

Spring 2022

Integrative Biology 113L, Class Number #: 24586, 4 units

Paleobiological Perspectives on Ecology and Evolution

Instructor

Prof. Charles Marshall (crmarshall@berkeley.edu)

Office Hours: [1] Mondays 12:10 pm to 1 pm

[2] Thursdays 11:10 am to 12 noon

[3] By appointment (e-mail me to find a time).

Communication will be via the online discussion forum, Piazza. Please sign up at: <https://piazza.com/berkeley/spring2022/ib1131> (Links to an external site.). This will be your main venue to ask questions of the Instructor and GSIs, discuss problems, and help each other out (assuming we can get it to work properly – this our first time using it). *However, if you have a question or a situation that requires privacy, feel free to e-mail any of us directly.*

Prerequisites: Some background in organismal biology preferred but not required (if you have doubts contact the Instructor). *No paleontological or geological background knowledge assumed.*

Lectures: Tuesdays and Thursdays, 2:00–3:30 pm. Synchronous attendance preferred, but lectures will be recorded.

Zoom:

<https://berkeley.zoom.us/j/92660138207?pwd=VmtCYU1wR3NsQU84WnVuSDFTb0VyQT09> (Links to an external site.) (Links to an external site.) Meeting ID: 926 6013 8207, Passcode: 537103

When (if) we go back in-person: Etcheverry 3106 (lectures will still be recorded).

Lecture Slides: PDF versions of the PowerPoint presentations will (typically) be posted on bCourses the evening before (see the appropriate week under Files).

Lab sections: Wednesdays, either 9-noon or 3-6 pm, Valley Life Sciences Building 3003. *You can only switch sections with the explicit agreement of both GSIs.*

Course goals: To help you discover what the fossil and geologic records tell us about the history of life on Earth and the nature of the environmental, ecological and evolutionary processes that have shaped it. The course will emphasize what cannot be learned from the living world alone. In the labs your GSI will help you learn how to ‘read’ fossils and the fossil and rock records. You will work in groups, learning from each other as well as from your GSI (and the fossils and other materials presented).

Textbook: There is no adequate textbook available for this course. Weekly readings (see syllabus below) that provide background information will be made available via bCourses (under the appropriate week under 'Files'). *Exam questions will not be drawn from the readings.*

Grading: I recently participated in a program to improve my teaching (called FLOSS, Faculty Learning Optimizes Student Success program). As a consequence, I have redesigned several elements of the course to try and reduce stress, be as fair as possible, and enhance your learning experience. Since these are new approaches, please give me immediate feedback if you have any issues with the course, or if you have ideas on how to improve your learning experience.

Your grade will be determined by:

In-class participation	(5%)
Homework (exit tickets)	(10%)
Midterm exam	(20%)
Final exam	(25%)
Weekly lab exercises	(25%)
Lab exam	(15%)

In-class participation will be recorded via your participation in the Poll Everywhere questions in lecture. This is part of your formative evaluation, so you will receive full credit for participation. You will need to talk to us if attending lecture is a problem (or if your connection cuts out, for example).

Homework (exit tickets, see Quizzes on bCourses) after each lecture. These are also part of your formative evaluation, so typically just providing an answer will be sufficient for full credit. Some questions will be so we can learn about you and what works for you, some will be to help you prepare for the exams (including practice questions), some will supplement the lecture materials. None will be especially arduous.

Midterm exam (open book) will be on Thursday March 3rd. If we are back in person, it will be during the normal lecture time in the lecture room. If we are still online, you will have a 24-hour window within which to sit the 80 minute exam (via bCourses).

Final exam (open book) is really a 2nd mid-term; it will cover the material since the midterm (although some of that content builds on material before the midterm). The campus has assigned us an exam time of Monday, May 9th, 11:30 am to 2:30 pm.

Grading scale: Grades will be based on an absolute scale: 100-90 A; 90-80 B; 80-70 C; 70-60 D; <60 F. If you all get >90% you will all get As.

