# GEOSCIENCE 541: PALEOBIOLOGY SYLLABUS

## Course Information

- LEAD INSTRUCTOR: ANDREW ZAFFOS
- ASST. INSTRUCTOR: SHANAN PETERS
- OFFICE: WEEKS HALL 487
- EMAIL: AZAFFOS@WISC.EDU
- CLASS HOURS: 1:20-2:10 MONDAY, WEDNESDAY.
- LAB HOURS: 4:00-6:00 MONDAY.
- OFFICE HOURS: 12:00-2:00 WEDNESDAY, FRIDAY OR BY APPOINTMENT
- COURSE WEBSITE: HTTPS://GITHUB.COM/AAZAFF/TEACHPALEOBIOLOGY

## COURSE PHILOSOPHY

This course is organized around the idea of ontogeny. Ontogenesis is a concept in biology that describes the anatomical and behavioral development of an organism from its birth to its death. In other words, it means progression through the successive stages of life as you age – e.g., birth, childhood, adolescence, adulthood, and death.

Paleobiology can be thought of as an extension of this idea, ontogeny, from individual organisms to species. Species are born into this world via abiogenesis or evolution from parent species; they grow in population size and geographic extent; and they eventually become extinct. If you understand the general processes governing the ontogenetic development of species and fossils, then you are equipped to hypothesize about the origins of any pattern you observe in the fossil record, whether or not you are familiar with the particulars of the place or time in question.

The course is split into two phases. In the first phase, we discuss the ontogeny of species and fossils in general terms. In the second phase, we proceed through successive periods in the history of complex animal life, and analyze the specific ontogenetic development of different evolutionary faunas. Evolutionary faunas are groups of species that evolved, dominated the globe, and became extinct around the same time. In other words, evolutionary faunas are the concept of ontogeny applied to groups of species.

## COURSE SKILLS

In addition to the theoretical framework discussed above, this course places a strong emphasis on practical skills, especially data analytics. This includes downloading data sets, entering and editing data, and statistical analysis of those data. Ideally, at the end of this course, you will be able to construct and test your own paleobiological hypotheses using available online databases.

In particular, we will use the R statistical software, the Paleobiology Database, Github, and the Macrostrat Database. All of these services are free, available online, and work with Mac, Windows, or Linux systems. R is an especially powerful tool that is highly sought after in the job market. Companies like Google, Microsoft, and Amazon, as well as most major Universities and graduate programs are looking for R and Git proficiency.

## COURSEWORK ORGANIZATION

There are no midterms or final exams in this course. Instead, coursework is broken down into the following types of weekly assignment: short tests, reading and writing assignments, and lab-assignments. Each week will include one of each type of assignment. If you would like to learn more about this grading philosophy, and other study tips, I recommend the following book: Make it Stick: The Science of Successful Learning.

### TESTING (10 POINTS EACH)

Short weekly tests will be given online over the weekend. Tests will generally consist of 10 short answer or multiple-choice questions related to the material covered that week. The tests are administrated via the learnuw.wisc.edu tool.

### READING AND WRITING (10 POINTS EACH)

Reading assignments will be given each week throughout the semester. These assignments may be formal scientific articles or popular science essays. You must read these papers and be prepared to discuss them in the following class.

In addition, you will write a two-page summary of the article describing the overarching question it addresses, the hypothesis tested, data, methods, results, and conclusions. An example writing exercise, with more detailed directions, is available online. Write-ups are due at the beginning of the next class.

### LAB ASSIGNMENTS (20 POINTS EACH)

You will have open access to the lab area and can complete unfinished lab assignments at your convenience. Many labs will be lengthy and require you to continue working on them, as homework, after the official lab period has ended. Most labs will require the use of a computer, so please bring your laptop if you have one. Lab assignments will generally be due at the start of the next lab period, unless otherwise specified.

### MAKE-UPS

There are no make-ups for missed assignments. Instead, your lowest assignment grade is dropped at the end of the semester – i.e., you get one “freebie” to use for emergencies or even if you just want to take a day off. It will automatically be dropped when calculating your final grade, and you do not need to notify me in order for the grade to be dropped.

In the event of a truly significant medical (or other) emergency that spans for more than two weeks (significance determined entirely at my discretion), you can petition me directly to substitute two additional writing exercises for each missed lab assignment. These make-up articles will generally be longer and more sophisticated than the regular readings.

### RESEARCH PROPOSAL (60 POINTS TOTAL)

Towards the latter half of the course (starting March 16th), you will design a (hypothetical) research project utilizing the Paleobiology Database to test a hypothesis related to one of the biodiversification, dispersal, or extinction events covered in the class. Students can also cover topics not covered in the class with my approval.

