduction and Development
    a. In contrast to clitellates, polychaetes have no permanent sex organs and are _____.
    b. Gonads appear as simple temporary swellings of the _____.
    c. Gametes are shed into the coelom and exit by gonoducts, metanephridia or rupturing of the body.
    d. Fertilization is external and the early larva is a _____.

8. _____ Worms: *Nereis* - errant polychaetes that live in mucus-lined burrows near the low tide level or mark.
    a. They wiggle out of hiding places at night to search for food.
    b. Clam worms feed on small animals, other worms and larval forms.



9. _____ Worms
    a. Their flattened bodies are covered with broad scales.
    b. Some are large, all are _____ and some are _____ (they live in the burrows of other animals, to their benefit, without harming the other animal).

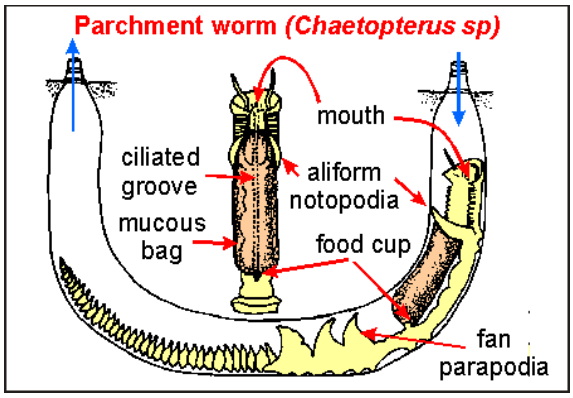
10. _____ have hollow, brittle setae that contain poisonous secretions; they feed on cnidarians.

Fireworm

Fanworm

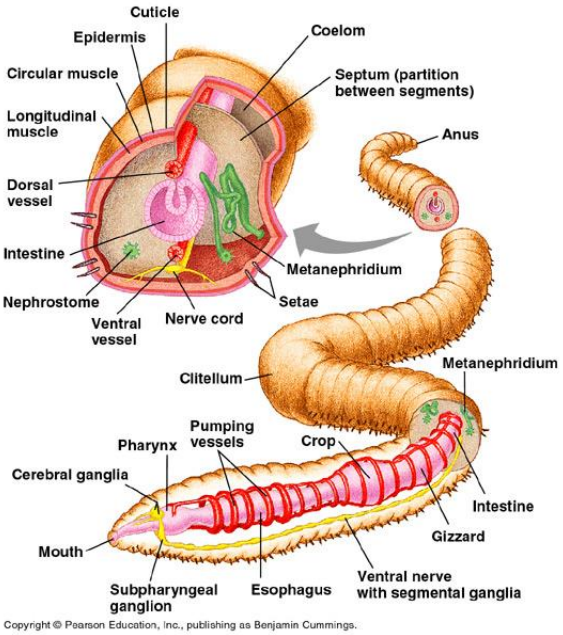
11. _____ unfurl tentacular crowns to feed; food is moved from radioles to the mouth by ciliary action.

12. The _____ worm lives in a U-shaped tube; modified segments pump water through the tube.



B. Class Clitellata – Subclass Oligochaeta - Over 3000 species occur in habitats from soil to freshwater

1. Earthworms
   a. Earthworms burrow in moist, rich soil; they emerge at night.
   b. In wet weather they stay near the surface; in dry weather they burrow deep and become dormant.
   c. Earthworms have an important role in churning the soil, mixing materials and adding nutrients.
2. Form and Function of oligochaetes
   a. In most earthworms, each segment bears four pairs of chitinous _____
   b. Each seta is a bristlelike rod set in a sac and moved by tiny muscles.
   c. Setae anchor segments during _____.



3. Nutrition - Most are _____, feeding on decayed organic matter, leaves, refuse, etc.
   a. Food is moistened by the mouth and drawn in by a sucking action of the muscular _____.
   b. Soil calcium produces a high blood calcium level; _____ along the esophagus keep down the calcium ion concentration in the blood and are ion-regulatory rather than digestive in function.
   c. Food passes the _____ to be stored in a thin-walled _____.
   d. The muscular _____ grinds food into small pieces.
   e. Digestion and absorption occur in the _____.

4. Circulation and Respiration
    a. Both coelomic fluid and blood carry food, wastes and respiratory gases.
    b. Blood circulates in a closed system with five main trunks running lengthwise in the body.
    c. The _____ above the alimentary canal has valves and functions as a true _____.
    d. The dorsal vessel pumps blood anteriorly into _____ pairs of _____.
    e. Earthworms have no special gaseous exchange organs; the moist skin handles all exchanges.
5. Nervous System and Sensory Organs
    a. Earthworms have both a central nervous system and peripheral nerves.
    b. A pair of cerebral ganglia connects around the pharynx to the ganglia of the ventral nerve cord.
    c. Fused ganglia in each somite contain both sensory and motor fibers.
    d. Neurosecretory cells in the brain and ganglia secrete neurohormones to regulate reproduction, secondary sex characteristics and _____.
    e. One or more giant axons are located in the ventral nerve cord to increase the rate of conduction and stimulate contractions of muscles in many segments.
    f. Earthworms lack eyes but have many photoreceptors in the epidermis.
    g. Free nerve endings in the tegument are probably tactile.
6. General Behavior
    a. Although they lack specialized sense organs, they are sensitive to many stimuli.
    b. They avoid _____ unless it is very dim.
    c. Chemical stimuli are important to find food.
    d. Earthworms have limited learning ability; it is mostly trial-and-error learning.
7. Reproduction and Development

