

Dr. Chris Ivey, Office: Holt 306, Office Hours: T 1:30-4:30, F 10-12, ph: 898-5812, email through Vista

Text: Freeman, Scott and Jon C. Herron. 2007. *Evolutionary Analysis*. (4th Edition). Prentice Hall, New Jersey. Other readings posted on WebCT. All assignments will only be accepted via WebCT unless otherwise noted.

1. Expectations: You will need to master vocabulary, theories, hypotheses, and some simple math for this course. Quizzes, exams and other assignments will evaluate your understanding of this information on a factual level as well as your ability to reach new conclusions based on synthesis of connections between concepts. To do well in this course, expect to spend **at least** 2-3 hours of **focused** study for each hour of class time. Simply spending time, however, does not guarantee a good grade, it must be time well spent.

2. How to study: 1) Read to understand; to do this you will probably have to read each chapter more than once (don't just read to finish the chapter). 2) Read chapter summaries *before* the chapter and ideally, before class. 3) Take advantage of the study tools provided on the textbook web page (URL in text), glossary, review questions at end of chapters, etc. 4) Take your own notes and do not rely exclusively on my handouts which are incomplete. 5) Form study groups of four or fewer and get together regularly to discuss the material - start this now! 6) Explain the material others in your study groups out loud, without looking at your notes or text, while your study partners listen carefully for mistakes or muddiness that needs clarification. 7) Ask questions in class. 8) Come and see me as soon as you have any questions/problems. 9) Cramming won't work - keep up with the material. 10) Attend all classes. If you follow this advice you are almost guaranteed do OK in the course.

3. Attendance is expected and I will record attendance daily. Good learning is collaborative and social and not a spectator sport. In other words come to class prepared to participate. Since you are responsible for everything that is said, shown, discussed and mentioned in class, be ready to go at 12:55 pm (late entries are disruptive), and generally behave in a positive, respectful, and engaged manner. If you miss a class, get the information from a classmate; my notes will not necessarily be available.

4. Quizzes will be posted online at several points throughout the course. These are intended to help you practice the material presented in class, and to reinforce ideas from the textbook. Most of the quizzes are during the first half of the course because this is the more math-intensive section of the course and because more of your time will be spent writing the review article in the second half of the semester.

5. Exams may include definitions, multiple choice, short answer, calculations, fill-in-the-blank, data interpretation, and essay questions. Material will come from the text, discussions, readings, lectures, or any other source associated with the class. All exams are potentially cumulative, as the course material is interrelated. There are no make up exams, although I will try to accommodate if you provide a **documented** (by Student Affairs) excuse **BEFORE** the scheduled exam time.

6. Discussions of papers from peer-reviewed scholarly literature or book chapters for 30-50 min are assigned periodically throughout the course. The discussion readings will be available on the Vista course website. Discussions will occur on WebCT through the course website and be available for about a week. Students who provide at least two thoughtful contributions to the discussion will receive full credit. Each contribution should be substantial (e.g., at least a paragraph) and relevant to the topic under discussion. At least one of the contributions must directly address material in the reading (perhaps by using examples) and demonstrate that you gave the material a careful read. At least one of your other contributions must be in response to something someone else has posted (in other words, participating in a conversation).

7. Review paper: Students will be expected to write a critical summary review article, which should be roughly 5-6 pages double-spaced, 1-inch margin, 12-pt font Times New Roman text, not necessarily including references or figures. The paper should cite and discuss **at least** five journal articles from real, scholarly biological journals (not web sites). They should all be peer-reviewed, such as original research or critical reviews. Good journals with lots of interesting articles include:

Evolution

Proceedings of the Royal Society of London, Series B

Trends in Ecology and Evolution

Annual Review of Ecology, Evolution and Systematics

American Naturalist (some articles may be mathematical)

Journal of Evolutionary Biology
Heredity

You may also use journals that are dedicated to particular groups of organisms, like
Journal of Mammalogy, Annals of the Entomological Society of America, American Journal of Botany

In the text of your paper, cite your sources as the author's last name and the year the article was published (Wilson & Thomson 1996; Ivey et al. 1999). Give the full citation at the end your paper in a "Literature Cited" section using the following format:

Wilson P, Thomson JD. 1996. How do flowers diverge? Pp. 88-111 in D. Lloyd and S. C. H. Barrett (eds.). *Floral biology*. Chapman & Hall, New York.

