How to become a paleontologist (at UChicago*)

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(advice is my own, not curated by profs/admin)

*as of 2019-2020 school year

While this advice is tailored to students at UChicago interested in paleontology, much of this advice can be used when considering paleontology at other universities or even advanced degrees in other fields.

This document is also just one person's take on how to work on your career in paleo – ask around, get multiple opinions. Everyone's perspectives and experiences are different, and you might find additional opportunities.

Contents

Introduction

Paleontology is a very interdisciplinary field, as such, courses and research are split between two main majors: Geophysical Sciences and Biological Sciences. Depending on which areas of research you are interested in, you can major in one or the other or both. Many courses are cross-listed between majors and many faculty interact with both as well.

Courses and faculty in Geophysical Sciences tend to cover topics like stratigraphy, geochemistry, paleoenvironments, and major macroevolutionary patterns. Biological Sciences tend to have more courses in anatomy and vertebrate paleontology. Both majors have additional cross-listed classes covering topics like phylogenetics, conservation paleobiology, and invertebrate paleontology.

Starting at page 9, degree requirements and courses are listed for Biological Sciences and for Geophysical Sciences relating to paleontology, as of the 2019-2020 catalog. This is not a permanently complete list – it keeps changing, so just double check on the official schedule too. When in doubt, email a professor asking whether their course is offered that year – sometimes they teach it every other year or skip a round for a sabbatical, so it might take some planning ahead to fit in all the courses you want.

If you are concerned about pre-reqs, send an email to the professor before the course, explaining your background and interest in the course and ask if you will be fine or if you would be at a serious disadvantage. Sometimes, like in the case of more anatomy-based courses, the pre-reqs are more to establish the course as an upper-level elective, but molecular bio won't help you pass anatomy, so the professor might be okay with you taking the course. (For either major, just get your fundamentals out of the way asap, anyway.)

Disclaimer – while most of this information will stay roughly the same, a few nuances of the majors will change over the years, so discuss your interests with the senior advisor for your given major and consult the most recent course catalog to make sure you stay on top of the most recent info.

Research

The other thing to think about while you're going through your college career as a budding paleontologist is research.

How do you get into a research lab? Look up professors or grad students who do work that interests you. Here's a few links to peruse:

https://oba.bsd.uchicago.edu/ - Dept. of Organismal Biology and Anatomy

https://evbio.uchicago.edu/ - Committee on Evolutionary Biology

https://geosci.uchicago.edu/ - Geophysical Sciences

Send them an email saying you're interested in their work and asking to discuss how you can get involved in their lab. That's it, really. Everyone is excited when someone expresses interest in their research, so they'll definitely want to talk with you.

Keep your email relatively short and sweet – you're just briefly introducing yourself and starting a conversation. Cover the basics – What year you're in, major, a sentence or two about what drew you to their research and what you want out of working for them. Are you trying to learn a technique that interests you, are you particularly interested in the group of animals they're studying, are you trying to figure out what you're interested in and want to explore different research options, are you aiming to do a senior thesis at some point, etc. All are valid and all are accepted, this just helps the professor sort out how to incorporate you to their lab and start the right conversations. You don't have to have a concrete research plan or any experience with the lab's techniques, just introduce yourself and try to set up a meeting to continue the discussion.

It's okay if you try one lab and you feel it's not the right fit for you. Go try another one. This happens all the time and professors won't (shouldn't) hold it against you. This is your time to work on sorting out what's right for you and your interests in the long-run.

You can also learn to prepare fossils – cleaning rock off of the bones. The Sereno Fossil Lab accepts volunteers working a minimum of three hours per week, based on available space. You can contact Paul Sereno (dinosaur at uchicago.edu) and Tyler Keillor (tkeillor at uchicago.edu) to see if there is space. The Field Museum also accepts and trains volunteers to prep fossils in their labs too. You can contact Akiko Shinya or Connie Van Beek if you're interested in working there. Fossil prep is a tedious task, but very rewarding when you finished cleaning off a bone. There is a bit of a learning curve, and it's not for everyone, but worth trying if you have the time.

How do you figure out what you want to study as a potential 1) undergrad thesis or 2) grad school research trajectory? This is a bit of a trick itself – take a variety of classes and think about what you enjoyed studying and what you never want to see again. Try working in a couple different labs, either at this university or spend some time over the summer doing NSF REUs, internships, or fellowships at other universities. Don't forget we also have the Field Museum a short distance from here – there's some awesome paleo research going on over there too!

