ZOOLOGY – SEGMENTED WORMS (Phylum Annelida)

I. Compared and Contrasted to Phylum Mollusca.

A. They are like the molluscs in that they…
   1. are eucelomate 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

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

   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.