

ZO 150 Course Action Form Documentation

Course Justification:

A new approach to introductory zoology is needed to encompass the growing breadth of the discipline, and to ensure that majors achieve a common core of knowledge of animal taxa and zoological concepts while allowing a greater variety of choices among subdisciplines as preparation for different career tracks in zoology, health sciences and other life sciences. With increasing pressure on limited teaching resources, the Zoology Department must reduce overlap in course offerings (ZO 201 and ZO 208 in this case). The proposed course will provide a more consistent quality of introductory material on animal diversity, classification and phylogeny to majors, and fulfills one component of a new introductory Zoology core of four courses. It will be offered every semester in two sections, increasing access to a first introductory zoology course for SZO and ESC curricula, as well as sustaining access to non-majors.

Unlike ZO 201 and ZO 208, the proposed course has no prerequisite of college biology. As Zoology majors progress through all four of the proposed four courses, they will learn most subjects covered in BIO 125 in greater depth than can be achieved in the one-semester survey. To balance the lack of specific lecture topics on plants, fungi, and bacteria which are provided in BIO 125, the proposed ZO 150 will bring out the relationship of animals to other living organisms. The Kingdoms of Life will be introduced at the beginning and animal functions such as obtaining energy and materials will be compared to comparable functions of plants, fungi and protists. The pattern of diversification of animals through geologic time will be compared with diversification of the other eucaryotic Kingdoms, and concepts of how the evolution of plants and fungi affected animal evolution will be included.

The proposed new course is intended to replace much of the general introduction to the animal kingdom which is currently provided by ZO 201 for non-majors and by ZO 208 for majors. It differs in that:

- there is no prerequisite at the college level, which will be addressed by including material on universal properties of living organisms and contrasts among the Kingdoms of Life;
- zoology of invertebrate animals will receive greater emphasis, particularly in contrast to ZO 208,
- descriptions of selected animal communities, animal paleontology, and phylogenetic theories about the origin of modern animal diversity will receive greater emphasis;
- like ZO 201 but unlike ZO 208, it will contain a required laboratory in which students gain first-hand experience with identification of animals and recognition of differences associated with different habitats and phylogenetic backgrounds;
- most material on anatomy and physiology will be left to the proposed course ZO 250 Animal Anatomy and Physiology, since it will be part of the Zoology curriculum core;

- most material on ecology and behavior will be left to the proposed course ZO 260 Evolution, Ecology and Behavior, since it too will be part of the Zoology curriculum core;
- amount and difficulty of material covered will be reduced slightly, commensurate with lowering from sophomore to freshman level; and,
- it will be designed to appeal more to students' inherent interest in the natural history of animals than have ZO 201 and BIO 125, and to increase student appreciation for the value of animals to modern human endeavors.

The proposed course will strengthen the SZO major by contributing to a new introductory core. It will require a laboratory experience in contrasts among animal body designs and how these are used to classify animals which may be bypassed entirely under the current curriculum requirements. There is no present requirement in the SZO curriculum for study of invertebrate zoology beyond a week or two of lectures in ZO 208, and while most majors now are electing ZO 303 and ZO 304 Vertebrate Zoology, very few are enrolling in ZO 402 and ZO 403 Invertebrate Zoology or ZO 315 Parasitology. Through the laboratory and increased lecture emphasis, ZO 150 will do a better job of ensuring that all our majors have a basic knowledge of this dominant proportion of animal diversity.

Enrollment for the last 5 years:

Fall 1998	254
Spring 1999	240
Fall 1999	238
Spring 2000	269
Fall 2000	286
Spring 2001	139
Fall 2001	144
Spring 2002	144
Fall 2002	132
Spring 2003	126

Resources

Resources for this proposed course will be largely provided by dropping ZO 201 and ZO 208. ZO 150 will serve similar numbers in lectures as ZO 201 + ZO 208 and larger numbers in laboratories. Instructors and space for the greater number of laboratory sections will come from realignment of existing courses into a new introductory core. An analysis of the current demand for courses which will be replaced by this and other proposed core courses, and the expected reduced demand for the new courses created by a decline in the number of zoology majors (attached to this set of Course Action Forms), shows that resources can be shifted from the old to the new without a net increase. Smaller numbers of zoology majors are projected because of restructuring of the Pre dental-Pre medical program from a primary departmental major to a University-wide second major. However, many preprofessional health science students electing other first majors will probably select ZO 150 as a laboratory biology course to meet professional school requirements.