Evolutionary Morphology seminars are also a great free, local way to get to know people in the field, some from the Chicago area and some are flown in from other universities. These seminars are Thursday evenings at 7:30pm in Hinds 176, and you can sign up for the listhost (evmorph@lists.uchicago.edu). At the beginning of the quarter, they send out the schedule for the quarter, and each week you could also sign up to meet the speaker and talk one-on-one with them about their research and your interests, and for a couple bucks, you could also join the dinner at Siam Thai each evening before the talk.

You can also subscribe to paleo@lists.uchicago.edu to receive information about other talks and events either on campus or at the Field Museum. There is a weekly seminar at noon at the Field Museum in Montgomery Ward Hall (just inside the west entrance) that hosts a variety of speakers as well. The more opportunities you have to see 'what's up' in the world of paleo or related fields, the better idea you'll have of the things you like or not like, and what you might be interested in studying in the future.

UChicago PaleoClub hosts talks by a variety of evolutionary biologists (professors, staff, grad students, and undergrads), gives tours of the Field Museum, and aims to have an annual invert paleo field trip, so you can subscribe to their listhost as well: paleontologyclub@lists.uchicago.edu. And if you want to try your hand at presenting something that you've been working on or find interesting, get some low-pressure experience doing a presentation, feel free to contact the board, they're always happy to schedule you in. Grad students have practiced their thesis defense talks, and undergrads have presented their research from REUs or other experiences. We also aim to email out any internships we hear about that may be relevant for those interested in paleontology, so consider subscribing for the list to be kept in the loop.

Try and go to a conference if you have time (and, yes, a bit of money). You get a lot of exposure to a huge variety of paleontological research in a very short period of time. It may be a bit overwhelming at first, but there's a lot of cool stuff and awesome people out there. The Society of Vertebrate Paleontology, Geological Society of America (also Paleontological Society), North American Paleontological Convention, International Congress of Vertebrate Morphology, and the Society of Integrative and Comparative Biology are a few good ones to check out. They do cost money, so you might have to budget accordingly and/or look for funding opportunities (they exist!), but it's definitely worth the investment. These conferences are also great ways to meet potential grad school advisers and colleagues and see what their programs and personalities are like (both are important for your sanity). If you can present at a conference your fourth year or a gap year, that is also a really good experience. You don't need to have a brilliant *Nature*-worthy discovery, a poster with preliminary data and preliminary conclusions is perfectly fine.

Most conferences also have ways for students to apply for travel grants or waive registration/hotel fees, so keep an eye out for those as well. If you're presenting research from a lab, it is also worth checking with your professor and see if they can pay for or at least subsidize for your attendance. The Dean's Fund or other sources of undergrad funding would help with that too. Applying for little bits of money is good practice for future apps, you can put the awarded money on your CV, and it shows that you understand the importance of getting your own funding.

A few years ago, graduate students at UChicago and UMich started organizing the Great Lakes Student Paleoconference, an informal student paleoconference for the Great Lakes region, held the Veteran's Day weekend in November. Since then, it's expanded to include students from several universities in the area. Students come together for a weekend and give talks about their research to other students. It is supposed to be a relaxed, low-stakes environment, and it's free, just get yourself there and back. UChicago has a pretty good contingent each year with plenty of car-pooling options – what's a better way to meet fellow Chicago researchers than a road trip? You still get that experience of seeing other research and, if you choose, presenting your own.

Grad School

Just a few things to think about if you're considering grad school after this.

What's grad school like? In general, grad school is composed of a few courses to help broaden your knowledge and your techniques and some level of thesis to deepen a specific area of your knowledge, either masters or doctoral.

For a biology PhD at UChicago, students enroll in a PhD program, but also earn a "free" masters as they pass candidacy. The first two years are spent taking classes and doing lab rotations to try and help narrow your focus and figure out who's lab you'd actually want to do your PhD in. If you qualify, you are highly encouraged to apply for the NSF Graduate Research Fellowship Program (GRFP) at the beginning of your second year, which is a very prestigious fellowship that gives you three years of funding and access to the NSF scientific network. We also have a written preliminary exam the summer before your second year. A prelim committee will give you a question related to the specific area you study and you have one week to write a literature review on that topic, showing you can delve into the literature and synthesize the ideas in a cohesive and thoughtful manner. (Different departments and universities do this exam in different ways, so that could be a topic worth bringing up with current grad students.)