However, even though unlikely, if in our judgement the absolute scale is too high given the rubric given below, we will lower the cut-offs between the grades (e.g., we will set 100-85 A; 85-75 B; etc.). Under no circumstances will we raise it to make it more difficult to get a given grade.

Grading rubric: Grading is not curved but based upon your individual mastery of the course material, using the following rubric:

A: Excellent command of the material. Demonstrates an often-nuanced understanding of most of the important as well as many of the subsidiary ideas, concepts, tools, and data presented.

B: Good command of the material. Demonstrates a solid understanding of the most important and some of the subsidiary ideas, concepts, tools, and data presented, but with not infrequent lapses in understanding.

C: Fair command of the material. Demonstrates some understanding of the majority of the important ideas, concepts, tools, and data presented, but with frequent lapses in understanding.

D: Minimal command of the material. Demonstrates only a limited understanding of some of the most important ideas, concepts, tools, and data presented.

F: Fail.

For P/NP grades, following campus practice, a grade of C– or better will be assigned a Pass.

If you need help or information. We can't imagine all the challenges you might be experiencing, both with Covid, but in general. Please do not hesitate to alert us to any issues beyond the course that you might have with housing or food security, physical and mental health, connectivity, safety, etc. You may feel embarrassed to ask for help, but we are here to help. But there are also a wide range of resources available on campus:

Covid-19 resources and support. Please keep safe!

<https://coronavirus.berkeley.edu/Links to an external site.>

[https://uhs.berkeley.edu. \(Links to an external site.\)](https://uhs.berkeley.edu. (Links to an external site.)) This site includes support for mental health issues at Counseling and Psychological Services (CAPS) and Crisis Counseling for Urgent Concerns.

Basic needs – Food and Housing

<https://basicneeds.berkeley.edu>

Disability Access & Compliance

<https://dac.berkeley.edu/message-campus-disability-community-re-covid-19.Links to an external site.>

Health and Wellness

<https://diversity.berkeley.edu/health-and-wellness.Links to an external site.>

Student Technology Equity Program (STEP)

Resource for connecting laptops, Wifi hotspots, and other technology you might need.

<https://technology.berkeley.edu/STEP.Links to an external site.>

Privacy for Recorded Discussion Sections or Q&A Sessions

<https://ethics.berkeley.edu/privacy-considerations-when-using-zoomLinks to an external site..>

Please view these best practices. Your privacy is important and your choices need not be justified. In Zoom, please feel free to turn off video, change your name, or use Virtual Backgrounds. *Please let us know if there are any issues that make you feel uncomfortable.*

Academic Expectations. You are among the top students in the world. Being a student at UC Berkeley is a great privilege. You have worked hard to get here, but the hard work is not over – Berkeley produces great graduates by consistently challenging you to become better. I believe you will be able to understand the concepts covered in lectures, but that understanding may not always come easily. The GSIs and I will work hard to help you, but we also expect you to work hard and rise to the challenge. If you are having difficulty understanding something in class, please speak up! I guarantee that you will not be the only one who is confused.

Honor Code: The student community at UC Berkeley has adopted the following [Honor CodeLinks to an external site.](#): “*As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others.*” Thank you for adhering to this code.

Policy on UC Berkeley's Code of Student Conduct. All students are expected to follow the University of California at Berkeley's Campus Code of Student Conduct, as is published at <http://sa.berkeley.edu/uga/codeofconduct>. Cheating, plagiarism, or any other form of academic dishonesty will not be tolerated (102.01).

Collaboration and Independence: Reviewing lecture and reading materials and studying for exams with fellow is highly recommended. Nonetheless, exams and assignments are to be completed independently.

