Kingsborough Community College, The City University of New York
Department of Biological Sciences, Biology 2100

Comparative Anatomy

Course Outline

Instructor

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Email is the best way to get in touch with me. I will respond within 24 hours Monday through Friday during work hours (9 am to 5 pm). I will respond to weekend emails on Monday.

Course Description

Biology 21 is a 4-credit, 6-hour course with laboratory and lecture components, open to students who have completed Biology 14, and have passed the CUNY Math and English exams. It fulfills one of the two (Group V) laboratory course requirements for Biology majors. Course catalog description: Form, structure, classification and adaptive modifications of vertebrates, animals with backbones. Through dissections, representative vertebrates [dogfish, cat, etc.] are studied; vertebrates' major body systems and development of various representative structures are compared; relationships between form and function, and the use of certain structures in specific environments.

This course is offered in a hybrid format. The lecture is online and asynchronous, and the lab is in person on Wednesdays 12:40 – 4:00 pm. Students are expected to use Brightspace, Word, and email (including attachments) and to have consistent access to the Internet.

You will spend approximately 8-10 hours each week completing digital reading and writing assignments. If you're curious about why I assign that much work outside of class, it relates to the standard Carnegie Units for measuring college courses. One unit = one college credit, and each credit represents 45 hours of work (in class + out of class) per semester. For this 4-credit class, that is 45 hours x 4 credits = 180 hours. We meet 3 hours per week for 12 weeks (36 hours), and the remaining 144 hours represent the assignments and studying you do on your own. That comes out to approximately **10 hours per week** of independent study. Now you know why we call students "full-time" when you have 12 or more credits! You might also be interested in this course workload calculator, which is what I use to make sure that the work I'm asking you to do for this class matches the hours you are expected to spend.

Kingsborough Community College, The City University of New York
Department of Biological Sciences, Biology 2100

Bio 21 also fulfills the writing intensive graduation requirement. Honors credit is available for eligible students with a G.P.A. of 3.2 or higher (please contact professor for details).

Required Materials:

Vertebrates – Comparative Anatomy, Function, Evolution
Kenneth V. Kardong, Ph.D., McGraw-Hill, New York
You may use any of the following editions of the textbook: 4th, 5th, 6th, 7th, 8th
Below is a link to a free pdf of the 6th edition of the textbook:

https://ia801607.us.archive.org/16/items/KardongVertebratesComparativeAnatomyFunctionEvolution6thTxtbk/

Once the page opens, click on the first listing to open the book (it will take several minutes to load). Be patient. Once open, save it for reading so that you do not have to download it again.

The lab manual is available on Brightspace. A full-length lab coat, closed-toed shoes, and goggles are required to enter the lab. No one will be admitted to lab without the above.

Course Outcomes

1. Recognize the relationships between form and function in vertebrates.
2. Compare anatomy and body systems across the vertebrate classes, identifying similarities and differences, and conjecturing on adaptive modifications through natural selection.
3. Recognize the significance of embryonic development in vertebrate anatomical formation.
4. Further develop skills in observations and manual dexterity through careful and comprehensive dissection of representative vertebrates, recognizing their specialized design adaptations.
5. Conduct research as part of a class project utilizing knowledge of comparative anatomy.

Academic Integrity

I uphold the KCC policy on academic honesty (see pp. 71-72 in the Student Handbook). There can be serious consequences in college (and in your future professional life) for cheating or plagiarizing someone else's work (i.e., submitting work that is copied from another source), including a zero on the exam or assignment, a failing grade in the class, or dismissal from the college. **The work you do in this class must be your own and not the work of any other person or artificial intelligence (AI)**, except as

specified in certain assignments (such as group assignments, or an assignment where we are deliberately using AI).

Plagiarism

Plagiarism can sometimes be difficult to define. It is the use of others' words and/or ideas without clearly acknowledging their source. As students, you are learning about other people's ideas in your course texts, your instructors' lectures, in-class discussions, and when doing your own research. When you incorporate those words and ideas into your own work, it is of the utmost importance that you give credit where it is due. **Plagiarism is considered academic dishonesty and consequences may include receiving a zero for the assignment, quiz, or exam, a failing grade in the course, and/or referral to the Academic Judiciary for intentional or repeated offenses.** To avoid plagiarism, you must give the original author credit whenever you use another person's ideas, opinions, drawings/artwork, or theories as well as any facts or any other pieces of information that are not common knowledge. Additionally, quotations of another person's spoken or written words, or a close paraphrasing of another person's spoken or written words, must also be referenced. Accurately citing all sources and putting direct quotations – of even a few key words – in quotation marks are required.