Ivey CT, Lipow SR and Wyatt R. 1999. The mating system and interfertility of swamp milkweed (*Asclepias incarnata* ssp. *incarnata* and ssp. *pulchra*). *Heredity* 82: 25-35.

Avoid using quotations. Instead paraphrase the essential information using your own words, and then provide a citation. Formatting matters. Part of your score will be based on your ability to adhere to the formatting rules given above. Your paper is a mini-review or essay, so it might not have the standard headings characteristic of an experimental science paper (Introduction, Materials and Methods, Results, Discussion). Aim to make every word the best one. Technical methods should be kept to a minimum: you need not explain, for example, how to do multiple regression; rather, just say Grant et al. (1996) regressed survivorship on beak length, beak depth, and beak width; similarly, you need not explain how to do starch gel electrophoresis, just say variation in allozymes is shown in Figure 1. **The most important goal** should be to have a lucid flow of logic with *every detail* in the paper contributing sensibly to the ideas presented. Edit your paper carefully, and then realize it needs still more editing. I highly encourage you to consult the additional suggestions regarding grammar and style that are posted on the course website.

On November 4th, you are expected to turn in an **outline** for your paper. The outline will identify the topic you plan to address, detail in bulleted lists the main arguments you will make in your paper, and identify the literature you review. Thus, before the outline is due, you should have (1) chosen your topic, (2) chosen your papers, (3) read your papers, and (4) figured out what ideas you intend to emphasize. I will provide feedback on the topic and structure of your planned paper as well as the literature you have identified so that you have a better chance of receiving full credit on the final product.

Before October 14th, discuss with me the planned topic for your paper. I ask this so that you don't invest a lot of time pursuing a topic that will be unlikely to satisfy the assignment. Reviews should address one of following two broad areas of evolutionary biology

Adaptation & selection

Evolutionary biologists often study the selection regime and other factors responsible for the evolutionary dynamics in some sort of character in the researcher's favorite group of organisms. The first paper was about adaptation within a species or group of organisms, or how natural selection gives rise to the characters of interest. Examples include:

- the evolution of heterostylous flowers
- the evolution of viviparous reptiles
- the evolution of host specialization in folivorous beetles
- the evolution of hummingbird pollination
- the evolution of the annual life history in plants
- the evolution of extended seed dormancy
- the evolution of hibernation in arctic-alpine mammals
- the evolution of selfing in flowers
- the evolution of light-colored pelage on the bellies of mammals
- the evolution of mimicry coloration on the wings of butterflies
- the evolution of the respiratory system in diving mammals and birds
- the evolution of sclerophyllous leaves in arid-land shrubs

And the list could go on for pages. Look for scientific articles on some such topic. At least three should have original data. One or two could be scholarly review papers or chapters in scholarly books. Once you find one article that is really appropriate, it will cite others of interest. Weave together the ideas presented in these papers regarding

adaptive hypotheses, results, and suggested tests about your topic. Be very explicit about how you suppose natural selection acts; make the reader understand the nature of selection in your system. After posing the hypothesis or hypotheses, describe how they have been tested, and if the tests have not been very extensive suggest further tests that might be done.

Diversification

Evolutionary processes are often divided into two parts roughly distinguished by the scale at which they operate: (1) the study of natural selection with other processes that act *within* populations and (2) the study of speciation with other processes that give rise to the diversity of life. A similar but not exactly equivalent dichotomy would distinguish microevolution and macroevolution. The reason why it is not an exact equivalent is because macroevolution implies a much broader scale pattern of diversification at the level of genera or families, and can involve a paleontological perspective. The process of speciation, rather, lies right at the boundary between micro- and macroevolution. The previous topic (adaptation) may involve several species or a phylogeny as a means of achieving statistical replication, but the *differences* between the species should not be the focus of attention – instead it is about how selection has resulted in some adaptation within a population or group. The topic of diversification, rather, focuses on the *origin* of diversity. It should be a paper about how diversification occurs. Address the question of how evolutionary *processes* give rise to different species. Some example topics include:

- the origin of reproductive isolating barriers
- the role of diversifying selection
- character displacement
- host shifts
- pollinator shifts
- coadapted gene complexes
- macromutations that kick off evolution to an alternative niche
- the role of sexual selection in speciation
- the role of climate change in causing geographic isolation
- genetic correlations (pleiotropy) causing speciation

Or you may write about any other factor that plays a role in evolutionary diversification. Many of these evolutionary mechanisms involve natural selection but they also involve something more. The focus should not be natural selection, but the diversifying mechanisms of other these other evolutionary processes. Write about that other evolutionary mechanism, not natural selection.