Consultation with Other Departments

Besides the main SZO major, two other existing majors in Zoology are affected, ESC (Environmental Science-Ecology Concentration) which requires ZO 208 and SZM (Medical Technology {since dropped}), which requires ZO 201. The Environmental Sciences track specifies in its core an introductory zoology course, which will be satisfactorily provided by ZO 150. This substitution for ZO 208 will be proposed as a Minor Action as soon as ZO 150 is approved. Similarly, needs of the SZM curriculum will be better addressed by the proposed ZO 150 as preparation for sophomore anatomy and physiology courses which are also required.

Student Learning Outcomes:

Upon successful completion, students will be able to ...

- 1) describe and explain current concepts of the Kingdoms of Life;
- 2) compare and contrast the diversity and characteristics of animal phyla;
- 3) explain, using principles and terminology of cladistics, how phylogenetic trees of animals are constructed and supported with anatomical, embryological, and genetic data;
- 4) describe the timing and nature of major events in animal macroevolution;
- 5) relate representative animal adaptations to environments and ecological strategies;
- 6) explain how a cladogram (phylogenetic tree) can be constructed and supported with appropriate evidence, using the principles and terminology of cladistics;
- 7) compare and evaluate anatomical evidence, then use it to construct cladograms; and,
- 8) analyze examples of ambiguity in cladograms, and apply techniques that can resolve those ambiguities.

GER Category Objectives:

As a course in the Natural Sciences category of the General Education Requirements, ZO 150 will provide instruction and guidance that help students to:

1. use the methods and processes of science in testing hypotheses, solving problems, and making decisions; and,
2. articulate, make inferences from, and apply to solving problems, scientific concepts, principles, laws, and theories.

GER Student Learning Outcomes (condensed for inclusion in Course Objectives):

Upon successful completion of ZO 150, students will be able to:

- 1) explain how a cladogram (phylogenetic tree) can be constructed and supported with appropriate evidence, using the principles and terminology of cladistics;

- 2) compare and evaluate anatomical evidence, then use it to construct cladograms; and,
- 3) analyze examples of ambiguity in cladograms, and apply techniques that can resolve those ambiguities.
- 4) describe and explain current concepts of the Kingdoms of Life;
- 5) compare and contrast the diversity and characteristics of animal phyla;
- 6) explain, using principles and terminology of cladistics, how phylogenetic trees of animals are constructed and supported with anatomical, embryological, and genetic data;
- 7) describe the timing and nature of major events in animal macroevolution;
- 8) relate representative animal adaptations to environments and ecological strategies.

Means of Instructing and Evaluating GER Outcomes:

1. Key terms in cladistics and their applications to evolutionary relationships among animals will be introduced by assigned textbook readings and a lecture. Definitions of the terms and recognition of their correct application to specific cases will be tested in multiple choice format on the second lecture test.
2. An exercise added to the 4th laboratory meeting will challenge teams of three students to describe and evaluate anatomical characteristics from illustrations, microscope slides, and preserved specimens for use as cladistic evidence. This exercise will be guided and supported by a new handout supplemental to the Laboratory Guide.

Students will distinguish derived (more complex, advanced) from ancestral (simpler, older) conditions of each anatomical character, and explain their reasoning. They will apply their conclusions to construct a provisional cladogram for selected animals. The exercise will include a deliberately ambiguous set of characteristics, with which instructors will lead students into a discussion of techniques for resolving ambiguities using other data. Revised cladograms will be submitted as part of the lab grade.
3. A homework assignment later in the semester, weighted equally to a lecture test, will determine the ability of each student to apply these concepts to produce and justify a cladogram for a new set of animal taxa, using class informational resources.
4. A final exam discussion question will require students to explain a case in which application of cladistic principles has resulted in a major change in accepted taxonomic hierarchies of animals. For example: "Why is the former class Reptilia considered to be paraphyletic by cladistic standards? In your discussion, explain, with examples from this case, how the confusion of ancestral and convergent characteristics with derived characteristics led to the older classification. Finally, describe the newer classification and explain how derived characteristics support it."

How the Learning Outcomes Relate to GER Objectives in ZO 150:

The discipline of cladistics, which is essentially a set of rules for how data may be used to more accurately determine the evolutionary history of animals, has had a great impact on the biological sciences. This discipline integrates advances in genomic technologies, statistical procedures, and computing power with information about embryological, anatomical and physiological properties to construct more robust hypotheses about phylogenetic relationships among taxa of animals. It has stimulated new investigations of animal characteristics, significant changes in animal classification, and new perceptions of how modern animal diversity evolved. To understand the application of cladistic principles, students must master both the basic process of scientific reasoning, and ways of evaluating anatomical and other characters to draw inferences about origins of animal diversity.

