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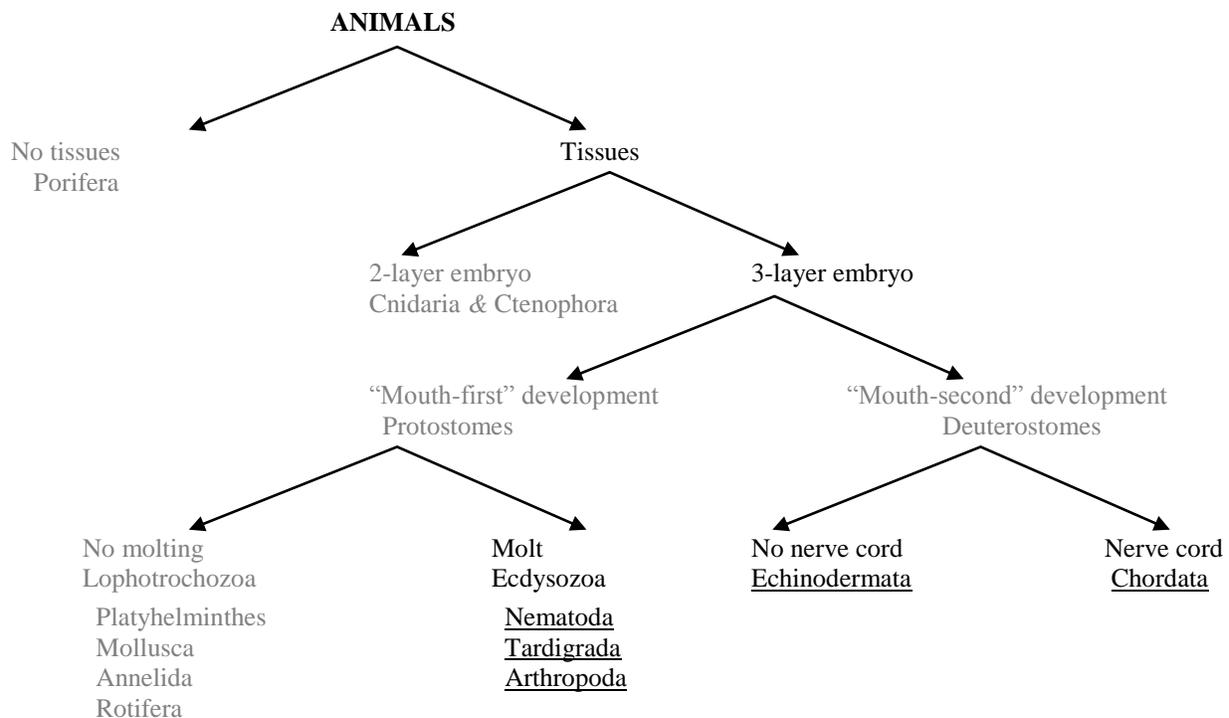
DATE: _____

PARTNER: _____

DIVERSITY IV

Animalia II: Ecdysozoan Protostomes and Deuterostomes

In this laboratory session we will conclude our examination of organismal diversity by looking at the ecdysozoa – the molting protostomes – and deuterostomes. These organisms form their anus first during embryonic development, and the mouth later (i.e., “mouth second”). Two of the phyla within this division are Echinodermata (e.g., sea stars, sea urchins, sand dollars, sea cucumbers) and Chordata (e.g., tunicates, lancelet fish, fish, amphibians, reptiles, birds, mammals). The majority of the activities in this exercise will include the examination and anatomy of these animals.



I. ECDYSOZOA

A. Collection of Assorted Nematodes

This exercise will involve setting up a wet extraction apparatus to isolate nematodes, tardigrades, arthropods, and any other organisms from soil samples. This should be started at the beginning of class to allow time for the extraction. Note that, in addition to the ecdysozoans, you may also observe some lophotrochozoa, especially rotifers.