During your second year, you will figure out your primary adviser and ask others to be part of your committee. These people should be able to contribute some expertise relevant to the topics you're interested in. Perhaps one person does a method you need, one person works with organisms you study, someone else stands back and asks "what's the point of all this?" The composition of your thesis committee is up to you, and each grad student has different needs, so that's an important thing to think about, even when choosing schools and interviewing.

At the end of your second year, you will give a public (usually advertised in the dept) presentation of your thesis proposal. After non-committee members ask their questions, they will get kicked out and your committee will continue asking questions to make sure you thoroughly understand the material and the methods, and are comfortable with you proceeding with your work. Then you spend more time doing research. You are also required to TA twice as part of your doctorate. This requirement varies depending on department and university as well. You are expected to schedule committee meetings to catch your professors up with your progress and make sure you're on track to graduate on time. Then, when you are ready, you give another public seminar on what you've found in your thesis work. Oftentimes, your actual thesis defense ends up to cover very a different trajectory of work than you proposed, depending on results of experiments. This difference is quite normal, so don't be concerned if it happens. The public asks their questions, the committee privately asks theirs, then they agree that you pass or pass with revisions, and tada, you made it!

A master's degree is usually 1-3 years and a PhD is 5-7ish years, but both have a similar sort of process. In terms of guaranteed funding support, masters tend to require you to pay and PhDs tend to have funding and pay you a stipend. Again, consult with the places you're interested in, it varies from place to place. And professors may even have advice about acquiring funding to do a masters.

How do I figure out where to go? Asking and googling. Professors, post-docs, and grad students here know a ton of people in their field – email and/or meet up with a few of them, get their thoughts on places that might interest you. They might also know who is advertising for grad students, so they are definitely a great resource. Believe it or not, Twitter has also become a great way to network, learn random cool facts, and find some of the people looking for grad students. Websites of the aforementioned conferences usually have a page of suggestions with schools to consider for grad school or open positions. Grad school is not like med school, in that you can apply to 5-10 places and have a good chance of getting a decent selection of acceptances if you invest the time.

Masters or Doctoral degree? After your bachelor's, you can apply for either masters programs of doctoral programs. How do you choose? It depends on where you feel you are in your career. If you have absolutely no clue regarding what you want to focus on for your PhD, or want to gain more research experience in an area you haven't worked in very much, a masters would be a good place to start. This degree is a good way to take classes and gain research experience with a small thesis (usually 1-3 years), and can establish he foundation of what you want to study as a PhD student. Nowadays, it is also common for programs to consolidate the PhD and masters, such that you enroll in a PhD program, but receive both degrees by the time you're done. PhDs are longer (usually 5-7ish years, depending on the school), and involve a more extensive thesis project. Also think about the kinds of careers you're interested in – if a masters is good enough, then maybe you don't have to commit to a whole PhD.

How do I apply to grad school? Applying to grad school (MS or PhD) is a bit different than applying for undergrad, it's a much more personal process. The faculty are the admissions committee, so it is very important to establish some sort of connection with them before you apply. Several months before applications are due (late Nov – mid Jan), send them an intro email, briefly introducing yourself, and saying you're interested in the lab/program for graduate school. Ask if they are taking students – sometimes they don't have funding for more students, they have too many already and couldn't give another student the proper attention, or they're going on sabbatical that year and won't take students that cycle. If you had your heart set on working with only that one professor and they are not taking more students, then that might help reduce applications you have to do.

Many of those aforementioned conferences are held over the summer or before applications are due. It might be worth asking if they're going and see if you could meet up to talk about grad school with them over a coffee. This way, they now have a face and a personality to go with the name that's been emailing them, and it's a nice thing for them to have as they begin reviewing a whole stack of applications.

Another thing to keep in mind is that the NSF GRFP is due in October, before grad school apps. It requires a research proposal and a personal statement. You do not have to commit to the project for grad school, you just have to show that you can think like a scientist and clearly articulate the importance and feasibility of the study as a potential thesis. This fellowship would give you three years of funding for grad school (professors are very appreciative – grad students can be expensive to support if they have limited funds), but it is also an excellent icebreaker if you need one. Either in your first intro email or in a reply, you can mention that you're working on an app for the GRFP and would be interested in their feedback on your app. If they are willing to help, you can tailor the app to better fit their lab, and you've already begun the discussion regarding thesis topics and why the school would be a good fit – all things that go into your grad school apps the following month and things that will come up during interviews Jan-Feb. You also get a better chance at winning the fellowship as an undergrad vs. a grad student – many schools encourage their grad students to apply, so the competition is much more intense. You can only apply once in your pre-grad school time (undergrad/gap year) and once in grad school (ideally at the beginning of your second year), so it's worth the practice.