Syllabus (See Attached)

ZO 150 Animal Diversity
Fall 2003

Class Meeting Times & Places: Section **001**: MWF 2:35-3:25 p.m., **3712** Bostian Hall, Sections **002, 003**: MWF 3:40-4:30 p.m., **2722** Bostian Hall. All **lab** sections (MTWH) meet in **4705** Bostian Hall. Laboratory sections begin meeting Monday, August 25.

Class Web Site: is accessible to enrolled students through WebCT:

<http://webct.ncsu.edu/>

There is also a page of useful links and public information for ZO 150 students on the open Web: <http://www.cals.ncsu.edu/course/zo150/index.html>

Instructor: Dr. Sam Mozley

Personal Web Page: <http://www4.ncsu.edu/unity/users/b/burbanck/www/scmindex.html>

Office Location: 4105 North Gardner Hall E-mail: s_mozley@ncsu.edu

Phones: office, 515-1981, home 851-9673 (both with message recording).

Open office hours: Mon. 10:20-11:40 a.m., Tues. 10:00 - 11:00 a.m.; Thurs. 12:30-13:30 p.m.; other visits by appointment.

Prerequisite: One year of high school biology, or one semester of college level biology. Although prerequisites are slight, the course is designed to be challenging and students must devote a substantial amount of time for study of concepts, names and terms.

GER Category Objectives:

As a course in the Natural Sciences category of the General Education Requirements, ZO 150 will provide instruction and guidance that help students to:

1. use the methods and processes of science in testing hypotheses, solving problems, and making decisions; and,
2. articulate, make inferences from, and apply to solving problems, scientific concepts, principles, laws, and theories.

Student Learning Outcomes :

Upon successful completion of ZO 150, students will be able to:

1. explain how a cladogram (phylogenetic tree) can be constructed and supported with appropriate evidence, using the principles and terminology of cladistics;
2. compare and evaluate anatomical evidence, then use it to construct cladograms; and,
3. analyze examples of ambiguity in cladograms, and apply techniques that can resolve those ambiguities.

Required Laboratory: All students enrolled in this lecture must also enroll in the laboratory. (*Exception: if you are repeating the course, you may request that your previous lab grade carry over to the present semester.*)

Computer Skills: Students are expected to be able to browse, download files, and print from the World Wide Web and use E-mail and a word processor. N. C. State University E-mail messages and the class Web pages (especially, WebCT Calendar and Discussion Topics tools) should be checked at least weekly for important information.

Credit by Examination: This class may be challenged by exam. The challenge exam consists of both a written and a laboratory test on recognizing and classifying several domains and kingdoms of life and the more diverse animal phyla, and explaining animals' anatomical adaptations and phylogeny. Schedule the challenge exams with Dr. Mozley by August 22.

Goals of the course: Upon successful completion, students will be able to ...

- 1) describe and explain current concepts of the Kingdoms of Life;
- 2) compare and contrast the diversity and characteristics of animal phyla;
- 3) explain, using principles and terminology of cladistics, how phylogenetic trees of animals are constructed and supported with anatomical, embryological, and genetic data;
- 4) describe the timing and nature of major events in animal macroevolution; and,
- 5) relate representative animal adaptations to environments and ecological strategies.

Role in Zoology Curriculum: ZO 150 is intended as the first class in the core series for Zoology majors, and prerequisite to ZO 250 and ZO 260.

Textbooks: Campbell, N. A., and J. B. Reece 2002. Biology (6th ed.) Benjamin Cummings, Inc. (**required**)
Hickman, C. P., Jr., L. S. Roberts, and A. Larson. 2003. Animal Diversity (3rd ed.) McGraw-Hill Publ. (**optional**)

Lab Manuals: Van de Graaff, K. M., and J. L. Crawley. 2002. A Photographic Atlas for the Zoology Laboratory. (4th ed.) Morton Publ. Co., Englewood, CO (**required**)
Mozley, S.C. August, 2002. ZO 150 Guide to Laboratory Exercises (**required**).

Schedules of lecture topics and reading assignments and laboratory exercises are posted in class Web pages

Special schedule items:

Lectures will not meet on September 1, October 10, or November 26 or 28.

Normal laboratory sections (except Tuesday night # 207) will not meet during the weeks beginning September 1, October 6, November 24, or December 1. However, the lab will be open for individual review on October 6 and December 2 and 3.

