Comparative Vertebrate Anatomy – Lecture Examination I

Name of Examinee: ________________________

I. (25 points). Define, describe, compare or otherwise characterize five (5) of the following:

A. Streamlining

This term describes the moving layers of a fluid (could be liquid or gas) that surround and affect any object traveling through them. Organisms that live or travel in streamlines, such as fish & birds, have evolved streamlined morphologies in response. Characteristic shapes are fusiform like a bullet, or thin, while also having smooth surfaces, such as scales & feathers, that have no features to obstruct streamline flow.

B. Analogy

Analogies in anatomy are comparable structures/features between organisms that have similar functions, but are <u>not</u> derived from a common ancestor. An example would be the wings of birds and bees. Both wing types have converged upon a similar structure, but were not inherited from the last common ancestor of birds & bees. They look similar because successive adaptations in each class's evolutionary history converged upon the same structure in the same environment (air).

C. Alfred Russell Wallace

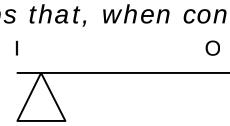
Wallace was a noted biologist who lived and worked mostly in the latter half of the 19th century. He made a living early on by sending exotic specimens he had collected in the tropics back to England. He deduced that many of the features and variations in organisms must have been selected for by nature. He sent this idea in written form to a man he respected and admired, Charles Darwin, who had also realized natural selection was real decades earlier. They published their hypotheses jointly, cementing Wallace's place in history as one of the first to think of natural selection.

D. Convergence (in a phylogenetic context)

Convergence is a term that explains why wholly different organisms in similar environments often have similar adaptations. This happens because similar selective pressures often have only a few ways of being adapted to by organism populations. An example would be the streamlined aerodynamic lifting surfaces all flying animals have evolved. All of their wings have converged upon a similar pattern to generate lift.

E. High gear muscle

This term describes a muscle that has a small input lever arm and a long output lever arm. This produces small amounts of force, but great speed in the output lever. Animals, such as deer, use these muscles to great advantage. They have long limbs that, when connected to a high gear muscle/limb, move very quickly after reaching speed.



F. Rhipidistian

This was an early fish that became extinct during the Permian. They were members of Sarcopterygii within Osteichthyes. They were separated from Actinopterygii by these characters: Having bony elements in their girdles & associated musculature <u>outside</u> the body wall, resulting in fleshy lobe fins. Freshwater forms in the early Devonian are considered to have evolved terrestriality. Many boney elements in several fossilized taxa have homologous characters with later tetrapods, particualry in the limb elements. They also had lungs, paired fins, and labyrinthodont dentition.

II> (25 points) Compare and explain the differences between five sets of the following pairs of terms, or define or otherwise characterize the individual terms listed.

A. Allometry

Allometry is a term that describes how separate body parts in an organism change during ontogenetic growth, or phylogenetic development within taxa. Isometry is when body parts grow/change at equal rates. Positive allometry is when a body part grows/changes faster than other body parts. Negative allometry is when a body part grows/changes more slowly than another body part(s). These changes often result in body parts that the organism needs for survival/fitness, like a large claw in lobsters.

B. Sarcopterygian

A taxon of bony fish within Osteichthyes that were separated for sister group, the ray-finned fishes (Actinopterygii) by several characters. Unlike ray-finned fishes, which keep fin muscle/bony elements <u>inside</u> the body wall, sarcopterygians evolved to have them <u>outside</u> the body wal,; resulting in what was called lobed fines. Early species had lungs, as Dipnoi (lungfishes) still do today. Crossopterygians (coelocanths) are also still alive today, although unlike lungfishes, which live in fresh water, they inhabit deep marine waters.

C. Synapsid & Diapsid

Synapsids and diapsids are terms originally used to denote skull types within tetrapod amniote taxa. Synapsids have one set of temporal fenestra above a bar comprised of the squamosal & postorbital bones. Diapsids have two sets of temporal fenestra. The supratemporal fenestra are above the squamosal/postorbital bar, and the infratemporal fenestra are below that bar. Today the terms are still used, although not as the main distinguishing character of tetrapods. Mammalian ancestors and descendants are synapsids, while Eureptilia (within Reptilia) such as lepidosaurs, archosaurs, sauropterygians, and icthyopterygians are diapsids.

D. Squamate

This group includes all recognizable extant reptiles, except for turtles and crocodylomorphs. Squamates are lizards, snakes, and a small group of legless reptiles, the amphisbaenids. The squamates are separated from other reptiles by their having lost the lower temporal bar, giving their skulls the appearance of having a huge conjoined fenestra, that also frees their skull to be more kinetic, and therefore better adapted for catching/swallowing food (like a snake).

E. Pelycosauria

Pelycosaurs were basal synapsids that originated early on in tetrapod history sometime in the Carboniferous. Early types, such as the carnivorous sail-backed Dimetrodon and the herbivorous sail-backed Edaphosaurus, had sprawling body postures, synapsid skulls, and presumably low metabolic rates. They were quite common and successful during the late Carboniferous and early Permian and evidence suggests some evolved higher metabolic rates and evolved into Therapsids. Therapsids were very mammal-like and evidence suggests that they evolved into more derived groups such as Cynodonts and eventually some evolved into mammals by the Late Triassic.