GRE??? Many universities are beginning to drop the general GRE exam requirement, at least for domestic students, so check on that as you apply, if that's a concern. Sometimes you might also see a GRE bio subject test as optional… in my personal opinion, it wasn't worth it. These exams are ridiculously expensive, and it's 200 multiple-choice questions on molecular/cell bio, physio, and ecology/evolution – very little of that was related to what I had actually studied in undergrad as one interested in paleo. I spent my third and fourth year doing paleo and anatomy classes, so the other subjects were buried deep in distance memory, and with everything going on, I didn't have much time to study. Again, my personal story, but many paleo programs don't require it, so don't worry about it.

Take the exam a few months before you apply, to make sure it gets processed in time. At the end of the test it will offer to send the scores to four schools for free – whether they're a definite four or four possibilities, might as well take advantage of free score reports. (Otherwise, they're $25 each.)

Application waivers! Unfortunately, applying to grad school can be expensive. Many schools do offer application waivers for grad school, so seek those out and apply for them when possible. Why spend more than you have to?

What are grad school interviews like? If you get selected for a school's grad student recruitment/prospie weekend, congrats! This is the time to visit the school, see what the campus is like, what the various professors are like, what the students/potential future friends are like, etc. You're scoping them out as much as they're scoping you out. If you get along great with the current students, lose track of time coming up with various questions and projects with a couple professors, and have a good gut feeling about the place, sounds like a solid place. If you get a weird vibe from the students, or they say the program is not really supportive of the students, or you can't really picture yourself fitting in, maybe reconsider. Don't disregard your gut feeling. You are going to be spending the next several years at the school with these people – you might as well find a place you can see yourself being happy and supported. Sure, maybe a professor does things you're interested in, is a Nobel laureate (ok, maybe not in paleo), and/or has published dozens of *Science* and *Nature* papers, but if they're a jerk or their students are miserable, it's not worth you going there and suffering too.

Think about potential committee members as you're interviewing too. Does it seem like the department has a few professors that would be able to provide useful feedback to help you through your thesis, or is there only one person there who you'd want to engage with? Also, in the worst case scenario, the professor you initially choose as your adviser seemed fine during interview weekend, but the more you two worked together, the more you realize that was a bad match. Is there another person in the department you could also see yourself working for if you need to switch labs? Or maybe you're doing a lab rotation with someone you didn't intend on working for long-term, but you find their work very interesting – is there flexibility to commit to a different lab? Again, grad school is all about you and what you need to develop into successful scientists, not about the professors.

You also don't need to have your whole thesis planned out for interviews. Again, just be able to show that you can think like a scientist and discuss ideas intelligently. You can express that you don't know things and ask questions of students and professors – they love interest in their work. Don't feel you need to have memorized the ten most recent papers they wrote. It's worth checking out their website and getting a gist of what sorts of things they do, but I'd say it's almost better not knowing everything, and just ask "I saw you work on this stuff and thought it was really interesting… can you tell me more?" (Genuine interest though.) Above, all… relax. They're just curious to learn about you, they know its stressful, and they want you to succeed and find the right fit.

Aside from the official interviews, there are usually a few tours to check out various facilities or local attractions and social events to meet people in a more casual environment over food and drink. Remember, this is also the time to figure out if you could live in that particular location with those particular people for a few years – could you tolerate a rural location with little night life, or do you need a bustling city? How about the weather, how much do you hate winter or too much sun? Grad school can be stressful enough, try to minimize these sorts of additional stress factors if you can.

The dress code is relatively casual – typically interview day, I'd recommend business casual, and days with tours or social events, you can be more casual. It's not necessary to get fully suited up like in other interview settings, but you can if you want. Bring good walking shoes, because you typically do a lot of walking during interview weekends. Check the weather before you pack, bring appropriate clothing. If you've got a pair of sweet earrings made of snake vertebrae, go ahead and wear them! You're going to be surrounded by a bunch of nerds who love that sort of stuff! If you don't have that, don't feel pressured to get them – my point is just be yourself, present your genuine personality, and have fun.