Laboratory Practical Exams (1-hour periods) must be arranged by all students for October 7 or 8 and December 4 or 5.

Lecture Tests will take place during the class period on
September 10
October 3
October 29
November 24

Phylogeny Charts

Assignment posted on Web site September 26
Due at lecture time on November 17

The Final Exam (comprehensive) will be given:

For Section 001: December 15 Monday 1:00 - 4:00 p.m.

For Sections 002 and 003: December 12 Friday 1:00 - 4:00 p.m.

Other important schedule items:

October 1 Wednesday Last day to withdraw or drop ZO 150 without a grade, change it from credit to audit, or change to credit only (appropriate only if ZO 150 is a free elective for you). Last day to submit all Requests for Course Repeat Without Penalty.

Lecture Policies

Lecture Tests - Test format will be multiple choice and a discussion question selected from a study question list posted online. Sample multiple choice questions will also be provided online before the first lecture test. The lowest of 4 lecture test grades will be dropped, provided it is not a "0" for cheating. The first missed test counts as your dropped grade and may not be made up. Other tests missed due to unavoidable circumstances may be made up by individual student arrangement within two weeks after the scheduled test date.

Phylogeny Chart Exercise: Although calculated as part of your lecture grade, this exercise will be introduced and guided in lab meetings. See the class Web site for details.

Late Assignments: Phylogeny charts and field lists for the lab that are submitted after the class period or lab meeting time at which they are due will be penalized by deduction of 10% of maximum possible points for every weekday they are late. Papers turned in after the beginning of the respective meetings are considered one day late.

Attendance: Attendance consists of arriving before class begins and remaining until it ends. Five-minute quizzes will be given at the beginning or end of lectures many times through the semester, and may yield a total, final grade supplement of up to 6 points. Quizzes may not be made up, regardless of reason for missing. They will be based on facts presented in the preceding lecture. Besides regular and punctual attendance, quizzes reward regular study of class notes and enhancement of your notes from textbook reading assignments before every class meeting. Always bring the previous lecture's notes to class.

Incomplete Grades: A mark of "incomplete" may be negotiated when a student is unable to complete the class due to personal difficulties that arise late in the semester. Earlier difficulties are better handled by dropping the course.

Academic Integrity: Evidence of cheating or helping others on tests or copying parts or all of the Phylogeny Chart will result in a grade of 0, in addition to other consequences, according to the Code of Student Conduct:
http://www2.ncsu.edu/prr/student_services/student_conduct/POL445.00.1.htm

Auditing and Credit-Only Options A recognized audit requires regular attendance. Since attendance is recorded by pop quiz papers, auditors must take the pop quizzes to document their attendance.

Basis of Grade

Component	%
Lecture Grade	
Lecture Exams: best 3 at 13 % each	39
Phylogeny Chart	13
Final Exam (comprehensive)	23
<i>Lecture Subtotal</i>	<i>75</i>
Lab Grade (see Laboratory Information)	25
Total Course Points	100

Fractions of 0.50 or higher will be rounded to the next higher integer. Letter grade ranges: A+ 97 or higher; A 93-96, A- 90-92, B+ 87-89, B 83-86, B- 80-82, C+ 77-79, C 73-76, C- 70-72, D+ 65-69, D 60-64, D- 55-59, F 54 or below.

Laboratory Information

Laboratory Materials

Bring biology drawing paper (minimum of 5 heavy-weight, 3-hole punched, loose-leaf sheets for the semester), a soft lead pencil, a white, block eraser, and a 30-cm, clear ruler to each meeting which involves a drawing. Bring the Laboratory Guide course pack and Photographic Atlas to all meetings. Bring a dissecting kit (sold in lab meetings for \$13) to all lab meetings beginning with the fourth lab (mussel dissection).

Schedule of Exercises, Preparatory Readings, and Testing

In reading assignments, LG = Lab Guide, PA = Photographic Atlas, C = Campbell and Reece.

Lab quizzes are limited to the first 5 minutes of the scheduled meeting time. Questions will come from the last, preceding lab exercise and preparatory readings for the current exercise.