This paper will likely focus on a particular type of organism. You are free to end up writing about any kind of organism (yuccas, song birds, weevils, cichlid fishes, moon jellies, whatever). However, you will need to explain how the peculiar biology of that kind of organism interacts with your mechanism-of-diversification. What does the organism “bring to” the evolutionary process? Stated another way, how might prior evolutionary innovations have affected subsequent diversification? This may be an important secondary topic in your paper that should not be avoided. The paper is intended to be on evolutionary mechanisms leading to diversification, and the effectiveness of these mechanisms could be constrained (or enhanced) by the organism’s evolutionary history. Be wary, however, of the huge number of papers on the patterns of diversification (e.g., “Phylogenetic reconstruction of the Abcaceae?”). Don’t waste a lot of time trying to read these articles, at least not until your paper is well on its way to being written and you’re just trying to look up some detail or background information. Many phylogeny articles don’t have much on evolutionary *processes*, and your paper should be about processes, using patterns as evidence and as background. Make sure the paper is about processes. How did your species come to be different and distinct?

Papers and outlines are to be submitted electronically via the course website on WebCT. Late assignments will be penalized 10% per 24-hour period following the beginning of the class period on the due date, including weekends & holidays. Assignments that are more than 4 days late will receive no credit.

7. Academic dishonesty in any form will be immediately referred to Student Judicial Affairs. This includes plagiarism, failing to provide proper credit for an idea, copying or borrowing coursework from another student, paraphrasing someone else’s idea without acknowledging the source, copying answers from your text, etc. Another form of plagiarism involves copying text from another source, modifying a few words, and claiming it as your own. There will be no credit awarded for any assignment that involves even a hint of plagiarism. Go out of your way to not be tempted and to not tempt anyone else. There are no group assignments in this course. Every word you write

should be your own. Additional information on academic integrity is available in the Code of Students Rights and Responsibilities, which is available from www.csuchico.edu/sjd.

8. Students with disabilities: CSU, Chico acknowledges each student's unique set of abilities and limitations, and works to provide all students with an enriching educational experience. If you are disabled, contact Disability Support Services (www.csuchico.edu/dss or Student Services Center 170 or 898-5959) and notify me as soon as possible.

9. Grading:

Assignment	Points
Discussion participation (5@10 each)	50
Quizzes (6@10 each)	60
Homework	10
Review paper	
Outline	30
Final	100
Exams	
2 Midterms@50	100
Final	100
Total	450

A (92%)	C (72%)
A- (90%)	C- (70%)
B+ (87%)	D+ (67%)
B (82%)	D (63%)
B- (80%)	F (<63%)
C+ (77%)	

Learning objectives

Upon completion of this course, students should be able to:

- Explain the main evidence supporting the scientific theory of evolution.
- State the postulates of evolution by natural selection.
- Explain the circumstances under which natural selection is constrained
- Calculate expected Hardy-Weinberg genotype frequencies from allele frequencies and vice versa
- When provided with data, compute selection coefficients, relative fitness and interpret the results with respect to evolutionary change and the mode of selection
- Explain the circumstances under which migration, genetic drift, selection, mutation, and non-random mating can change allele frequencies between generations
- Compute inbreeding coefficients from a pedigree and predict recessive trait expression
- Contrast quantitative vs. qualitative traits, and contrast how evolutionary mechanisms influence them
- Define heritability and describe three ways to measure it
- Explain how to measure the strength of selection and how to predict the response to selection
- State three potential constraints on adaptive evolution
- Provide arguments for/against the leading definitions of species
- Name three prezygotic and three postzygotic reproductive isolating mechanisms
- Demonstrate how phylogenies are reconstructed, interpret evolutionary patterns in a phylogenetic tree
- Contrast sympatric, parapatric, and allopatric speciation, and explain the circumstances under which each occurs
- Explain the RNA world hypothesis and its relevance to the origin of life
- Explain what is meant by the inefficiency of sex, and state the leading hypotheses for its persistence
- Define Bateman's Principle and state how it explains gender contrasts in mating behavior
- State the leading hypotheses for the persistence of senescence

