BSC2011L
Midterm Lecture Exam- Dr. Tschinkel

Here are examples of answers that would have received full credit on the midterm lecture exam. Please note the clarity and precision of the answers. Dr. Tschinkel will be glad to proofread answers to sample essay questions for the final exam

1. (30 points) What do we mean by metamerism, tagmosis and serial homology? Of what importance are these to the animals and to zoologists? How do they relate to the evolution of the annelids and the arthropods? Illustrate your answer with examples.

Sample answer: Metamerism refers to a body composed of a series of more or less similar segments. This creates a situation in which parts of different segments of the same body correspond to one another, as judged by location in the metamere and/or embryonic development. Such corresponding parts within one body are said to be serial homologues. Tagmosis is an evolutionary process in which (usually) groups of originally similar metameres evolve into body regions of similar and specialized (and more restricted) function by becoming morphologically modified. The body comes to consist of distinct regions, with each region composed of (usually) several metameres. Tagmosis is clearly seen in the annelids, for example the tube-dwelling *Chaetopterus*, or *Amphitrite* or even, it could be argued, earthworms in which the clitellum is a specialized region. Tagmosis is much greater in the arthropods, where the patterns of tagmosis actually define the major classes. Thus the evolution of the arthropods has been largely defined by tagmosis. Examples abound: the head/thorax/abdomen (6-3-11) body region patterns of the insects; the 5-8-5 pattern of crustacea, etc.

The usefulness of serial homology is that it allows us to compare how evolution has changed corresponding parts within the same body. In many cases, especially in the arthropods, serial homologues can become so modified that they no longer resemble one another.

2. (30 points) As an object increases in size without changing shape, what happens to the surface/volume ratio? Of what importance is this to animals? How have animals responded to this problem during evolution? Using examples from 5 different taxa that we have covered so far, describe 5 bodies or body parts whose structure evolved (at least partly) in response to the surface/volume problem.

Sample answer: With increasing size, the surface/volume ratio decreases because the volume increases in proportion to the cube of dimensions, whereas the surface grows more slowly in proportion to the square of these dimensions. The exchange of materials such as gases or solutes (or heat) with the environment can only occur across surfaces in contact with that environment. The animal's capacity for exchange is proportional to its surface area. However, its demand for exchange of gases and solutes is proportional to its mass or volume (i.e. the amount of metabolizing tissue). Thus, as body size increases, demand increases more rapidly than exchange capacity. Animals solve this problem by various changes of shape: by evolving flat, thin bodies, or structures that greatly amplify surface area by folding, evagination, invagination, etc. Examples include: the thin body of flatworms; the single cell layers of scyphozoans; the twin layers of other Cnidaria; the parapodial gills of polychaetes, the tracheae of insects; the flat bodies of tapeworms; the typhlosole of earthworms; the book lungs of spiders or pillbugs; the book gills of horseshoe crabs; any other correct examples.

3. (30 points) Why does the evolution of mesoderm represent a major advance in the evolution of animal complexity? In what taxon is the effect of mesoderm on complexity first apparent? How is the mesoderm formed during development of this taxon? Name 3 types of structures that are formed from mesoderm in that taxon.

Sample answer: The evolution of mesoderm transforms an animal with two germ layers into one with three, a large jump in complexity. This is in part a matter of geometry, with the mesoderm capable of producing structures between the endoderm and ectoderm, and partly because each germ layer gives rise to a characteristic set of adult tissues specialized for restricted functions. One of the most important effects of the evolution of mesoderm is that it relieves the ectoderm and endoderm from participation in mobility. In diploblastic animals such as the cnidaria, both the epidermis and the gastrodermis are contractile, limiting the degree to which they can become specialized for non-motility functions. Diploblastic animals have therefore not progressed beyond the tissue level of body organization. Among the animals we have studied, the mesoderm makes its first appearance in the Platyhelminthes. During gastrulation, it arises from the base of the archenteron (endoderm) by a proliferation of cells into the blastocoel to form (initially) a solid mass of mesodermal cells (can accept a well-drawn and labeled diagram in lieu of this sentence). During continued development, these differentiate into the mesenchyme, various muscle sheaths and muscle groups and the gonads. As a result of the possessioin of mesoderm, the Platyhelminthes are at the organ grade (acoelomate) of body organization.

4. (30 points) Considering the sponges, cnidarians, nematodes, polychaetes and arthropods, how does each solve the problem of soluble waste excretion? Name the structure or organs involved, if any, and briefly describe how they work. Enter your answers in the table below. Note that a taxon may have more than one solution. If so, enter the name of the group exhibiting the solution you indicated.

Taxon	**How does this taxon solve the problem of soluble waste excretion?**
sponges	No special structures present. All waste products exchanged by direct diffusion into seawater.
Cnidaria	No special structures present. All cells are in direct contact with seawater because both gastrodermis and epidermis are only one cell-layer thick. Waste products diffuse directly into seawater.
Nematodes	Excretory system based on renette cells. Waste products cleared from fluid in pseudocoel by renette cells, pass into paired lateral excretory canals in the lateral cords (or lateral line), exiting via an excretory pore near the nematodes anterior end.
Polychaetes	Primitively, each metamere contains a pair of metanephridia that receive fluid from the coelomic compartment in which they are located. Fluid enters the nephrostome, resorption occurs in the long metanephric tubule in the next posterior segment, and the waste urine is excreted via the nephridiopore.
Arthropods	In Crustacea, soluble wastes are excreted by a pair of green glands or coelomoducts located in the cephalothorax. These evolved from coelomic compartments, and vent their product to the outside via an excretory pore. Spiders excrete soluble waste via Malpighian tubules and the rectum (give extra credit for this).