1. Collect a sample of moss from a tree, the ground or a ledge.
2. Fill a petri dish approx. half full of spring water (not tap water) and invert the moss sample (green side down) into the dish. Keep soil out of the water. Let this set until near the end of the lab.
3. Carefully remove the moss and observe using a dissecting microscope. Try to avoid excess soil as this will obscure observation of the invertebrates present in the sample.

4. Using the dichotomous key on the next page, see if you can identify any of the organisms you observe. List any you can identify. Do any organisms seem to be more abundant than others in your sample? If so, why do you think this is? _____

B. Phylum Nematoda

The "roundworms" are examples of pseudocoelomates, organisms with an open but unlined cavity between their gut and body wall. The nematodes are a large group, approx. 25,000 named species, and although most of these are harmless many do exist as parasites of animals and plants. Examples of the parasites include *Ascaris* (live within the digestive system), *Trichinella* (encyst in muscle) and *filaria* worms (cause elephantiasis). In this exercise, you will observe preserved species.

Examine the specimens on display.

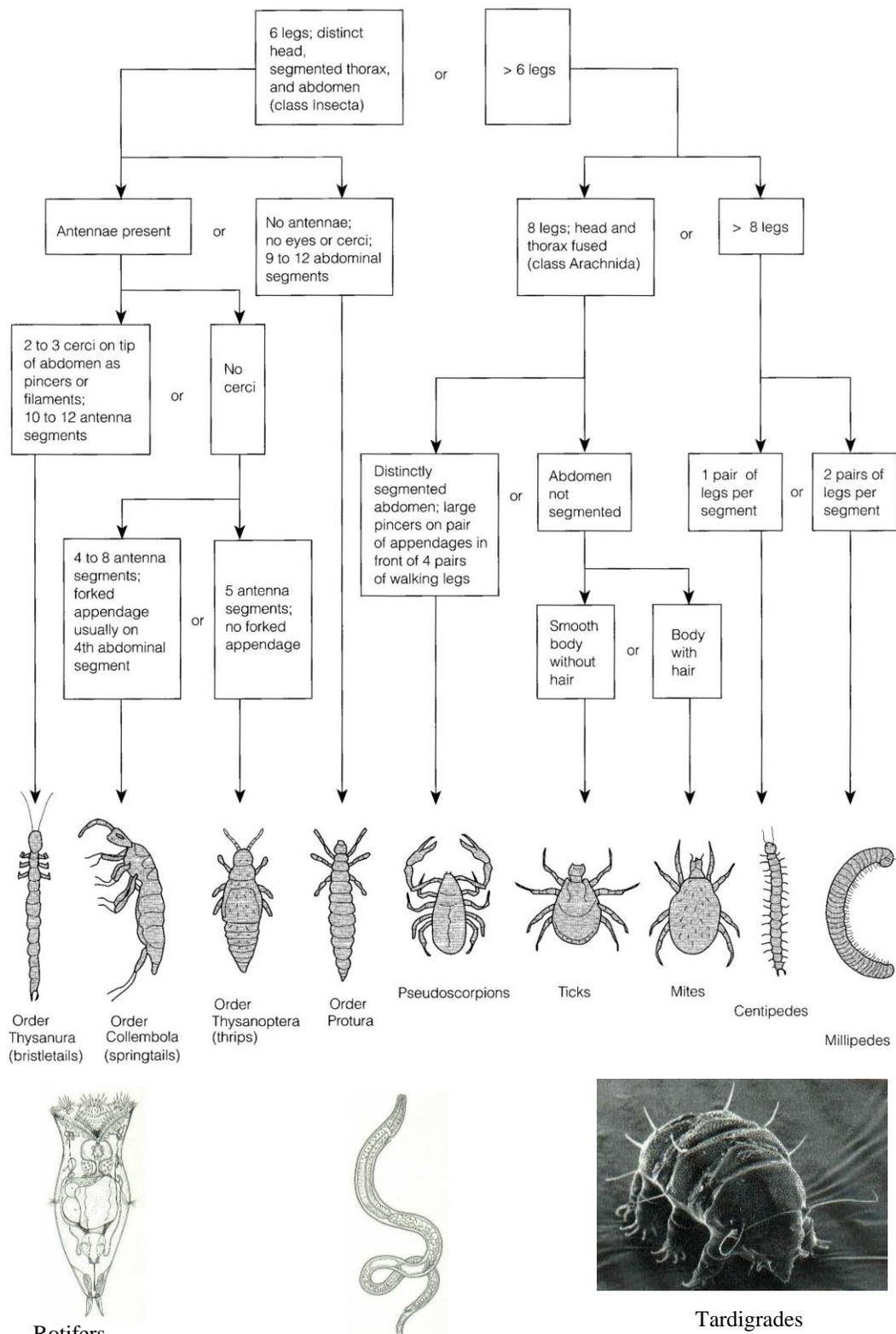
1. *Ascaris*. This parasite is one of the largest of the nematodes to infect humans. It typically resides in the intestines (but can infect other organs such as the liver) and can grow to over a foot in length. A mature female can lay up to 200,000 eggs per day.

