**Fossil / Invertebrate Exercise - BIO354**

Answer the following questions using specimens in class, those in display cases around Hitchcock, and information you've learned in chapters 9 and 10. Please use Fig 10.16 for phylogenetic questions (but realize this isn't the most up-to-date!). Submit this assignment when we meet at the Burke Museum next week.

1. **Echinodermata:** List some characteristics that are shared by all members of this group (sand dollars, sea urchins, sea cucumbers, starfish, sea biscuits, brittle stars and crinoids). Are echinoderms protostomes or deuterostomes? List a closely related group.
   - Larvae are bilaterally symmetric, adults have pentameral radial symmetry; mesoderm-derived calcitic endoskeleton, unique water vascular system used in locomotion (tube feet)
   - Deuterostomes
   - Hemichordates are their sister group

2. **Trilobita:** What major group would you place trilobites in? Which characteristics make them fit or not fit into that group? What does the shape of the trilobite tell you about its lifestyle?
   - Arthropoda
   - Tough, segmented exoskeleton; jointed legs
   - Benthic (flat body best for crawling around on ground, probably ate smaller animals living in mud, could defend itself by curling into a ball)

3. **Mollusca:** Name some major mollusk groups. Are they ecdysozoans or lophotrochozoans?
   - Bivalves (clams), cephalopods, gastropods (snails)
   - Lophotrochozoans

4. **Cephalopoda** (ammonoids, nautiloids, octopus, squid, cuttlefish, etc.): Which members of this group would most easily fossilize and why? How can you distinguish between an ammonite and a nautiloid?
   - Ammonoids and nautiloids; both have hard shells
   - Nautiloid: simple sutures between chambers, inner whorls not visible (involute), always planispiral (coiling within one plane)
   - Ammonites: more complex suture patterns between chambers, inner whorls often visible (evolute), sometimes heteromorphic (coiling in multiple planes, irregular coiling, straight, etc)

5. **Bivalves vs. Brachiopods:** How can you tell these two groups apart? Are they closely related? Why or why not?
   - Easiest way:
     - Brachiopods are symmetrical when cut at the midline of their shells.
     - Bivalve shells are symmetrical to each other, but an upper or lower shell (valve) by itself is not symmetrical
   - Not really closely related, but much closer than was previously thought; Bivalves are nested within Mollusca while brachiopods are closely related to phoronids. Both are Lophotrochozoa

6. **Cnidaria:** What do corals and jellyfish have in common? What cnidarian characteristics will fossilize best? Which ones won't? Which aspect of *Aequorea* is significant in the history of modern experimental biology?
- Corals and Jellyfish are both in the phylum Cnidaria, a synapomorphy of which is the presence of nematocytes (stinging cells).
- Characteristics that fossilize best include those that are hard (shell or bone), or with some sort of hard structure. Some Cnidarians, lacking bone or “shell,” do have calcified “skeletons” (like the corals) that could be preserved in the fossil record. Soft tissues are unlikely to fossilize (unless they are preserved as carbon films/prints, as we saw in the Ediacaran fauna).
- *Aequorea* is significant in the history of modern and experimental biology because the gene for bioluminescent green fluorescent protein (GFP) was isolated from species in this genus. This work was done largely at Friday Harbor Lab (part of the UW).

7. **Porifera** (sponges): Compare some specimens of modern sponges with fossil specimens. How would you know that a fossil sponge is a sponge? Are these protostomes or deuterostomes? Why?
- Sponges are composed of spicules, glassy, needle-like skeletal structures that provide support and deter predators. These are large enough in some cases to be seen with the naked eye. A highly porous quality to a fossil may also be an indicator of a sponge, should all the spicules be broken or abraded.
- Sponges are neither protostomes nor deuterostomes, and are actually basal to the split between protostomes and deuterostomes. The cnidarians and ctenophores are also neither protostomes nor deuterostomes, they are sometimes called diploblasts or basal groups.

8. **Annelida**: List some members of this group. Do you see any segmentation in their bodies? Are they more closely related to arthropods or molluscs?
- Some members of this group: earthworms, leeches, polychetes, etc. (“the worms.”)
- Body segmentation is a synapomorphy of this group.
- The annelids are more closely related to molluscs than arthropods, (they’re Lophotrochozoans, along with the molluscs, bryozoa, brachiopods, and platyhelmints).

9. **Tunicata** (ascidians [sea squirts and sea pork]): Are these protostomes or deuterostomes? What group(s) are they most closely related to? Who is a discerning, profound, and jovial researcher of tunicates?
- Tunicates are deuterostomes (just like us!)
- They are most closely related to us, the vertebrates.
- Associate Professor, Dr. Billie Swalla, works on tunicates.

10. In the space below, make a cladogram of the major groups studied in lab today. Also include clade names. Which are deuterostomes? Which are protostomes? Which invertebrate group is most closely related to us?
- See figure 10.16 in your book for the cladogram you will be expected to know for the exam.