

Comparative Anatomy and Functional Morphology

University of California at Berkeley

Department of Integrative Biology

(5 Units)

Course Description:

This course is an in-depth look at the biology of form and function. We will examine vertebrate anatomy to understand how structures develop, how they have evolved, and how they interact with one another to allow animals to live in a variety of environments. We will study the integration of the skeletal, muscular, nervous, vascular, respiratory, digestive, endocrine, and urogenital systems to explore the historical and present diversity of vertebrate animals.

Format:

This course will include lecture, discussion, and laboratory sessions. Lectures will focus primarily on broad concepts and ideas. Discussion sections will emphasize how to both read and analyze primary scientific literature. Laboratory sessions will allow students to physically explore the morphologies of a diversity of taxa and will include museum specimens as well as dissections of whole animals.

Lecture: Monday, Tuesday, Wednesday, and Thursday, 9:30-11:00a.m.

Discussion: Monday and Thursday, 11:00a.m. or 12:00p.m.

Laboratory: Monday, Tuesday, Wednesday, and Thursday, 2:00-5:00p.m.

All students must take lectures, discussion sections, and laboratory sections concurrently. Attendance of all sections is required.

Goals:

1. A comparative approach will allow students to gain experience in identifying similarities and differences among taxa and further their understanding of how both evolutionary and environmental contexts influence the morphology and function.
2. Students will improve their ability to ask questions and answer them using scientific methodology.
3. Students will gain factual knowledge of terms and concepts regarding vertebrate anatomy and functional morphology.

Instructors:

TBD

Grade Breakdown:

Practical Exam 1:	100 points
Practical Exam 2:	100 points
Midterm Exam 1:	100 points
Midterm Exam 2:	100 points
Final Exam:	150 points
Discussion Quizzes:	100 Points
Term Project:	200 points
<u>Term Paper:</u>	<u>150 points</u>
Total:	1000 Points

Course Activities and Readings:**June 18:**

Lecture: Introduction to the Course and Overview of Essential Concepts

Laboratory: Systematics

Discussion: Systematics Literature

June 19:

Lecture: Systematics and Vertebrate Evolution

Laboratory: Hagfish and Lamprey Specimens

June 20:

Lecture: Vertebrate Evolution

Laboratory: Developmental osteology

June 21:

Lecture: Properties of Bone and Skull Development

Laboratory: Skull Anatomy

Discussion: Shubin Chapters 1-5

June 25:

Lecture: Skull Evolution

Laboratory: Axial and Girdle Bone Specimens

Discussion: Bone or Skeletal Morphology Literature and Shubin 6-7

June 26:

Lecture: Axial Skeleton

Laboratory: Fins and Limbs

June 27:

Lecture: Girdle Evolution and Appendages

Laboratory: Fins and Limbs

June 28:

Lecture: Muscle Development and Mechanics

Laboratory: Fish Myology

Discussion: Homology, homoplasy, or analogy.

July 2:

Lecture: Biomechanics and Aquatic Locomotion

Laboratory: Fish Myology

Discussion: Locomotion literature

July 3:

Lecture: Transition to Terrestrial Locomotion

Laboratory: Amphibian Myology

July 4:

Lecture: Holiday – no class

Laboratory: Holiday – no class

July 5:

Lecture: Specialized Terrestrial Locomotion

Laboratory: Mammalian Myology

Discussion: Locomotion Literature

July 9:

Lecture: **Midterm 1**

Laboratory: Mammalian Myology

Discussion: Neural Function Literature

July 10:

Lecture: Neural Structure and Function

Laboratory: Neural Structure and Function

July 11:

Lecture: Brain and Cranial Nerves

Laboratory: **Practical 1**

July 12:

Lecture: Special Senses

Laboratory: Sheep Brain Dissection

Discussion: Sensory Literature and Shubin 8-10

July 23:

Lecture: Aquatic Feeding

Laboratory: Comparative Sensory Organs – Sheep and Cow Eye Dissections

Discussion: Feeding Literature

July 24:

Lecture: Terrestrial Feeding

Laboratory: Aquatic Feeding Specimens

July 25:

Lecture: Heart and Aortic Arches

Laboratory: Terrestrial Feeding Specimens

July 26:

Lecture: Veins and Arteries

Laboratory: Sheep Heart Dissection

Discussion: Cardiovascular System Literature

July 30:

Lecture: Gill Respiration

Laboratory: Blood Vessel Anatomy

Discussion: Respiration Literature

July 31:

Lecture: Lung Respiration

Laboratory: **Project Laboratory**

Aug. 1:

Lecture: **Midterm 2**

Laboratory: Comparative Respiration

Aug. 2:

Lecture: The Digestive Tract and Urogenital System

Laboratory: Comparative Digestive Systems

Discussion: Digestive or Urogenital Literature and Shubin Chapter 11

Paper Due

Aug. 6:

Lecture: Endocrine System

Laboratory: Endocrine System Dissection

Discussion: **Project Presentations**

Aug. 7:

Lecture: Integumentary System

Laboratory: Diversity of Integuments

Aug. 8:

Lecture: Course Overview and Final Review

Laboratory: **Lab Practical 2**

Aug. 9:

Lecture: **Final Exam**

Laboratory: No Class

Discussion: No Class

Required Texts:

Shubin, N. *Your Inner Fish: A Journey into the 3.5-Billion-Year History of the Human Body*. Vintage Books, 2009.

Liem, K.F., Bemis, W.E., Walker, W.F., and Grande, L. *Functional Anatomy of the Vertebrates: An Evolutionary Perspective*. 3rd Ed., Harcourt, Inc., 2001.

Sample Reading List:

Arnold, S.J. (1983) Morphology, performance and fitness. *American Zoologist*, **23**, 347-361.

Carroll, A.M. Wainwright, P.C., Huskey, S.H., Collar, D.C., and Turingan, R.G. (2004)

Morphology predicts suction feeding performance in centrarchid fishes. *Journal of Experimental Biology* **207**, 3873-3881.

Dickinson, M.H., Farley, C.T., Full, R.J., Koehl, M.A.R., Kram, R., and Lehman, S. (2000) How animals move: an integrative view. *Science* **288**(5463), 100-106.

Gingerich, P.D. ul Hak, M., Zalmout, I.S., Khan, I.H., and Malkani, M.S. (2001) Origin of whales from early Artiodactyls: hands and feet of Eocene protocetidae from Pakistan. *Science* **293**, 2239-2242.

Hale, M.E., Ritter, D.A., and Fetcho, J.R. (2001) A confocal study of spinal interneurons in living larval zebrafish. *The Journal of Comparative Neurology*, **437**(1), 1-16.

Irschick, D.J. (2002) Evolutionary approaches for studying functional morphology: examples from studies of performance capacity. *Integrative and Comparative Biology*, **42**, 278-290.

Losos, J.B. (2011) Convergence, adaptation, and constraint. *Evolution*, **65**(7), 1827-1840.

Maina, J.N. (2015) The design of the avian respiratory system: development, morphology and function. *Journal of Ornithology*, **154**, S41-S63.

Wiens, J.J., Brandley, M.C., and Reeder, T.W. (2006) Why does a trait evolve multiple times within a clade? Repeated evolution of snakelike body form in squamate reptiles. *Evolution* **60**(1), 123-141.