- Since *Ascaris* does not involve an intermediate host (vector) during its life cycle, how do you think this organism is able to be passed directly from human to human? In what way will this realization influence your personal hygiene behavior? _____

2. *Trichinella*. Juveniles of these parasites mature and reproduce in the intestines. Newly hatched worms then burrow their way through the intestinal wall and into muscle tissue (most commonly) where they form cysts. In actuality, the cyst itself is harmless and the worm will eventually die. Disease, and potential fatality, is due to the extent and type of tissue that is damaged – for example, if the worm burrows into the heart, this will be more damaging than if the worm encyst in a small muscle in your pinky finger.

- a. Use a microscope to observe one of the slides of *Trichinella* encysted in muscle.
- How would these parasites be passed to humans and what is one way this can this be prevented? In what way will this inform your personal dietary choices? _____

KEY TO COMMON SOIL INVERTEBRATES



C. Phylum Arthropoda

The arthropods ("jointed-feet") are considered the most diverse and numerous organisms on the earth (over 1 million named species). General characteristics include a hardened exoskeleton, jointed appendages, fused or modified body segments and more specialized sensory structures (e.g., compound and/or simple eyes). Compound eyes allow for some degree of vision and are made up of multiple individual visual units; simple eyes (ocelli) can distinguish light from darkness. Some of the major groups can also be categorized based on the type of mouthparts they possess. The chelicerates (e.g., arachnids) lack jaws and their first appendages (chelicerae) are often in the form of fangs or pinchers. The mandibulates (e.g., crustaceans) possess antennae as their first appendages and jaws (mandibles) for biting and chewing.

1. Class Arachnida

The arachnids include the spiders, scorpions and ticks. These animals can be characterized as having chelicerae, pedipalps, 4 pairs of walking legs and body segmentation consisting of a cephalothorax (fused head and thorax) an abdomen, simple eyes and no antennae. Refer to your text and the manuals on display for additional information.

a. Spiders

- i. Watch the video clip "Orb Weaver" at one of the computer stations.
 - ii. The chelicerae of spiders form fangs; what are the pedipalps used for?
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b. Scorpions

- i. Watch the video clips "Scorpion Combs" and "Scorpion Feeding" at one of the computer stations. What is the function of the combs? _____
 - ii. Locate the pedipalps. How does their function differ from that of spiders?
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2. Class Merostomata

The horseshoe crabs are one of the few species of marine chelicerates. Examine the specimens on display and note the formidable exoskeleton. It is interesting to note that although these arthropods live in deep waters, each spring they leave the ocean and crawl up the beach in order to mate.

- a. Watch the video clip "Horseshoe Crabs" at one of the computer stations.