Careers

What do I do with a degree in paleontology? An often asked question by paleo enthusiasts thinking about committing to a paleo career, and especially by family and friends who are concerned about the lucrativeness of such a field. Classical paleontology (galivanting around the world, digging up and describing new species) is admittedly a pretty competitive field, but as paleontology has become more interdisciplinary, options have expanded.

There are a couple options if you want to be a professor. You can aim for an R1 institution, which are careers heavily focused on research and require you to teach a little. Depending on funding, you'd likely have a bigger lab with a number of post-docs, grad students and undergrads. Usually paleo labs are harder to fund, so these labs likely are not as large as cancer bio labs or genetics lab, for example. Tenure-track positions are usually heavily influenced by publications from your lab, so it's good to have several people working on several projects at once.

On the other hand, you could work for a liberal arts college. This job would put more emphasis on teaching courses to undergrads, but still expect some research. Your lab would likely be smaller, and more undergrad-heavy, especially if there is no grad program at the college.

Many vertebrate paleontologists have also worked as medical anatomy instructors and do paleontology research when they're not teaching. Medical schools are always needing human anatomy instructors and who better to teach human anatomy than those who've studied the evolution of the vertebrate body plan and can help explain why humans experience certain pathologies more than others or why the body is structured in a way that doesn't make sense to an engineer?

You can also work in museums as curators or collections managers, depending on your background or interests. Curators conduct research on the museum's specimens and do fieldwork to collect more specimens and expand their collections. They can also work with the exhibits department and put together exhibits on their specimens and help communicate their science. Collections managers are needed to, well, manage the collections. It's not as easy as put it in a box in a drawer and be done with it. There are hundreds-thousands of specimens to keep organized – millions if you're in the insect department. Collections managers are managing loan requests from other researchers, updating taxonomies of their specimens as research expands, keeping track of volunteers, and making sure the specimens are kept in the best condition as possible for as long as possible. Specimens degrade over time, but new methods to better preserve or better repair specimens are always coming out, so paying attention to the latest research on maintaining natural history collections is also important.

If you're less into doing research and more into communicating research and outreach, you can work in the education/outreach department of museums or work as a science writer or communicator. As you may have noticed, some scientists are better at explaining their work to non-scientists than others, and media can be rather appalling in terms of twisting results into sensationalized clickbait. Scientists neck-deep in research projects may not have the proper time to communicate their science well, so they need people to act as the bridge to the interested public.

In terms of non-academic careers, I'll admit my knowledge is a bit weaker. The oil industry loves those with geology degrees – and they have good money. With either degree, you could consult for various companies regarding environmental concerns. If construction companies find something that looks suspiciously like a fossil when digging a foundation, they should report it and have a paleontologist come out and take a look. If it is a fossil, you can then bring in a team and dig it up, then the construction can continue. (Unless it's a mammoth graveyard, then the company better find a different place for their building.) You could work for the government, the National Park Service or the Bureau of Land Management to take care of the lands that contain fossils and manage permits for conducting fieldwork.

UChicago Biological Sciences courses

You'd start out with either the Life, Ecosystems and Evolution sequence or the Advanced Biology sequence. Take the sequences/requirements that you feel most comfortable with. (Biodiversity with LaBarbera and Andrews is a great class, regardless of your choice.)

I'll point out that you can register for undergraduate research to count as a general elective, either BIOS 00199 (Undergraduate Research) or BIOS 00299 (Advanced Research: Biological Sciences). This would be good for your third or fourth year, if you're working towards a thesis. It won't count as an upper-level elective, but if you need to block out research time and take only two classes while staying a full-time student, that's how.

Your specialization would likely be in Ecology and Evolution, which does include a quarter of statistics. STAT 22000 is a good course, and you'll likely encounter the need to do some statistical analyses. (Don't worry too much about calculus if you don't want to – I haven't needed it in my area of study.)

As for your upper level electives, it's up to what you're interested in as a paleontologist/evolutionary biologist.

BIOS 21356. Vertebrate Development. 100 Units.
This advanced-level course combines lectures, student presentations, and discussion sessions. It covers major topics on the developmental biology of embryos (e.g. formation of the germ line, gastrulation, segmentation, nervous system development, limb pattering, organogenesis). We make extensive use of the primary literature and emphasize experimental approaches including embryology, genetics, and molecular genetics.