Dates **Topics - Readings** (tested in quizzes at start of lab meetings)

- Aug. 25-28 Laboratory Safety and Policies; Using Microscopes; Cell Structure;
 Drawing Technique
Drawing I - Plant Parenchyma Cell
LG ch. 1-3; **PA** Fig. 1.1; **C** Fig. 7. 8, 7.28
- Sep. 1 *Labor Day Holiday No Labs This Week*
- Sep. 8-11 Comparison of Domains and Kingdoms: Bacteria, Euglenozoa,
 Stramenopila (diatoms), Alveolata (ciliates), Plantae (Main Types and
 Life Cycles), Fungi; Animalia (Porifera). Lab Quiz 1.
LG ch. 4, 5; **PA** ch. 3, 4; **C** figures in ch. 28-31, Tables 28.1, 29.1
- Sep. 15-18 Cnidaria; Early Embryonic Phases; Lab Quiz 2
Drawing II - Hydra Cross Section.
LG ch. 6, 7; **PA** ch. 5, Fig. 2.2
- Sep. 22-25 Platyhelminthes; Mollusca - Mussel and Squid Dissections; Lab Quiz 3;
 Phylogeny Chart Introduction.
LG ch. 8, 10; **PA**, ch. 6, 8; **C** 25:492-505
- Sep. 30-Oct. 3 Rotifera; Bryozoa; Annelida - Earthworm Dissection; Lab Quiz 4,
 revised cladograms due
Drawing III - Earthworm Cross Section
LG ch. 9-11; **PA** Fig. 7.9, 7.10, ch. 9; Bryozoa images on class Web
 site
 Lab Practical I sign-up sheets posted in elevator foyer on Sept. 30.
- Oct. 6 Lab Open for Individual Review and make-up of excused absences 9:00
 a.m. - 10:00 p.m.
- Oct 7- 8** **Lab Practical 1** Sessions from Thurs. 2:35 to Fri. 4:45 p.m. Bring only
 a pencil or pen. A practical consists of short answers (fill in blank) to
 questions about specimens on display.
- Oct. 13-16 Nematoda, Tardigrada, Onychophora, and Arthropoda; Crayfish and
 Grasshopper Dissections, Lab Quiz 5 (on preparatory readings, only)
Drawing IV. Nematode Cross Section
LG ch. 12-14; **PA** ch. 7, 10; Tardigrada & Onychophora images, Web
 site
- Oct 20-23 Field Trip to Collect Animals; Taxa List Assignment (no Lab Quiz,
 depart for field at beginning of scheduled meeting time)
LG ch. 23
- Oct 27-30 Echinodermata, Sea Star Dissection, Hemichordata, Introduction to
 Chordata, Field Taxa List due, Lab Quiz 6 on exercise of Oct. 13-16
 and preparatory reading.
Drawing V - Lancelet Cross Section
LG ch. 15-17; **PA** ch. 11, Table 12.1, Fig. 12.1 - 12.5
- Nov 3- 6 Introduction to Craniata: Hagfish, Lamprey, Perch, and Shark
 Dissections; Lab Quiz 7.
LG ch. 18; **PA** Fig. 12.6 - 12.16, ch. 13

- Nov 10-13 Amphibia and Ectothermous Diapsida; Frog Dissection; Lab Quiz 8
LG ch. 19, 20; **PA** Fig. 12.17-12.22, ch. 14, 15
- Nov 17-20 Order Aves, Class Mammalia; Pigeon and Fetal Pig Dissections; Lab Quiz 9.
LG ch. 21, 22; **PA** ch. 16, Fig. 17.1-6, 17.23-37, 17.48-49, 17.77-78, 18.4, 18.8-10, 18.51
- Nov. 24-27 *Thanksgiving Week, no labs this week*
 Lab Practical II sign-up sheets posted in elevator foyer on November 24.
- Dec. 2- 3 Lab Open for Individual Review and make-up of excused absences
 Tues. 1:00 - 10:00 p.m., Wed. 1:00 - 10:00 p.m.
- Dec 5- 6 Lab Practical II** Sessions from Thurs. 2:35 to Fri. 4:45 p.m.

Laboratory Grade Basis

<u>Item</u>	<u>Points</u>
Quizzes (best 8 of 9 at 10 each)	80
Revised Team Phylogeny Chart	50
Field Taxa List	50
Lab Practicals (2 at 100 each)	200
Graded Drawings (4 at 50 each)	200
<u>Participation (attendance, punctuality, interaction)</u>	<u>40</u>
Total	620

Total points will be divided by 620 and multiplied by 25 to calculate the percentage of the course grade (up to 25%) for the laboratory component.