Policy on accommodation of religious holidays and other scheduling conflicts (for example, athletic events, job interviews): In compliance with Education code, Section 92640(a), it is the official policy of the University of California at Berkeley to permit any student to undergo a test or examination, without penalty, at a time when that activity would not violate the student's religious creed, unless administering the examination at an alternative time would impose an undue hardship which could not reasonably have been avoided. All deadlines are noted on this syllabus. It is your responsibility to note any conflicts with the exam and due dates and let the instructor and GSIs know in a timely fashion. If you have other scheduling conflicts, please see the guidelines at: <https://teaching.berkeley.edu/academic-calendar-and-student-accommodations-campus-policies-and-guidelines>.

Policy on exams, lecture, and design assignments due dates. We have due dates for all assignments. Keeping pace is in your best interest because material builds on that all comes before. Given the challenging circumstances and the inequities present, we will be as flexible as possible with due dates. *However, if you do find yourself facing an unforeseen circumstance, please contact us as soon as possible to let us know so we can work out how best proceed.*

Policy on students with learning disabilities. Disabled students please make certain that your letter from the Disabled Students Program is sent to us as soon as possible, and that you contact us so we can help you succeed in the course. See <http://dsp.berkeley.edu>.

Policy on recording lectures or selling slides or notes. Posting or selling video recordings are expressly prohibited by University of California policy. Lectures are comprised of copyrighted intellectual material, and the recording and sharing of that material without express permission is a violation of copyright and personal privacy. Note, it is a violation of copyright to sell notes, assignments or exams to on-line companies.

Course Schedule

(Note: the **readings** provide background information only and your knowledge of the material contained within will not be examined directly)

Week 1:

Jan 18 1) Introduction to the course

Jan 19 **No LAB this week**

Jan 20 2) Fossils, the fossil record, and its completeness

Reading: Foote, M.J. & A.I. Miller. 2007. Chapter 1: “Nature of the Fossil Record” in *Principles of Paleontology*. Pp. 1–30.

Week 2:

Jan 25 3) Exceptional preservation; Geological time

Jan 26 **LAB 1:** Intro to Fossils

Jan 27 4) Continental drift and plate tectonics

Reading: Stanley, S. M. 1999. Ch. 1: “Earth as a system” in *Earth System History*. Pp. 1–27.

Reading: Stanley, S. M. 1999. Ch. 6: “Correlation and dating of the rock record” in *Earth System History*. Pp. 151–178.

Week 3:

Feb 1 5) An overview of the history of the Earth and life

Feb 2 **LAB 2:** Fossilization

Feb 3 6) Major transitions: Origins of the living California biotas; origin of life

Reading: Knoll, A.H. & R.K. Bambach. 2000. Directionality in the history of life: diffusion from the left wall or repeated scaling of the right? *Paleobiology* **26**: (Supplement): 1–14.

Reading: Brunk, C.F., & C.R. Marshall. 2021. ‘Whole organism’, systems biology, and top-down criteria for evaluating scenarios for the origin of life. *Life* 11:690–715.

Week 4:

Feb 8 7) Time in the rock record

Feb 9 **LAB 3:** Nature of the Rock Record

Feb 10 8) Major transitions: Cambrian explosion and the invasion of land

Reading: Coe A.L., et al. 2003. Ch. 4: “Sequence Stratigraphy” in *Sedimentary Record of Sea-Level Change*. Pp. 57–95.

Reading: Marshall, C.R. 2003. Nomothetism and understanding the Cambrian “explosion”. *PALAIOS* 18: 195–196.

Reading: Marshall, C.R. 2006. Explaining the Cambrian “explosion” of animals. *Annual Review of Earth and Planetary Sciences* 34: 355–384.

Week 5:

Feb 15 9) How species richness has changed with time

Feb 16 **LAB 4:** Diversity Dynamics – DNA vs. The Fossil Record

Feb 17 10) Extinction: background vs mass extinctions; the death of the dinosaurs

Reading: Sepkoski, J.J.Jr. 1997. Biodiversity: past, present, and future. *Journal of Paleontology* 71: 533-539.