Instructor(s): V. Prince, P. Kratsios. Terms Offered: Spring
Prerequisite(s): For Biological Sciences majors: Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20189 or BIOS 20190
Equivalent Course(s): ORGB 33600, MGCB 35600, DVBI 35600

BIOS 22233. Comparative Vertebrate Anatomy. 100 Units.
This course covers the structure and function of major anatomical systems of vertebrates. Lectures focus on vertebrate diversity, biomechanics, and behavior (from swimming and feeding to running, flying, seeing, and hearing). Labs involve detailed dissection of animals (muscles, organs, brains) and a focus on skull bones in a broad comparative context from fishes to frogs, turtles, alligators, mammals, birds, and humans. Field trip to Field Museum and visit to medical school lab for human dissection required.

Instructor(s): M. Westneat. L. Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.
Note(s): Offered Winter 2019 and every other year thereafter.
Equivalent Course(s): ORGB 32233

BIOS 22236. Reproductive Biology of Primates. 100 Units.
The aim of this advanced-level course is to provide a comparative overview of adaptations for reproduction in primates as a background to human reproductive biology. Where appropriate, reference will be made to other mammals and some comparisons will be even wider. Ultimately, the aim of all comparisons is to arrive at concrete lessons for human reproduction, notably in the realm of obstetrics and gynecology. For this reason, the course will be of interest for medical students as well as for those studying anthropology, biology or psychology.

Instructor(s): R. Martin Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

BIOS 22245. Biomechanics: How Life Works. 100 Units.
This course will explore form and function in a diversity of organisms, using the principles of physics and evolutionary theory to understand why living things are shaped as they are and behave in such a diversity of ways. Biomechanics is at the interface of biology, physics, art, and engineering. We will study the impact of size on biological systems, address the implications of solid and fluid mechanics for organismal design, learn fundamental principles of animal locomotion, and survey biomechanical approaches. Understanding the mechanics of biological organisms can help us gain insight into their behavior, ecology and evolution.

Instructor(s): M. Westneat   Terms Offered: Spring. L. Spring.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence. Physics useful.
Note(s): This course will include a lab and will alternate years with BIOS 22233.
Equivalent Course(s): EVOL 32245, ORGB 32245

BIOS 22250. Chordates: Evolution and Comparative Anatomy. 100 Units.

Chordate biology emphasizes the diversity and evolution of modern vertebrate life, drawing on a range of sources (from comparative anatomy and embryology to paleontology, biomechanics, and developmental genetics). Much of the work is lab-based, with ample opportunity to gain firsthand experience of the repeated themes of vertebrate body plans, as well as some of the extraordinary specializations manifest in living forms. The instructors, who are both actively engaged in vertebrate-centered research, take this course beyond the boundaries of standard textbook content.

Instructor(s): M. Coates   Terms Offered: Winter. L.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, including BIOS 20187 or BIOS 20235
Note(s): Not offered Winter 2019 - Offered Winter 2020 and every other year thereafter.
Equivalent Course(s): ORGB 30250, EVOL 30200

BIOS 22260. Vertebrate Structure and Function. 100 Units.

This course is devoted to vertebrate bones and muscles, with a focus on some remarkable functions they perform. The first part takes a comparative look at the vertebrate skeleton via development and evolution, from lamprey to human. The major functional changes are examined as vertebrates adapted to life in the water, on land, and in the air. The second part looks at muscles and how they work in specific situations, including gape-feeding, swimming, leaping, digging, flying, and walking on two legs. Dissection of preserved vertebrate specimens required.

Instructor(s): P. Sereno. L.   Terms Offered: Spring. Not offered 2019; ***may not be offered 2020, TBD.***
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and consent of instructor. See also http://paulsereno.uchicago.edu/fossil_lab/classes/vertebrate_structure_and_function for more information.

BIOS 22265. Human Origins: Milestones in Human Evolution & Fossil Record. 100 Units.