Lecture Schedule

August

- 20 Course Policies and Overview
- 22 Cell Features; Prokaryotic and Eukaryotic Domains 1:1-6a, 9d -13a, 7:108-9, 112-6, 123b-5a, 128c-31a, 132b-2c, 27: 526-8c, Fig.'s 27.7, 27.8, p. 532d -3a, 540-2.
- 25 Kingdoms; Unicellular Eukaryotes 26: 522b-523; 28: Fig. 28.8, p. 555-572 - cellular characteristics, examples of 8 kingdoms).
- 27 Plants 29: 575-576c, Fig. 29.1, 29.2, p. 580a-c, Fig.'s 29.14, 29.16, 29.23; 30: 597-600b, 610d-513.
- 29 Fungi and Symbioses; Classification and Phylogenetic Systematics 31: 616-619a, Fig.'s 31.5, 31.7, p. 626-631; 25: 492b-495a .

September

1 Labor Day - Class Holiday

- 3 Early History of Life and Animal Origins Table 25.1; 26: 510-516a; 32: Fig. 32.2, p. 642d-644.
- 5 Overview of Animal Phylogeny; Sponges; Cellular Organization Level 32: 633-642c; especially Fig. 32.8; 33: 646-648

8 Diploblastic Design; Cnidarians 33: 648-651; Fig. 41.11, 42.1, 48.15a.

10 Test 1 on Lectures from Aug. 20 - Sep 8

12 Bilateral Design; Protostomes; Turbellaria 33: 651-653; Fig. 44.18; 48.15c; 49.7.

15 Parasitic Trematoda and Cestoda 33: 653-654; Fig. 46.6.

17 Spiralia; Nemertea; Ciliated Marine Larvae 32: 638, Fig. 32.8, 32.9, 32.12.

19 Classification, Phylogeny and Cladistics 25:492-505

22 The Coelom; Introduction to Mollusks 33: 656-659

24 Mollusk Diversity 50: 1097d-1098a; Fig. 42.19; 48.15 f, g.

26 Metamerism and Polychaetes 33: 659-661; Fig. 33.36, 42.2b, 42.19, 44.19; 49.27

29 Pogonophora, Clitellate Annelids Fig. 33.23, 41.12 a; 48.15 d.

October

1 Rotifera; Bryozoa, a Lophophorate Phylum 32: 641-642; 33: 654-655.

3 Test 2 on Lectures from Sep 12 - Oct. 1

6. Ecdysozoa Concept; Nematoda 33: 661c-662a.

8 Tardigrada; Onychophora; Introduction to Arthropods 33: 662-664a, Fig. 44.15

9/10 NCSU Fall Break

13 Trilobitomorpha; Chelicerata; Introduction to Mandibulates 33: 664b-666a.

15 Myriapoda; Introduction to Insecta 33: 666-670; Fig. 44.13, 44.20.

17 Insect Classification and Biology Fig. 41.12b, 42.2a, 42.22; 45.2; 51.27.

20 Crustaceans 33: 670-671; Fig. 42.19.

22 Introduction to Deuterostomes; Hemichordata 32: 638-639, 33: 672

24 Echinodermata 33: 672-674; Fig. 42.19; 48.15b

27 Chordate Features and Subphyla 33: 674-675, 34: 678-684c.

29 Test 3 on Lectures from Oct. 6 - 27

31 Evolution of Craniates; Jawless Fishes 34: 682-686; Table 25.1

November

3 Cartilaginous Fishes; Intro. to Bony Fishes 34: 686-690c; 42: 873-874, Fig. 42.20; 49.20a.

5 Bony Fish Diversity 34: 688-690; Fig. 34.7, 44.14

7 Evolution of Tetrapoda; Amphibia 34: 690d-693a

10 Evolution and Paleontology of Amniotes 34: 693-697.

12 Turtles, Snakes, Lizards, and Crocodiles 34: 697-698; Fig. 42.3, 49.6.

14 Birds: Designed for Flight 34: 698-699c; Fig. 42.25.

17 Bird Origins and Diversity 34: 699d-701c.

19 Mammal Characteristics 34: 701d-702c; Fig. 42.3c, 42.4, 42.23; 44.6. 49.17b.

21 Mammal Diversity 34:702d-706; Fig. 41.20.

24 Test 4 on Lectures from Nov. 3 - 21

27-29 NCSU Thanksgiving Break

December

1 Evolution of Primates. 34: 707-709.

3 Humans as Special Apes. 34: 709-715.

5 Review for Final Exam and Course Evaluations

Dec 9 1:00 p.m. Final Exam on all lectures for 2:35 lecture (Section 001)

Dec 16 1:00 p.m. Final Exam on all lectures for 3:40 lecture (Sections 002 and 003)