3. Class Crustacea

These arthropods possess mandibles, 2 pairs of antennae, compound eyes and may have "legs" extending from both their thorax and abdomen. Members of this group can vary tremendously in size and form and include lobsters, crabs, *Daphnia*, pillbugs and barnacles. We will focus our attention on decapod crustaceans (e.g., crabs, crayfish, lobsters, shrimp) which refers to the presence of 5 pairs of walking legs. The latter also show fused body segments in the form of a cephalothorax (covered with a carapace) and a segmented abdomen. Refer to your text and the manuals on display for additional information.

- a. Examine the specimens on display and try to identify the structures mentioned above.

- b. What are the appendages on the abdomen of the crayfish called and what is their function?

4. Classes Diplopoda and Chilopoda

- a. Compare the live and preserved specimens of millipedes (Class Diplopoda) and centipedes (Class Chilopoda) on display.
- b. Although their names would imply the presence of a hundred (centi-) or thousand (milli-) legs, they actually don't have that many. How many pairs of legs per body segment are present in each of these animals and approx. how many legs total are present for each? _____

5. Class Insecta

The insects are by far the largest group of arthropods and can be found in nearly every environment on land, fresh and marine waters. Over 90,000 species have been identified in the U.S. alone. Characteristics of the insects include a 3-part body plan (head, thorax, abdomen), 3 pairs of legs (all attached to the thorax), 1 pair of antennae, and simple and/or compound eyes. Many have 1-2 pairs of wings. Mouthparts for these organisms may vary considerably. Refer to your text and the manuals on display for additional information.

- a. Examine the specimens on display and note the general features mentioned above.
- b. For the preserved grasshoppers, try to locate the spiracles in the abdomen segments. What is their function? _____

6. Summary: Comparison of the General External Features of Selected Arthropods

	Arachnids	Crustaceans	Insects
List main body divisions			
Which body segment(s) contain legs?			
# of pairs of legs for walking			
# of pairs of antennae			
List types of mouthparts			
List types of eyes			

II. DEUTEROSTOMES

Deuterostomes are characterized primarily by the way in which they develop during embryonic development. They are distinct from the protostomes in that when their gut begins to develop, the first opening develops into the anus, while the second opening develops into the mouth. The two phyla of deuterostomes have little else in common with each other: Phylum Echinodermata is composed exclusively of invertebrates whose adults have radial symmetry; while Phylum Chordata is composed mostly of vertebrate animals with a bilateral body plan.

A. Phylum Echinodermata

A unique water vascular system used for movement provides one of the key characteristics of this group of marine invertebrates. Most also have a calcareous (calcified) endoskeleton that provides their characteristic eponymous “spiny-skinned” appearance. Although classified as having a bilaterally symmetrical body plan, this is typically a characteristic of their larval stage, as most adults within this group show a form of radial symmetry. Examples include the sea stars, brittle stars, crinoids (feather stars), sea urchins, sand dollars and sea cucumbers.

1. Sea Stars (Class Asteroidea)

These animals are easily identified by a series of rays (arms) radiating from a central disk. This feature is especially pronounced in the brittle and basket stars.

- a. Examine the specimens on display and refer to your text and the manuals on display for additional information.
 - i. Do all of these (or nearly all) have the same number of arms? _____
 - ii. How many are present in these examples? _____
- b. Watch the video clip “Tube Feet” at one of the computer stations.
- c. Locate the madreporite (sieve plate) of one of the specimens. What function does it serve? Relative to this function, how is its structure significant? _____

2. Sea Urchins & Sand Dollars (Class Echinoidea)

The endoskeleton (test) of these animals is constructed of a series of interlocking plates. Connected to this are very pronounced (sea urchin) or velvety (sand dollars) moveable spines. Among these extend their tube feet. Refer to your text and the manuals on display for additional information.