You will write up the proposal following the Geological Society of America graduate research grant guidelines. You can examine examples of successful research grants on the course website. You can also find a detailed breakdown of due dates on the website.

You will not have to actually carry out the proposed research project, but your proposal will be evaluated based on its scientific accuracy, clarity, and feasibility. The grading rubric and further details will be disseminated once we begin the grant-writing process.

### FINAL GRADE

Final grades are the sum total of all points you earned throughout the semester divided by the total number of possible points. Each test is worth 10 points, each reading and writing assignment is worth 10 points, each lab assignment is worth 20 points, and the research proposal is worth 60 points (30 points for the first draft, and 30 points for the final draft).

### TEXTBOOK

Several textbooks have been put on reserve in the Geology Library. Although the course listing recommends Principles of Paleontology by Foote and Miller, it is an optional purchase.

### LAB ATTENDANCE

You are not graded on attendance, but it is highly recommended that you make an effort to attend all labs. The lecture will continue for a portion of the lab period in my cases.

## Course Schedule

| CalendarDate | Assignments | Topics |
|---|---|---|
| WED: Jan 20 | Reading 1 | 1. Course overview 2. Definition of paleontology |
| MON: Jan 25 | Lab 1 | 1. Review Reading 2. Morphology and Morphometrics |
| WED: Jan 27 | Reading 2 | 1. Ontogeny 2. Heterochrony 3. Phylogeny and Cladistics |
| MON: Feb 01 | Lab 2 | 1. Review Reading 2. Abiogenesis 3. Genetic drift and neutral theory 4. Molecular clocks |
| WED: Feb 03 | Reading 3 | 1. Sexual Selection 2. Geographic models of speciation |
| MON: Feb 08 | Lab 3 | 1. Review Reading 2. Ecological niche 3. Ecological competition and facilitation 4. Ecological gradients |
| WED: Feb 10 | Reading 4 | 1. Anatomical and behavioral mechanisms of dispersal 3. Common patterns of species distribution |
| MON: Feb 15 | Lab 4 | 1. Review Reading 2. Determinants of extinction 3. Pseudoextinction |
| WED: Feb 17 | Reading 5 | 1. Measuring biodiversity 2. Measuring extinction 3. Measuring origination 4. Measuring evenness |
| MON: Feb 22 | Lab 5 | 1. Review Reading 2. Review and catch-up session |
| WED: Feb 24 | Reading 6 | 1. Types of fossils. 2. Ideal fossilization conditions (lagerstätten) 3. Fossilization processes. 4. Diagenesis |
| MON: Feb 29 | Lab 6 | 1. Review Reading 2. Fossil transport 3. Time-averaging 4. Taphonomically active zone 5. Condensed sections |
| WED: Mar 02 | Reading 7 | 1. Lazarus, Elvis, and Zombie taxa 2. Signore-Lipps effect 3. Holland effect 4. Common-cause hypothesis |
| MON: Mar 07 | Lab 7 | 1. Review Hendy (2009) 2. Unlithified vs. lithified sediments 3. Increased bioturbation 4. Pull-of-the Recent |
| WED: Mar 09 | Reading 8 | 1. Siliciclastic vs. carbonate environments 2. High vs. low latitude paleocontinents 3. Epicontinental vs. open ocean 4. Ice House vs. green House |
| MON: Mar 14 | Lab 8 | 1. Review Reading 2. Ediacran biota 3. Cambrian Explosion 4. Ordovician Radiation |
| WED: Mar 16 | Reading 9 | Review grant proposal instructions and grading rubric. |
| | | **BREAK FREE ON SPRING BREAK** |
| MON: Mar 28 | Lab 9 | 1. Review Reading. 2. Late Ordovician extinction |
| WED: Mar 30 | Reading 10 | 1. Terrestrial transition 2. Late Devonian mass extinction |
| MON: Apr 04 | Lab 10 | 1. Review Reading 2. Mid-Carboniferous Rainforest Collapse |
| WED: Apr 06 | Reading 1 | 1. Late Permian Mass Extinction. |
| MON: Apr 11 | Lab 11 | 1. Review Reading 2. Early Triassic fossil gap 3. Late Triassic Extinction |
| WED: Apr 13 | Reading 12 | 1. Mesozoic plant and microfossil revolution 2. Dinosaurs |
| MON: Apr 25 | Lab 12 | 1. Review Reading 2. End Cretaceous Mass Extinction |
| WED: Apr 27 | Reading 13 | 1. Cenozoic biogeography 2. Cenozoic Climate Change 3. Cenozoic mass extinctions |
| MON: May 02 | Lab 13 | 1. Review Reading 2. The “sixth” mass extinction. |
| WED: May 04 | | 1. Review Class Material. 2. Class Evaluation |