Tentative Schedule (subject to change)

Week	Section	Date	Lecture	Text	Assignments
1	Part I. Darwinism & Evidence for Evolution	8/24	Intro, History	Ch.1&2	Read paper 1 Quiz 1 (on Chap 1)
		8/26	Evidence for evolution	Ch. 1&2	
		8/28	Darwinian natural selection	Ch. 1&2	
2		8/31	Natural Selection - Creationism	Ch. 3	Discussion – paper 1
		9/2	Furlough Day – no class		Read paper 2
		9/4	Phylogenetics	Ch. 4	Quiz 2 Last drop day w/o COP
3	Part II. Mechanisms of Evolutionary Change	9/7	Labor Day – no class		Homework due Quiz 3
		9/9	Tree building exercise		
		9/11	Genetic variation – Hardy Weinberg	Ch. 5	
4		9/14	Hardy-Weinberg Examples	Ch. 6	Discussion, paper 2
		9/16	General selection model	Ch. 6	Quiz 4 Last day to drop w/o serious & compelling reason
		9/18	Forms of selection	Ch. 6	
5		9/21	Furlough Day – no class		
		9/23	Forms of selection	Ch. 6	
		9/25	Exam 1		
6		9/28	Mutation-selection balance, migration	Ch.7	Read paper 3
		9/30	Genetic drift	Ch 7	Quiz 5
		10/2	Inbreeding	Ch 7	
7		10/5	Linkage disequilibrium	Ch. 8	Discussion paper 3
		10/7	Sex	Ch.8	Sean Carroll, 7:30 pm, Laxson Auditorium
		10/9	Sex	Ch.8	
8		10/12	Quantitative genetics	Ch.9	Read paper 4
		10/14	Heritability	Ch. 9	Topic for review paper due
		10/16	Response to selection	Ch.9	Quiz 6
9	Part III. Adaptation	10/19	Furlough Day – no class		Discussion paper 4
		10/21	Adaptation	Ch. 10	
		10/23	Constraints to adaptation	Ch. 10	
10		10/26	Sexual selection	Ch. 11	5 points EC for pirates see www.venganza.org
		10/28	Sexual selection	Ch. 11	
		10/30	Exam 2		
11		11/2	Furlough Day – no class		Review outline due
		11/4	Kin selection & altruism	Ch. 12	
		11/6	Eusociality, parent-offspring conflict	Ch. 12	
12		11/9	Aging & senescence	Ch. 13	Read paper 5
		11/11	Aging & senescence	Ch. 13	
		11/13	Life histories	Ch. 13	
13	Part IV. History of life	11/16	Species concepts	Ch. 16	Discussion paper 5
		11/18	Reproductive isolation	Ch. 16	Origin party – 150 years
		11/20	Speciation	Ch 16	
14		11/30	Speciation	Ch. 16	Review paper due
		12/2	Furlough Day – no class		
		12/4	Origins of life	Ch. 17	
15		12/7	Universal phylogeny	Ch. 17	
		12/8	Extinction	Ch. 18	
		12/10	Review for final		
16		12/16	Final Exam 2 pm BUTE 219		

Research in Biological Sciences (Biology 600) Fall 2009

Tuesday/Thursday 11:00-12:30, Holt 129

Dr. Chris Ivey, 898-5812

Office Hours: Tuesday 1:30-4:30, Friday 10:00-12:00, Holt 306

Policies and procedures

This course is intended to provide incoming graduate students in biology with the necessary tools to efficiently conduct thesis research and to facilitate the transition to becoming a professional scientist. Attendance at all departmental seminars is mandatory (concurrent enrollment in Biol 492 is required). Unless otherwise indicated, you must submit all assignments online through WebCT to receive credit. Late assignments will not receive credit and there are no make-up assignments or extra credit opportunities. Academic dishonesty in any form will be immediately referred to Student Judicial Affairs. This includes plagiarism, failing to provide proper credit for an idea, copying or borrowing material from another student, paraphrasing someone else's idea without acknowledging the source, copying material from a text or paper, etc. Note that plagiarism also includes copying phrases or ideas from another source. Additional information on academic integrity is available in the Code of Students Rights and Responsibilities, which is available from www.csuchico.edu/sjd.

