

Comparative Vertebrate Anatomy

Specific Objectives

General Information

A course in Comparative Morphology can be approached from a number of different directions. In my opinion, the important aspects of the course are those which involve the **comparison** of the functional morphology of vertebrates rather than learning in great detail the anatomy of one or two representative vertebrates. Some general objectives for the course are as follow:

1. You should be able to identify all organs and organ systems of vertebrates.
2. You should be able to explain the evolutionary significance and function of each of these systems.
3. You should be able to identify all classes of vertebrates by their various anatomical features.
4. You should be able to explain and apply the concepts of homology, analogy, morphogenesis, ontogeny, and phylogeny relative to the anatomical features of vertebrates.
5. You should acquire the skill of careful dissection.

Lecture

The lecture portion of the course will emphasize the inter-relationship of structure and function and will act as the conceptual foundation for our study of Comparative Vertebrate Morphology. It is important to remember that we will be stressing the functional and evolutionary significance of structure throughout this course. The concept of homology will be applied to the study of all organ systems. Form and function in one system effects that of others.

Laboratory

We will conduct in-depth dissections of representatives of all major vertebrate classes for most organ systems. You will need to obtain some dissecting instruments to carry out the dissections later in the semester. Dissection is the careful study of anatomy, both in identifying structures and in discovering the positional relationships of structures to one another. It is important that you take care to retain clearly delineated regional dissections.

SPECIFIC OBJECTIVES FOR LECTURE EXAM # 1

Specific Objectives for Chordate Ancestry

1. You should be able to list those features that chordates share with other animal phyla, and those that are unique to chordates.
2. You should be able to explain the phylogenetic position of the Urochordates, Hemichordates, and Cephalochordates relative to the Vertebrates -- i.e., be able to draw and explain a phylogenetic tree (phylogeny) of these groups.
3. You should be able to explain why protostomes are not usually considered as immediate ancestors to the chordates.

Specific Objectives for Comparative Biology & Vertebrate Diversity

1. You should be able to describe how cladograms are constructed, how they are used to summarize similarity, how they are used as hypotheses to test **homology**, **analogy**, and **convergence**. What relationship does a cladogram have to a classification?
2. You should be able to characterize the subphylum Vertebrata.
3. You should be able to draw a phylogenetic tree for the classes, subclasses, and infraclasses of vertebrates.

Specific Objectives for Vertebrate Embryology

1. You should be able to explain the evolutionary significance of neural crest cells and epidermal placodes (see pgs. 186-187, and article).

Specific Objectives for the Integument

1. You should be able to distinguish between dermal and epidermal scales and be able to list examples in which each occur.
2. You should be able to explain the function, and name (in order) the layers of the vertebrate epidermis.
3. You should be able to trace the evolution of epidermal derivatives including integumentary glands.

Specific Objectives for Dentition

1. You should be able to describe the **form** and **functional** of teeth. Be able to apply and use concepts – homodont, heterodont, brachyodont, bunodont, lophodont,
2. You should be able to explain the functional significance of tooth attachment and replacement patterns. Be able to use and apply the concepts – acrodont, pleurodont, thecodont, diphyodont, polyphyodont.

Specific Objectives for the Skeletal System

--General--

1. You should be able to discuss the physical properties of skeletal materials and relate these to their functions.
2. You should be able to compare and contrast membrane and endochondral (replacement) bone.

--Head Skeleton--

1. You should be able to list and identify, in appropriate order, the dermal roofing bones of all vertebrate classes. With respect to fish skulls, I will expect you to know about 50 % of the bones by their position.
2. You should be able to state the function and discuss the evolution of the secondary palate.
3. You should be able to discuss the evolution of sound conduction in the vertebrate skull.
4. You should be able to discuss the evolution of the mandibular suspensorium (jaw mechanism) relative to various feeding adaptations.
5. You should be able to identify or otherwise classify any bone from any vertebrate skull.

--Visceral Skeleton--

1. You should be able to outline, illustrate, or otherwise explain the evolution of the visceral skeleton of vertebrates and relate this to evolutionary opportunism and terrestrialization.
2. You should be able to trace the evolution of each component of the visceral skeleton in each group of vertebrates (for example, the first arch, the second arch, etc...)

--Feeding Adaptations--

1. You should be able to outline the adaptations of the feeding apparatus among vertebrate groups, including teeth, epidermal derivatives, tongue, and cranium.
2. You should be able to explain the functional and evolutionary variations in feeding mechanisms among vertebrates, including suspension, suction, projectile, lingual, and inertial feeding.
3. You should be able to discuss the functional and evolutionary trends in cranial kinesis among the vertebrates. Why are the teleosts considered to possess among the **most derived** feeding systems of all vertebrates ?

TEXT RESOURCES FOR TEST # 1

[Make sure you understand all concepts and terms listed in **boldface type** in Kardong textbook]

KARDONG CHAPTERS 1, 2, 3, 6, and 7; and 184-187 and 499-509 (teeth)

ANY ARTICLES or HANDOUTS announced/distributed in class

SPECIFIC OBJECTIVES FOR LECTURE EXAM # 2

Specific Objective for Skeletal Support and Locomotion

--Postpharyngeal Axial Skeleton--

1. You should be able to explain the original function and secondary function of the vertebral column.
2. You should be able to explain the four major trends (regionalization, antitorion mechanisms, suspensory adaptations, and cranial mobility) of the vertebral column with respect to terrestrialization.
3. You should be able to explain the function of the sternum and discuss its origin.