Civility Statement

As an institution of higher education, Kingsborough Community College and its faculty and staff are committed to supporting a community in which learning can thrive. As such, we strive to interact with each student equitably and professionally while providing an environment of mutual respect and civility.

Civility in the classroom (including the virtual, online classroom) and respect for the opinions of others is very important in an academic environment. It is possible that you will not agree with everything that is said or discussed in the class. Courteous behavior and responses are expected. Therefore, in this class, any acts of harassment, and/or discrimination based on matters of race, gender, sexual orientation, religion, and/or ability are not acceptable. My goal is to provide a class atmosphere that welcomes, includes, and celebrates diversity in culture, ethnicity, race, gender, and the whole range of human experience. The ideas, background, life experiences, and opinions of each individual enhance the learning in our class. If you feel at any time that this is not your experience in our class, I would be very happy to listen to your feedback and address any issues. We all make mistakes (including me!), and when that happens we all can learn to do better by communicating honestly and respectfully with one another. I am also willing and available to talk through racist or discriminatory comments or behavior that occur on campus or in our wider community, should you wish to do so. **Please consider me a supportive resource to listen and respond to any concerns that you may have.**

Pronouns

If you have a preferred name and/or pronouns (ex. he/she/they), please let me know so I may use your preferences.

Accessibility

I try to make all the materials I post on our Brightspace site accessible (for example, including captions on all videos, making documents available as pdfs, providing downloadable forms of most assignments and other resources for offline use, using alt-text for images, and formatting so that students using screen readers can easily navigate the documents). If you notice that some materials are not accessible or do not open correctly on your device, please let me know and we'll fix the issue.

Access-Ability Services (AAS) serves as a liaison and resource to the KCC community regarding disability issues, promotes equal access to all KCC programs and activities, and makes every reasonable effort to provide appropriate accommodations and assistance to students with disabilities. Please contact this office if you would like to request such accommodations and assistance (Access-Ability Services). I will be glad to make the accommodations you need, but you will need documentation from the Access-Ability office for any academic accommodations.

Changes to the syllabus:

Please note that we may need to make reasonable changes to these policies as necessary during the semester. Any potential changes will be discussed in advance in class, and changes will be posted on Brightspace in the Announcements.

Lecture Topics & Sequence

Week	Topic(s)	Textbook Reading
1	Introduction Chordates	Chapters 1 & 2
2	The Vertebrate Story Biological Design	Chapters 3 & 4
3	Life History Integument	Chapters 5 & 6
4	The Skeletal System: The Skull The Skeletal System: The Axial Skeleton	Chapters 7 & 8
5	The Skeletal System: The Appendicular Skeleton	Chapter 9
6	The Muscular System	Chapter 10
7	The Respiratory System	Chapter 11
8	The Circulatory System	Chapter 12
9	The Digestive System	Chapter 13
10	The Urogenital System	Chapter 14
11	The Endocrine System	Chapter 15
12	The Nervous System Sense Organs	Chapters 16 & 17

Kingsborough Community College, The City University of New York
Department of Biological Sciences, Biology 2100

Laboratory Topics and Sequence

Week	Topic(s)	Laboratory Exercises
1	Amphioxus Anatomy Lamprey Anatomy	Amphioxus Dissection Lamprey Dissection
2	Dogfish Shark External Anatomy & Integument Skeletal System Muscular System	Shark Dissection 1 Shark Dissection 2 Shark Dissection 3
3	Dogfish Shark – continued Internal Anatomy	Shark Dissection 4
4	Dogfish Shark – continued Internal Anatomy	Shark Dissection 4
5	Perch	Perch Dissection
6	Necturus (Mud Puppy) External Anatomy & Integumentary System Skeletal System Muscular System Internal Anatomy	Necturus 1 Dissection Necturus 2 Dissection Necturus 3 Dissection Necturus 4 Dissection
7	Reptiles – Turtle	Turtle Dissection
8	Cat External Anatomy & Integumentary System Skeletal System	Cat 1 Dissection Cat 2 Dissection
9	Cat – continued Muscular System	Cat 3 Dissection
10	Cat – continued Internal Anatomy	Cat 4 Dissection
11	Topic: Cat – continued Internal Anatomy	Cat 4 Dissection
12	Research Project/Lab Wrap Up	

Attendance Policy, WU, and INC Grades

Students who stop submitting work or responding to emails will earn a WU final grade. INC is only assigned if a student is passing the class and can pass the class if they take the final. All college policies regarding attendance and grades will be adhered to.