CSU, Chico acknowledges each student's unique set of abilities and limitations, and works to provide all students with an enriching educational experience. Accommodations will be made, as possible, in cooperation with Disability Support Services (www.csuchico.edu/dss), but it is the responsibility of the student to communicate his/her needs.

Course activities

1. Writing assignments. Writing is probably our most important mode of communication in science. As a consequence, writing will be a large component of this course. Written assignments are due at nearly every class meeting. It will be vital to student success in this course to develop the discipline to stay abreast of the writing schedule. Late assignments cannot be accepted. Because writing improves with iteration and practice, students will have opportunities to improve written assignments based on feedback from your colleagues.

2. Editing & reviewing. Thoughtful (even ruthless!) criticism is one of the most important means of scientific progress. Students are expected, therefore, to dig in and challenge their colleagues while editing and reviewing assignments. If you decide to be an easy reviewer, everyone loses. Writing assignments will be reviewed (not anonymously) and revised, once or twice before finishing a final product. Reviews will be evaluated on the depth and breadth of comments. In addition, nearly all reviewing will occur during class.

3. Peer review. All master's students, during their graduate career, will be exposed to the peer-review process, when submitting research for publication (which is required for graduation, in most cases). To introduce this process, students will independently review a manuscript submitted by Ivey. After discussion and revision of reviews, the class will read and discuss anonymous reviews received by Ivey, and read his response to those reviews.

4. Research Proposal. An important outcome of this class is the development of a complete and formal research proposal, which will describe in some detail the motivation, significance, planned experiments, data analysis, interpretation of possible results, budget, justification of budget, and schedule for your thesis research. The aim of this exercise is to make plain what must be accomplished and why it is useful, so students can embark on data collection and writing right away. We will spend much of the course discussing and developing components of the proposal, which then will be assembled into a coherent whole. This will presumably form the basis for discussions with committee members and development of grant proposals (see below).

5. Grant proposal. A grant proposal is not the same as a research proposal, in that to be successful it must emphasize the contribution of the research to the aims of the granting agency. Also, many grant proposals have specific requirements with respect to length and formatting. Thus, students are expected to identify at least one (preferably multiple) sources of funding for their research, revise their research proposal to conform to the requirements of the agency, and submit their proposal for consideration of funding. Students must provide evidence that their proposal has been submitted before credit will be awarded for this component of the course. As funding agency deadlines for grant competitions vary, students are encouraged to identify grant sources early in the semester and plan proposal development accordingly.

6. Web page. Each student is expected to develop a web page (or update an existing one) with (at a minimum) a copy of their cv, a paragraph or two about their research plans, teaching assignments (if any), contact information, image(s), and links to other sites. Additional minimal requirements for the web page will be discussed in class. The student's page must be linked to the departmental web site before credit will be awarded for this component of the course.

7. Presentation. Students will prepare a formal presentation that distills the essence of their research proposal and deliver it in to the biology department during the last two weeks of the Biology departmental seminar series. In addition to honing

presentation skills, this exercise will provide students with an opportunity to expose their proposal ideas to broader criticism, which will result in a more robust research plan.

8. Journal. Students are expected to keep a neatly hand-written journal for the course, which will hold at least two types of records, paper summaries and research progress. At least one entry per week in each category is required, for which you can receive up to five points for a total possible of 75 (5 points x 15 weeks = 75 points). You are responsible for seeing that I check your notebook each week. If you fail to have your notebook checked at some point during each week you will not receive credit for that week. Deadline for check off is 5 pm Friday, except week 1, which will be 5 pm Tuesday 1 Sept.

Paper summaries: Each week you are expected to identify and read at least one peer-reviewed paper. These papers ultimately may be of use in developing your research, and may be used in the proposal bibliography. Summaries will start with a complete citation (no DOIs, urls, etc), and should consist of at least two paragraphs followed by three questions. The first section should summarize the paper **in your own words**. Phrases copied from the abstract or elsewhere in the paper will be considered plagiarism and will be dealt with accordingly (see Policies and Procedures). The second section should identify weaknesses or limitations from the interpretation of the data, important areas where the research could be extended, or ways in which the material is conceptually linked to other ideas from class or ideas in other papers. In this section, I'm looking for some evidence of sincere intellectual engagement with the material presented in the paper – thus, this will require some reflection on your part. Finally, summaries should end with three questions about the paper – these can be on any aspect of the paper, but the best questions are those that extend the scope of the paper or study, were they answered. An example of a paper summary will be provided online.