G. Acanthodian & Elasmobranchian

Acanthodii and Elasmobranchii were/are both types of jawed-fishes (Gnathostomes). Acanthodians perhaps evolved during the midde/late Ordovician from jawless fishes and became during the Permian. Primarily small freshwater types; characterized by long spines in their fins, a hodge-podge of ossified endo/ectoskeletons, odd fin pairings, short snouts, and large eyes. Elasmobranchians are the sharks and rays within the Chondrichthyes (cartilaginous fishes) They also originated in the late Ordovician and are characterized having lost their bony skeletons, polyphodont teeth (unlike acanthodians), placoid scales (unlike acanthodians), pelvic claspers on males, and a mostly marine distribution. They underwent a 2^{nd} major radiation in the Jurassic and are still very successful today.

II. (15 points). Discuss the contribution to the history of anatomy by the three scientists you believe are the most influential. You may choose from among those we discussed in class, or other sources, but they must be famous (in other words, not your 3rd cousin Sally Jane, just because she dissected a fetal pig in high school biology without fainting!). If you answered question IC about a famous scientist you cannot use him either. For each of these individuals, you must describe their contribution to the field of comparative anatomy, and what they did in your opinion to deserve this distinction.

Charles Darwin: Naturalist from Victorian England (1800s) who is credited with first describing, elucidating, and providing evidence for a valid mechanism for evolution. His mechanism, derived after years observing tropical species and his own experiments, was natural selection. This helps explain nearly all aspects of biology, such as anatomical function, structures, and phylogeny.

Ernst Haeckel: German contemporary of Darwin who used Darwin's hypothesis of phylogeny in his embryological studies. His hypothesis that ontogeny recapitulates phylogeny was later refuted, but its implications were important. He garnered attention to the idea that developmental patterns are often conserved between related species, and anatomical studies can compare these similarities and differences.

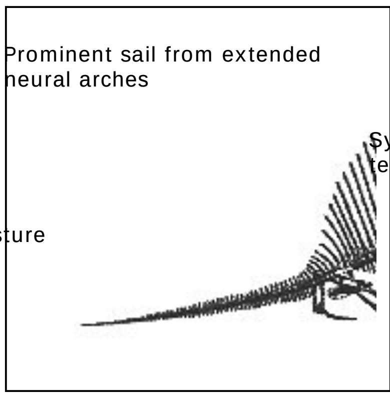
Georges Cuvier: Early anatomist of the late 1700s and early 1800s of France. He was important for his studies of comparisons between extant organisms and fossilized forms. One of the first anatomists to try and characterize what fossils were and whether evolution had occurred to produce extant species. He mistakenly believed that he had evidence that evolution had not occurred and that organismal forms were immutable, but he helped start today's field of comparative anatomy, regardless of his hypotheses about evolutionary time and its effect on species.

IV. (10 points). Explain how a hierarchical system of classification such as the Linnaean system works. Use an example of how you would classify any group of vertebrates using this system. Include five taxa. Describe the kind of characters you use to place the taxa into your classification scheme and explain the significance of each character (or character group). And, y'all thought I was going to ask you to produce a detailed cladogram of a group, didn't you?)

Kingdom
Phylum
Class
Order
Family
Genus
Species

The Linnaean System of Classification works by grouping organisms together by shared characteristics. Historically this was done by lumping organisms together by morphological similarities, but has given way today to diverse sets of derived (shared=synapomorphies) characters such as: Molecular characters, morphological characters, behavioral characters, and rarely, statistical characters. These groups of organisms are then grouped into frameworks (cladograms) each more specific than the other. As you go down the list, species become grouped together by more and more synapomorphies. Molecular characters using genetic or structural proteins are the most accurate, but are limited to extant taxa. Morphological characters are next, but again limited to taxa that can be differentiated by shape(rarely prokaryotes!) or by hard parts (fossil taxa). Behavioral characters are even harder to record for many taxa, (such as fossil taxa). Statistical characters are rarely used, but mathematics can show relations between taxa. The Linnaean System today is making more use of phylogeny(evolutionary genealogy) based characters that show common ancestory.

V. (25 points). You are a world famous vertebrate paleontologist and comparative anatomist. Because of this, a fossil collector (your cousin Sally Jane who wants to become a famous paleontologist) who has found a new complete specimen of a vertebrate brings it to you and asks you to tell her everything you can about it. The specimen is depicted below. Include information on structure, function, habits, habitat, biomechanical analyses, classification, and geologic age (when the animal lived) and other information you deem important in understanding this animal. Explain how you would make this analysis because your thought process is as important as your conclusions. You may use diagrams you draw, label the one provided or give your answer entirely in words.



Kingdom-Animalia
Phylum- Chordata
Subphylum-Vertebrata
Class-Reptilia
Order- Pelycosauria
Family-Sphenocodontia
Genus- Dimetrodon
Species- ?

This animal, a Dimetrodon, lived during the early Permian along the equatorial belt of an Earth going through a period of glaciation. Many fossils of this genus are found in the southwestern USA, particularly in Texas. It was a carnivore as evidenced by its large sharp teeth. It was a one of the pelycosaurs, which were synapsids, (one temporal fenestra with a squamosal/postorbital bar defining lower edge) that are believed to have been the ancestors of modern mammals. Dimetrodon was not mammal-like, however, but it was related to them with its synapsid skull. It was probably cold-blooded and may have warmed itself with a large sail upon its back. Its prey consisted of other pelycosaurs, captorhinid reptiles, small amphibians, and larger labyrinthodont amphibians that inhabited the wet swampy habitats it's been found in. Dimetrodon had the same sprawling posture of the amphibians and reptiles it was contemporary with. It may have had a rich network of blood vessels in its sail that enabled it to warm up quickly when broadside to the sun. This may have given it an advantage I pursuing prey, although, a comtemporary herbivorous pelycosaur, Edaphosaurus, had the same structure upon its back. It may have just been for sexual display. This animal became extinct by the Mid-Permian as more mammal-like therapsids evolved from animals like it.