Week 6:

Feb 22 11) The emergence and evolution of plants (Guest Lecturer: Dr. Looy)

Feb 23 **LAB 5:** Fossil plants

Feb 24 12) Mass Extinctions (continued) and their evolutionary legacy

Reading: Taylor T.N et al., 2009. Ch. 1: Introduction into paleobotany, how fossil plants are formed. In: *Paleobotany - the biology and evolution of fossil plants*. Academic Press, Pp 1-42.

Reading: Marshall, C.R. 2010. Using confidence intervals to quantify the uncertainty in the end-points of stratigraphic ranges. In: *Quantitative Methods in Paleobiology*, J. Alroy & G. Hunt (eds). The Paleontological Society Papers 16: 291–316.

Week 7:

Mar 1 13) Diversity dynamics – what drives species richness change?

Mar 2 **LAB 6:** Tour of the UCMP

Mar 3 **MIDTERM**

Week 8:

Mar 8 14) Systematics and the fossil record

Mar 9 **LAB 7:** Dinosaurs and some of their Relatives

Mar 10 15) Stratigraphic data, phylogeny reconstruction, and ancestors

Reading: Smith A.B. 1994. Ch. 6 “The construction of evolutionary trees” in: *Systematics and the Fossil Record*. Pp. 125–141.

Reading: Marshall, C.R. 1999. “Missing links in the history of life.” In: *Evolution: Facts and Fallacies* (J.W. Schopf, ed.). Pp.37-69.

Week 9:

Mar 15 16) Punctuated equilibrium and rates of evolution

Mar 16 **LAB 8:** Dinosaurs in Motion

Mar 17 17) Macro-evolution (in contrast to micro-evolution)

Reading: Sheldon, P.R. 2001. Punctuated equilibrium and phyletic gradualism. *Encyclopedia of Life Sciences*, pp 1-6.

Reading: Foote, M.J. and A.I. Miller. 2007. p.190–210 in: *Principles of Paleontology*.

SPRING BREAK

Week 10:

Mar 29 18) The evolution of Marine ecosystems

Mar 30 **LAB 9:** Early life and Sepkoski’s Cambrian and Paleozoic faunas

Mar 31 19) Diversity change versus disparity change; why is there complexity?

Reading: Bush et al. 2007. Changes in theoretical ecospace utilization in marine fossil assemblages between the mid-Paleozoic and late Cenozoic. *Paleobiology* **33**: 76-97.

Reading: Foote, M.J. and A.I. Miller. 2007. p.243–248 in: *Principles of Paleontology*.

Week 11:

Apr 5 20) Theoretical morphology

Apr 6 **LAB 20:** The Paleozoic fauna (continued)

Apr 7 21) Fossil molecules: stable isotopes; biomarkers

Reading: Foote, M.J. and A.I. Miller. 2007. p.135–148 in: *Principles of Paleontology*.

Reading: Koch P.L. 2007. Isotopic study of the biology of modern and fossil vertebrates. In: Michener R, Lajtha K (eds) *Stable Isotopes in Ecology and Environmental Science*, 2nd Ed. Pp. 99-154.

Week 12:

Apr 12 22) Life in moving fluids; Molecular clocks

Apr 13 **LAB 11:** Sepkoski’s Modern Fauna

Apr 14 23) Calibrating time trees; Ancient DNA

Reading: Vogel, S. 1981. *Life in Moving Fluids*. Princeton Univ. Press. Pp. 25–33; 41–43; 50–51; 61-81; 127–129; 141–143; 152–157; 241–243.

Reading: Smith, A.B. and K.J. Peterson. 2002. Dating the time of origin of major clades: molecular clocks and the fossil record. *Annu. Rev. Earth Planet. Sci.* **30**: 65-88.

Reading: Holmes R.D.M. & E.C. Holmes. 1998. Ch. 7 “Models of molecular evolution” in *Molecular evolution. A phylogenetic approach*. Pp. 228–279.

Reading: Slatkin, M. & F. Racimo. 2016. Ancient DNA and human history. *Proceedings of the National Academy of Sciences, USA*, **113**: 6380–6387.