--Appendicular Skeleton--

1. You should be able to diagram, as well as identify, all the components of the pectoral and pelvic appendages. Some groups of bones (for example, the carpals and tarsals) will not be identified individually.
2. You should be able to discuss the major evolutionary and functional trends of the pectoral and pelvic bones.
3. You should be able to identify each girdle element and trace its evolutionary history through the various vertebrate groups.

Specific Objectives for Muscles

1. You should be able to describe the structure of a typical skeletal muscle (see FIG 10.2) and discuss tension-length curves for single muscle fibers and whole muscles.
2. You should be able to define and explain the fundamental concepts of force in relation to bone-muscle systems (see notes and articles on reserve)

Specific Objectives for Biomechanics

1. You should be able to apply biomechanical models to adaptations for locomotion, support, and feeding found in vertebrates. Refer to your notes and especially the articles on reserve.
2. You should be able to discuss the major biological and physical factors effecting locomotion by **swimming, flying, digging, walking, and running**.
3. You should be able to describe how different vertebrates have solved design problems **in the same and different ways** for swimming, flying, digging, walking, and running.

TEXT RESOURCES FOR EXAM # 2

[Make sure you understand all concepts and terms listed in **boldface** type in Kardong textbook]

KARDONG CHAPTERS 4, 8, 9, and 10.

ANY ARTICLES or HANDOUTS announced/distributed in class

SPECIFIC OBJECTIVES FOR LECTURE EXAM # 3.

Specific Objectives for Respiratory System

1. You should be able to produce a flow diagram of respiration for each of the vertebrate classes.
2. You should be able to characterize the various modes and structures of breathing found in vertebrates (gills/lung)
3. You should be able to explain the form and function of swim bladders. How do they compare with lungs as respiratory organs?

Specific Objectives for Digestive Organs

1. You should be able to discuss the development of the mouth and pharynx
2. You should be able to describe and explain the form and function of the pharynx and its associated glands.
3. You should be able to discuss the structural and functional variations in the digestive tract in all vertebrate groups.

Specific Objectives for Circulation

1. You should be able to describe the form and function of blood forming tissues in vertebrates.
2. You should be able to diagram the evolution of the heart and aortic arches in all vertebrate classes (see handouts]
3. You should be able to relate the evolution of aortic arches to the overall evolution of the pharyngeal complex and explain how terrestrialization has affected these changes
4. You should be able to discuss the evolution of the hepatic portal, renal portal, and postcaval systems.
5. You should be able to discuss the functional and evolutionary implications of low pressure versus high pressure blood systems.

Specific Objectives for the Osmoregulatory & Waste Disposal Systems

1. You should be able to describe and discuss the fundamental challenges the vertebrates face in osmoregulation (hyper-, hypo-, and iso-) and their strategies to overcome them..
2. You should be able to describe the common structure of all vertebrate kidneys and how that impacts osmoregulation and waste disposal.
3. You should be able to compare and contrast osmoregulation through excretory versus integumentary systems.
4. You should be able to discuss how circulatory form and function is critical to osmoregulation and waste disposal.

TEXT RESOURCES FOR EXAM # 3

[Make sure you understand **all concepts** and **terms** listed in **boldface type** in Kardong textbook]

KARDONG CHAPTERS 11, 12, 13, and 14

ANY ARTICLES or HANDOUTS announced / distributed in class.

SPECIFIC OBJECTIVES FOR LECTURE EXAM # 4.

Specific Objectives for the Nervous System

1. You should be able to describe the basic organization of the nervous system, including cell types, functional groups, circuitry, and simple reflex arcs.
2. You should be able to identify the function and describe the components of all cranial nerves. Know their motor/sensory/mixed functions, placement on the brain (or brainstem), and region or tissues supplied.
3. You should be able to discuss the evolution of head segmentation in relation to peripheral and cranial nerves. You should be able to discuss the modern view of head segmentation.
4. You should be able to describe and explain the functional and evolutionary significance of the visceral nervous system, with emphasis on the autonomic system.
5. You should be able to describe and discuss the evolution of all major Parts of the brain. You should be able to outline the major patterns of brain circuitry in various vertebrate groups (e.g., medullary vs, tegmental vs. higher brain centers)

Specific Objectives for Sense Organs

1. You should be able to describe and discuss functional and evolutionary changes in vertebrate auditory and equilibrical organs.
2. You should be able to describe and discuss functional and evolutionary changes in the vertebrate eye.
3. You should be able to describe and discuss lateral line organs in fish-- how do they work and what function(s) do they possess?

TEXT RESOURCES FOR EXAM # 4

[Make sure you understand **all concepts** and **terms** listed in **boldface type** in Kardong textbook]

KARDONG CHAPTERS 16 and 17

ANY ARTICLES or HANDOUTS announced / distributed in class.