- a. Watch the video clip “Sea Urchins: Deep Sea” at one of the computer stations.
- b. Examine the sea urchins on display.
 - i. Look at the pores in one of the tests on display. These are the points where the tube feet extend away from the surface of the test.
 - ii. Look at the oral surface of one of the tests and locate the area that would represent the mouth. Note the calcified structures extending from here up into the test. This is part of a grinding mechanism called Aristotle’s lantern that is used to chew/tear food (seaweed) and carve depressions into rock to provide shelter. How many pairs of teeth are present in this structure? _____

3. Examine the sand dollars on display.

- a. Note the similarity in endoskeletal plates compared to the sea urchins.
- b. What do you think the purpose is of the slits seen in the aboral (top) surface?

4. The echinoderms are classified as bilateral animals, though species often show radial symmetry as adults. These animals show an additional pattern related to the radial symmetry that is generally described as a defining characteristic of this group. What is this other observable pattern? Give an example.

B. Phylum Chordata

Despite some rather drastic differences in physical appearance between certain members of this group, all of these animals, at least during some stage of their life cycle, possess the following characteristics: 1) a notochord (structural support rod which may become vertebrae), 2) a dorsal hollow nerve cord (may become spinal cord), 3) pharyngeal slits (gill slits) and 4) a post-anal tail. We will look at three subphyla of the chordates: Urochordata (sea squirts), Cephalochordata (sea lancelets) and Vertebrata (vertebrate animals).

1. Tunicates and Lancelets (Subphyla Urochordata & Cephalochordata)

The urochordates and cephalochordates are both invertebrate chordates. Although they possess a notochord (at least during some point of their life cycle), it does not become surrounded by a series of bony protective segments. Refer to your text book and the manuals on display for additional information.

- a. Examine the specimens of adult tunicates (“sea peach”) and the pictorial atlases on display.
 - i. Tunicate larvae ("tadpoles") are free swimming and possess all of the basic characteristics of chordates. The larvae eventually attach to a surface and undergo metamorphosis to transform into adults. What is the effect of this process on the notochord, nerve cord and tail of the adult? _____

- b. How does this organism feed, and what role is played by the pharyngeal slits in the process? _____

- c. Examine the specimens of lancelets and the model on display.
 - i. Note the cirri (prevent large debris from entering the mouth) and the pharyngeal slits (also used in filter feeding).
 - ii. Why do you think these animals were given the name Cephalochordate? _____

2. Vertebrates (Subphylum Vertebrata)

In this section we will review 8 of the 9 classes of living vertebrate animals: Myxini & Cephalaspidomorphi (hagfish and lampreys), Chondrichthyes (sharks, skates, rays), Actinopterygii (bass, trout, perch, etc.), Amphibia (frogs, toads, salamanders, newts), Reptilia (lizards, snakes, turtles, alligators, crocodiles), Aves (birds) and Mammalia (cats, dogs, humans, etc.). The defining characteristics of these animals include a spinal column consisting of segmented vertebrae, a distinct head region with specialized sense organs and an enlarged brain surrounded by a skull.

a. Fish

- i. *The hagfish and lampreys (Classes Myxini & Cephalaspidomorphi) have long slender bodies, a cartilaginous skeleton, median fins, 5-16 pairs of gill arches but*

lack jaws and scales. Examine the specimens on display and use your text as a reference.

- How do the mouth parts and, hence, feeding styles differ between these two types of fish? _____

ii. Sharks and rays (Class Chondrichthyes) possess a cartilagenous skeleton, scales (to some degree), both median and paired lateral fins, 5-7 pairs of gill slits and ventrally located mouth and jaws. Examine the specimens on display and use your text as a reference.

- Note the multiple rows of teeth in the shark jaw on display. Also note how they are not set deep into the jawbone as are the teeth of mammals. How might this arrangement be advantageous or necessary considering the feeding methods of these voracious predators? _____

iii. Salmon, perch, etc. (Class Actinopterygii) have a bony skeleton, a terminal mouth with jaws, covered gills slits, both median and paired lateral fins and, in most cases, scaly skin. Examine the specimens on display and use your text and the manuals on display as a reference.