Week 13:

Apr 19 24) The carbon cycle and climate change over geologic timescales

Apr 20 **LAB 12:** Ecology through time: Evolutionary escalation

Apr 21 25) The evolution of our humanness

Reading: DePaolo D.J. 2015. Sustainable carbon emissions: the geologic perspective. *MRS Energy & Sustainability* **2**: e1-e16.

Week 14:

Apr 26 26) *Homo sapiens* as a geologic force

Apr 27 **LAB FINAL EXAM**

Apr 28 27) How has paleontology changed our view of the present?

Reading: Waters et al. 2016. The Anthropocene is functionally and stratigraphically distinct from the Holocene: Review summary. *Science* **351**: 137.

Reading: Waters et al. 2016. The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science* **351**: 138-148.

Background Texts

Principles

Foote, M.J. and A.I. Miller. 2007. *Principles of Paleontology*. W.H. Freeman, New York, 354 pp.

Principles and taxonomy of fossil groups

Prothero, D.R. 2004. *Bringing Fossils to Life: an Introduction to Paleobiology*. 2nd Ed. McGraw-Hill, Dubuque, Iowa, 503 pp.

Benton, M.J. and D.A.T. Harper. 1997. *Basic Palaeontology*. Prentice Hall, London, 360 pp.

Morphology and taxonomy of fossil groups

Benton, M.J. 2005. *Vertebrate Palaeontology*, 3rd Ed. Blackwell Science, Oxford, 455 pp.

Clarkson, E.N.K. 1993. *Invertebrate Palaeontology and Evolution*. 3rd Ed. Chapman and Hall, London, 434 pp.

Boardman, R.S., A.H. Cheetham, and A.J. Rowell (eds.). 1987. *Fossil Invertebrates*. Blackwell Science, Oxford, 713 pp. [*An advanced text too hard for most introductory classes*]

The evolution of life in the context of our evolving planet

Stanley, S. M. 1999. *Earth System History*. W.H. Freeman and Company, New York, 615 pp.

Paleoecology (an underdeveloped field; there are no great texts)

Brenchley, P.J., and D.A.T. Harper. 1998. *Palaeoecology: Ecosystems, environments and evolution*. Chapman and Hall, London, 402 pp.

Flessa, K.W. et al. 2005. *The Geological Record of Ecological Dynamics*. National Research Council of the National Academies, National Academies Press, Washington, DC, 2000 pp. [*A report, not a textbook*]

Concise Syntheses

Briggs, D.E.G. and P.R. Crowther (eds.). 1990. *Paleobiology: A Synthesis*. Blackwell Scientific, Oxford, 583 pp. [*Some 100 topics covered, 3-8 pages each, with about 110 authors*]

Briggs, D.E.G. and P.R. Crowther (eds.). 2001. *Paleobiology II*. Blackwell Scientific, Oxford, 583 pp. [*Similar the volume above, with contributions from 170 authors*]

Lagerstätten

Bottjer, D.J., Etter, W., Hagadorn J.W. and C.M. Tang (eds.). 2002. *Exceptional Fossil Preservation: A unique view on the evolution of marine life*. Columbia University Press, New York, 403 pp.

Muller, K.J. and D. Walossek. 1987. *Morphology, Ontogeny, and the Life Habit of Agnostus pisiformis from the Upper Cambrian of Sweden*. Universitetsforlaget, Oslo, 125 pp.

Briggs, E.G., Erwin, D.H. and F.J. Collier. 1994. *The Fossils of the Burgess Shale*. Smithsonian Institution Press, Washington, London, 238 pp.

Xian-Guang, H., Aldridge, R.J., Bergstrom, J., Silvester, David.J., Silvester Derek J. and F. Xiang-Hong. 2004. *The Cambrian Fossils of Chengjiang, China*. Blackwell Science, Oxford, 233 pp.

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<http://www.lib.berkeley.edu/BIOS/ebooks.html>.