Grading

Lecture

1. Exams - Three (3) lecture exams will be given on the dates on the tentative schedule. Each will be graded on a scale of 100 points. No make-ups will be given. A missed exam counts as a zero for that exam. However, the lowest exam grade will be dropped at the end of the semester. The two (2) highest exam grades will be counted and comprise 20% of your final grade.
2. Assignments – Assignments are assigned via Brightspace and are due online on the dates indicated on the calendar and on Brightspace. Assignments will be submitted by each group, not individually. Late assignments will not be accepted/graded and will result in a grade of zero. The assignments comprise 20% of your final grade (10 assignments; 2% each). Each student in the group will earn the same grade on each assignment.
3. Final Exam – Final exam is cumulative and comprises 20% of the final grade. Details to follow.

Laboratory

1. Practical Exams – Three (3) practical exams will be given on the dates indicated on the tentative schedule. Details for each will be provided in laboratory. Each practical exam will be graded on a scale of 100 points. No make-ups will be given. A missed practical exam counts as a zero for that exam. However, the lowest practical exam grade will be dropped at the end of the semester. The two (2) highest practical exam grades will be counted and comprise 20% of your final grade.
2. Research Project – Each student will participate in a class research project. A research report and presentation will be submitted for this project by each group. More details will follow. The research project comprises 20% of your final grade.

Lecture:	Exams	20%	Laboratory:	Practical Exams	20%
	Weekly Assignments	20%		Research Project	20%
	Final Exam	20%			
	Total	60%		Total	40%

Lecture + Laboratory = 60% + 40% = 100%

All assignments are due on the dates indicated on the tentative schedule or as announced in class. Late assignments will not be accepted and will result in a grade of zero.

Student Objectives – Lecture

Ch. 1 - Introduction

1. Define anatomy and physiology and distinguish between the two.
2. Define comparative anatomy.
3. List the distinguishing characteristics of chordates and vertebrates.
4. Define morphological terms (symmetry, segmentation, etc.) and provide examples of each.
5. Define and describe phylogeny.
6. Interpret and use a cladogram.
7. Define paleontology.
8. Explain the role of the fossil record in comparative anatomy.

Ch.2 – Origin of Chordates

9. State the characteristics of each group of Protochordates (Hemichordates, Cephalochordates, and Urochordates)
10. Draw and describe the probable phylogenetic relationships of the deuterostomes, including echinoderms, hemichordates, cephalochordates, urochordates, and vertebrates.

Ch.3 – The Vertebrate Story

11. Draw and describe the phylogenetic relationships within the vertebrates (Agnathans, Gnathostomes, Teleostomi, Tetrapods, Amniotes).
12. Distinguish the above vertebrate groups by listing their unique characteristics.

Ch.4 – Biological Design

13. Describe the significance of body size and shape in the vertebrates, including the concepts of surface area-to-volume ratio and allometry.
14. Define biomechanics and biophysics, and describe how the basic principles of each (e.g., velocity, acceleration, force, diffusion, exchange) are applied to vertebrate organisms.

Ch.5 – Life History

15. Compare and contrast early embryological development (fertilization, cleavage, gastrulation, neurulation) among the main groups of vertebrates (lancelets, fish, amphibians, reptiles/birds, and mammals).
16. Outline the basic sequence of tissue development and organogenesis in vertebrates (epithelial, connective, neural).
17. Describe the development of the coelom in vertebrates.
18. Identify the role of each extraembyonic membrane in reptiles/birds and in mammals.
19. Define each of the following words in the context of its role in vertebrate development: metamorphosis, heterochrony, Hox genes, and epigenomics.
20. Describe the relationship between ontogeny and phylogeny, and the biogenetic laws associated with each.

Ch. 6 – Integument

21. List and discuss the general features of the integument (epidermis and dermis) in vertebrates.
22. Outline the phylogeny of the integument in fish, amphibians, reptiles, birds and mammals.
23. Differentiate the specializations of the integument (nails, claws, hooves, horns, antlers, baleen, scales, armor, mucus, color, etc.).

Ch. 7 – Skeletal System: The Skull

24. Define and differentiate the chondocranium, splanchnocranium and dermatocranium.
25. Provide an overview of skull morphology, including identifying the major bones of the skull in various vertebrates.
26. Describe the major phylogenetic transitions in skull morphology from agnathans to gnathostomes to tetrapods to amniotes.

Ch. 8 – Skeletal System: The Axial Skeleton

27. List and identify the basic components of the axial skeleton (vertebrae, ribs, sternum, gastralia).
28. Describe the embryonic development of the axial skeleton in fishes and tetrapods.
29. Identify the main phylogenetic transitions in the axial skeleton from fishes to tetrapods.
30. Discuss mechanical design considerations in the vertebrate axial skeleton (e.g., adaptations of the spine to various habitats or functions).