Copulating Earthworms

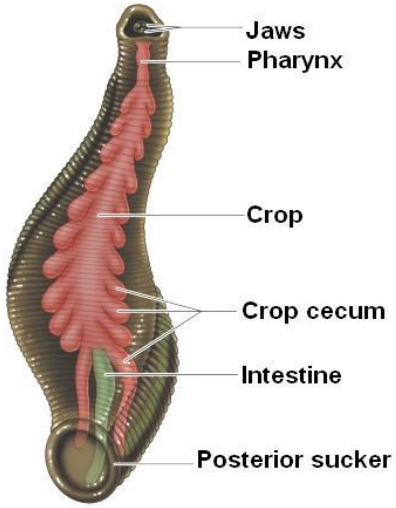
Photo source: wikipedia – earthworm

Earthworm Cocoons

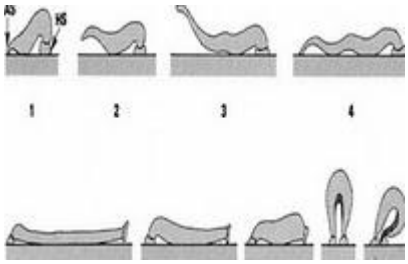
    a. Earthworms are _____.
    b. In *Lumbricus*, reproductive systems are in somites _____.
    c. Immature sperm from testes mature in _____ _____and then pass into sperm _____.

d. Eggs are discharged by ovaries into the _____ cavity; ciliated funnels carry them outside.
e. Two pairs of _____ receive and store sperm during copulation.
f. Earthworms mate at night during warm, moist weather.
g. They mate by aligning in different directions with ventral surfaces together.
h. Mucus secreted by the _____ holds them together.
i. Sperm travel to the seminal receptacles of the other worm along seminal grooves.
j. After mutual copulation, each worm secretes a mucus tube and chitinous band to form a _____.
k. As the cocoon passes forward, eggs, albumin and sperm pour into it.
l. Fertilization and embryogenesis takes place in the cocoon; young worms emerge.

C. Class Clitellata – Subclass Hirudinea: _____ - most live in freshwater but a few are marine or in moist terrestrial environments.



1. Most are flattened.
2. Some are carnivores on small invertebrates; others are temporary or permanent parasites.
3. Leeches are _____ and have a _____, but only during the breeding season.
4. The clitellum secretes a cocoon for reception of eggs.
5. They have lost setae and developed _____ for attachment while sucking blood.
6. The gut is specialized for storage of large quantities of blood.
7. Form and Function
    a. Leeches lack distinct coelomic compartments and septa have disappeared.
    b. Most leeches use suckers to attach so they can "inchworm" along the surface.



8. Nutrition
    a. Although popularly considered parasites, many are _____.
    b. Freshwater leeches have a proboscis for ingesting small invertebrates as well as to suck blood.
    c. Some terrestrial leeches feed on insect larvae, earthworms and slugs.
    d. Other terrestrial leeches climb trees or bushes to reach warm-blooded vertebrates such as baby birds.
    e. Most are fluid feeders that prefer tissue fluids and blood pumped from open wounds.
    f. Medicinal leeches were used when it was wrongly believed disorders were caused by excess blood.
        1) They are now being used to save severed body parts.

9. Respiration and Excretion
    a. Some fish leeches have gills; all other leeches exchange gases across the skin.
10. Nervous and Sensory Systems
    a. Leeches have two “brains”; the anterior fused ganglia form a ring around the pharynx.
    b. Seven pairs of fused ganglia are at the posterior.
    c. The epidermis contains free sensory nerve endings and photoreceptor cells.
    d. Pigment-cup ocelli are present.
11. Reproduction
    a. Leeches are hermaphroditic and cross-fertilize during copulation.
    b. Sperm are transferred by hypodermic impregnation.
    c. The clitellum secretes a cocoon to receive the sperm and egg.
    d. The cocoons are buried in mud or damp soil, and development is similar to that of oligochaetes.
12. Circulation
    a. The coelom has been reduced by invasion of connective tissue and chloragogen tissue.
    b. This forms a system of coelomic sinuses and channels.
    c. Some leeches have a typical oligochaete circulatory system; the coelomic system is auxiliary.
    d. Some leeches lack blood vessels and the coelomic sinuses are the only vascular system.