- Locate the operculum. What is its function? _____

iv. Fill in the following table summarizing some of the major characteristics of these groups of fish (identify traits as present or absent).

	Hagfish & Lampreys	Sharks & Rays	Salmon, Perch, etc.
Scales			
Median fins			
Paired lateral fins			
Jaws			
Bony skeleton			
Covered gill slits			

b. Reptiles and Amphibians

Amphibians (Class Amphibia) can be differentiated from reptiles (Class Reptilia) by their moist, glandular skin that lacks scales. Although adults are typically terrestrial (live on land), the larval stages typically require aquatic environments. Reptiles, on the other hand, have dry scaly skin and produce amniotic eggs (include tough extraembryonic membranes;

sometimes shells) which allow them to be deposited on land. Their scaly skin also “complicates” life in that it must be shed in order for them to grow. Both of these classes and all other animals discussed prior to this point are ectotherms (cold-blooded). This means that the gain/loss of body heat is dependent on their environment and control of this process is, therefore, regulated by behavioral rather than cellular metabolic processes. Examine the specimens on display and use your text and the manuals on display for further information.

- i. After examining (and handling) the specimens, which type of skin would you say offers the best protecting from desiccation (drying out) and how does this relate to the environments in which these animals are commonly found?

- ii. Compare the scales (number and size) on the dorsal surface of a snake with those on the ventral surface (called scots). How do they differ in appearance and how might this relate to their functionality? _____

- iii. Now compare the size of the scales on the dorsal surface of a lizard with those on its limbs. How might this arrangement relate to the lizard’s mobility?

c. Birds

The birds (Class Aves) and mammals (Class Mammalia) are the only two classes of animals that have the ability to generate body heat through cellular metabolic processes. Thus, these warm-blooded (endothermic) animals are typically able to remain active over a wide range of environmental temperatures. They are also amniotes (note the hardened calcified shells on display). Other distinguishing characteristics of the birds include feathers, a light bony skeleton (to aid in flight) and a toothless beak. Examine the specimens on display and use your text as a reference.

- i. Although beaks are a distinguishing trait of birds, different species may have very different kinds of beaks. The different kinds of beaks are functionally different and can be a clue as to the feeding habits of the bird attached. Note the pictures in the book on display. Note: not all of the beak types pictured will apply to the questions on the next page.

- Which bird shows a beak type that might be useful for tearing the flesh of prey?

 - Which bird shows a beak type that might be useful for cracking/opening seeds?

 - Which bird shows a beak type that might be useful for sifting through pond sediments for small invertebrates or plants? _____
- ii. Examine the bird feathers on display. Under the microscope you can observe the individual barbs that interconnect to make up the vane of the feather. Birds spend much of their time preening (running their beaks through their feathers) in order to realign these barbs. Why would so much time be spent on this task? _____
- _____
- _____
- _____

d. Mammals

Members of the class Mammalia can be characterized by the presence of hair, mammary glands that secrete milk for the nourishment of their young (which are live born) and heterodontition (varied types, number and size of teeth). Although most mammals are terrestrial, many (e.g., dolphins, whales, seals, etc.) are also found in aquatic environments. Examine the specimens on display and use your text as a reference.

- i. Mammals may possess 4 distinctly different types of teeth and those in the upper jaw match up with those in the lower jaw (unlike those of reptiles). These include chisel-like incisors (for cutting, gnawing), fang-like canines (for tearing, piercing), premolars (for crushing, shearing) and large flat molars (for grinding). Examine the skulls on display and note the types of teeth present.
- Which teeth are present in the rabbit (1) and cow (2)? Explain how this relates to their herbivorous diets. _____
 - Which teeth are present in the cat (3)? Explain how this relates to their carnivorous diet. _____
 - Based on the teeth present (identify them), what can be said about the diet of the bear (4)? Be sure to use the correct term for this type of diet. _____
- _____
- _____