Ch. 9 – Skeletal System: The Appendicular Skeleton

31. Identify the basic components of the appendicular skeleton (the bones of fins, limbs).
32. Discuss the origin (i.e., evolution) of paired fins.
33. Identify the main phylogenetic transitions of the vertebrate appendicular skeleton from fishes to tetrapods.
34. Discuss mechanical design considerations in the vertebrate appendicular skeleton (e.g., adaptations for swimming, terrestrial locomotion, flight).

Ch. 10 – The Muscular System

35. List and describe the types and structure of vertebrate muscle.
36. Describe basic muscle contraction on a microscopic and molecular level.
37. Discuss muscle mechanics in terms of length, tension, force, shortening and action.
38. Describe the embryonic origin of muscles in vertebrates.
39. Compare muscle anatomy across the major groups of vertebrates.

Ch. 11 – The Respiratory System

40. Identify the vertebrate respiratory organs and describe the structure and function of each.
41. Explain the four main mechanisms of vertebrate ventilation (cilia, dual pump, buccal pump, and aspiration pump).
42. Compare respiratory systems across the vertebrates.
43. Describe gas exchange, in air and in water.
44. Discuss the major evolutionary transitions in vertebrate respiratory systems.

Ch. 12 – The Circulatory System

45. Identify the components of the vertebrate circulatory system (blood, vessels, heart) and describe the structure and function of each.
46. Distinguish between single and double circulation.
47. Describe the embryonic development of the cardiovascular system.
48. Compare blood vessels across the vertebrates.
49. Compare hearts across the vertebrates.
50. Discuss cardiovascular system specialized adaptations (fetal, placental, etc.) across vertebrates.
51. Identify the components of vertebrate lymphatic systems and describe the structure and function of each.

Ch. 13 – The Digestive System

52. List the components of the vertebrate digestive system, including accessory organs, and describe the structure and function of each.
53. Compare the functioning of the digestive system across the major vertebrate groups.

Ch. 14 – The Urogenital System

54. List the components of the vertebrate urinary system and describe the function of each.
55. Describe in detail the structure and function of kidneys across the vertebrates.
56. Identify the major events in evolution of the vertebrate urinary system.
57. Discuss the embryonic development of the vertebrate reproductive system.
58. List the components of the female vertebrate reproductive system, and describe the structure and function of each.
59. List the components of the male vertebrate reproductive system, and describe the structure and function of each.
60. Compare external and internal fertilization across the vertebrates.

Ch. 15 – The Endocrine System

61. List the organs of the vertebrate endocrine system, and describe the structure and function of each.
62. Describe the major phylogenetic transitions of endocrine organs in vertebrates.
63. Explain endocrine coordination using the examples of mammalian reproduction and amphibian metamorphosis.

Ch. 16 – The Nervous System

64. List the types of cells in the vertebrate nervous system, and describe their structure and function.
65. List the components of the vertebrate peripheral nervous system, and describe the structure and function of each.
66. List the components of the central nervous system in vertebrates.
67. Describe the functions of the central nervous system in vertebrates.
68. Describe the major phylogenetic transitions in the vertebrate nervous system.

Ch. 17 – Sensory Organs

69. List and discuss the components of a sensory organ in vertebrates.
70. List and discuss general and special sensory organs in vertebrates.

Student Objectives – Laboratory

1. List and demonstrate laboratory safety procedures.
2. Identify components of Amphioxus anatomy.
3. Identify components of lamprey external anatomy.
4. Dissect and identify internal anatomical structures of the Llmprey.
5. Identify components of dogfish shark external anatomy.
6. Dissect the dogfish shark; identify internal components of the integumentary, skeletal, muscular, digestive, respiratory, urogenital, circulatory, lymphatic, nervous & endocrine systems.
7. Identify components of external perch anatomy.
8. Dissect the perch and identify internal anatomical components.
9. Identify external anatomical components of Necturus (mud puppy).
10. Dissect Necturus; identify components of the integumentary, skeletal, muscular, digestive, respiratory, urogenital, circulatory, lymphatic, nervous & endocrine systems.
11. Identify external anatomical components of a turtle.
12. Dissect a turtle and identify components of the integumentary, skeletal, muscular, digestive, respiratory, urogenital, circulatory, lymphatic, nervous & endocrine systems.
13. Identify external anatomical and skeletal components of birds.
14. Identify external anatomical components of the cat.
15. Dissect the cat and identify components of its integumentary, skeletal, muscular, digestive, respiratory, urogenital, circulatory, lymphatic, nervous & endocrine systems.
16. Compare the anatomical features of Amphioxus, lamprey, dogfish shark, perch, Necturus (mud puppy), reptiles, birds and cat.
17. Participate in a class research project, and report findings in the form of a written lab report and an oral presentation.