Research progress: Each week you are expected to record some evidence of progress in your research projects. This may involve reflections, data collected, summaries of conversations, observations, ideas for experiments from papers or books read, etc. You need to have a minimum of a couple paragraphs of thoughtful material each week providing evidence of what you have accomplished. As you begin to develop and execute your projects, this may expand.

9. Attendance & participation. Each week students will be evaluated based on punctuality, preparation, enthusiasm, attendance, and participation. Students can earn either 5 or 0 points for the week, all or nothing. To earn 5 points, a student must be present, prepared, and engaged during the entire period for all class meetings that week (including Friday seminars).

Course Objectives

By the end of this course, students will have:

- Prepared a formal curriculum vita
- Identified sources of peer-reviewed literature appropriate to disciplinary interests
- Chosen a research question for master's thesis
- Developed a comprehensive research proposal
- Identified sources of funding for master's research
- Critiqued the work of colleagues
- Critically evaluated and discussed professional research presentations
- Prepared and delivered a formal oral presentation to the department on planned research
- Submitted a research proposal to a funding agency
- Published or updated a web page with a professional profile

Text

McMillan VE 2006. Writing papers in the biological sciences, 4th ed. Bedford/St. Martin's.
Additional reading assignments will be posted weekly on WebCT

Highly Recommended:

Strunk Jr., W & White EB 1999. The elements of style, 4th ed. Longman.

Grading

Assignments: 27 @ 5 points each	135
Reviewing: 15 @ 5 points each	75
Final Proposal	100
Grant proposal, submitted	70
Web page, linked to departmental page	70
Final Presentation	100
Journal	75
Participation	75
Total	700

Schedule, subject to change (red indicates assignment due)

Week	Tuesday	Thursday	Reading (more online)
1 (24 Aug)	Introduction Jonathan Day*	Larry Hanne* CVs & Literature review Time management Grad career goals due Online assessment	Chap 1
2 (31 Aug)	Gordon Wolfe* Writing, editing, criticism CV 1 st draft	Richard Soares* Meet in room 226 of Library CV final	Chap 7
3 (7 Sept)	FURLOUGH DAY	Chris LaVerne* Planning research Developing a proposal 30 references due Time budget analysis due	Chap 2
4 (14 Sept)	Kris Blee* List of main questions due	Dave Keller* Meeting summary Proposal introduction, 1 st draft	Chap. 5
5 (21 Sept)	Don Miller* Proposal methods & design Introduction, 2 nd draft	Chris Ivey Introduction, final Methods, 1 st draft	
6 (28 Sept)	Jim Houpis* Budgets & justification Methods, final	Diane Johnson* Budget & justification, 1 st draft	Chap. 10
7 (5 Oct)	Jeff Mott* Summary of grant sources Budget & justification, final	Jay Boggiato* Publishing, I	
8 (12 Oct)	Full proposal, 1 st draft	FURLOUGH DAY	
9 (19 Oct)	Full proposal, 2 nd draft	Web publishing, meet in 253 Proposal, final	Chap 8
10 (26 Oct)	Jeff Bell* Discussion, grant proposals Targeted funding source	Colleen Hatfield* Publishing II Peer review Web page, 1 st draft	
11 (2 Nov)	Discussion of reviews Review of Ivey MS, 1 st draft Grant proposal, 1 st draft	Read & discuss anon. reviews Letter of resubmission Review of Ivey MS, 2 nd draft Web page, 2 nd draft	Chap 4
12 (9 Nov)	Grant proposal, 2 nd draft	Presentations Web page, link	
13 (16 Nov)	FURLOUGH DAY	Practice talks, part 1	
14 (30 Nov)	Practice talks, 2	Dress rehearsal talks, part 1	
15 (7 Dec)	FURLOUGH DAY	Dress rehearsal talks, part 2 Online assessment	