This course aims at exploring the fundamentals of human origins by tracking the major events during the course of human evolution. Starting with a laboratory based general introduction to human osteology and muscle function, the latest on morphological and behavioral evidence for what makes Homo sapiens and their fossil ancestors unique among primates will be presented. Our knowledge of the last common ancestor will be explored using the late Miocene fossil record followed by a series of lectures on comparative and functional morphology, adaptation and biogeography of fossil human species. With focus on the human fossil record, the emergence of bipedalism, advent of stone tool use and making, abandonment of arboreality, advent of endurance walking and running, dawn of encephalization and associated novel life histories, language and symbolism will be explored. While taxonomic identities and phylogenetic relationships will be briefly presented, the focus will be on investigating major adaptive transitions and how that understanding helps us to unravel the ecological selective factors that ultimately led to the emergence of our species. The course will be supported by fresh data coming from active field research conducted by Prof. Alemseged and state of the art visualization methods that help explore internal structures. By tracing the path followed by our ancestors over time, this course is directly relevant to reconnoitering the human condition today and our place in nature.

Instructor(s): Z. Alemseged   Terms Offered: Autumn
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, or consent of Instructor.
Equivalent Course(s): ANTH 28110, ORGB 33265

BIOS 22270. Bones and Genes: The Story of Homo Sapiens. 100 Units.

The primary aim of this course is to explore the biological and behavioral makings of our species, anatomically modern Homo sapiens, by considering hypotheses, models, evidence, and the latest consensus from the complementary fields of paleoanthropology and genetics. The course is divided into two blocks, one focusing on our origins and the other on migrations across the globe. After a brief introduction to the human skeleton, students will learn about the pool of potential direct ancestors that lived before Homo sapiens emerged 300,000 year ago, as well as the environmental and cultural environments that may have led to the arrival of our species. This will be complemented by an evaluation of competing genetic models for the origin of our species and evidence for genetic intermixing with archaic humans such as Neanderthals and Denisovans. We will, then, follow modern humans out of Africa and study the fossil, archaeological, and genetic evidence for the peopling of the planet and adaptations to novel environments. Finally, the contributions of paleoanthropology and genetics to our understanding of behavior, cognition, physical traits/phenotypes, diet, and disease evolution will be explored. Complementary laboratory and discussion sessions will expose students to state-of-the-art methods and current research endeavors in these fields.

Instructor(s): M. Raghavan, Z. Alemseged Terms Offered: Spring
Prerequisite(s): BIOS Majors: Three quarters of a Biological Sciences Fundamentals sequence. Also open to students in Anthropology and Genetics with an interest in human evolution, or consent of instructors.

BIOS 22306. Evolution and Development. 100 Units.
The course will provide a developmental perspective on animal body plans in phylogenetic context. The course will start with a few lectures, accompanied by reading assignments. Students will be required to present a selected research topic that fits the broader goal of the course and will be asked to submit a referenced written version of it after their oral presentation. Grading will be based on their presentation (oral and written) as well as their contributions to class discussions. Prerequisite(s): Advanced undergraduates may enroll with the consent of the instructor.

Instructor(s): U. Schmidt-Ott Terms Offered: Autumn
Prerequisite(s): Advanced undergraduates may enroll with the consent of the instructor.
Equivalent Course(s): EVOL 33850, DVBI 33850, ORGB 33850

BIOS 23100. Dinosaur Science. 100 Units.
This introductory-level (but intensive) class includes a ten-day expedition to South Dakota and Wyoming (departing just after graduation). We study basic geology (e.g., rocks and minerals, stratigraphy, Earth history, mapping skills) and basic evolutionary biology (e.g., vertebrate and especially skeletal anatomy, systematics and large-scale evolutionary patterns). This course provides the knowledge needed to discover and understand the meaning of fossils as they are preserved in the field, which is applied to actual paleontological sites. Participants fly from Chicago to Rapid City, and then travel by van to field sites. There they camp, prospect for, and excavate fossils from the Cretaceous and Jurassic Periods. Field trip required.

Instructor(s): P. Sereno. L. Terms Offered: Spring
Prerequisite(s): Consent of instructor, three quarters of a Biological Sciences Fundamentals sequence and a prior course in general science, preferably geology. See also http://paulsereno.uchicago.edu/fossil_lab/classes/dinosaur_science for more information.
Note(s): Need based financial assistance for field trip may be available. Apply to the Master of BSCD (jmalamy@bsd.uchicago.edu)

BIOS 23232. Ecology and Evolution in the Southwest. 100 Units.
This lecture course focuses on the ecological communities of the Southwest, primarily on the four subdivisions of the North American Desert, the Chihuahuan, Sonoran, Mohave, and Great Basin Deserts. Lecture topics include climate change and the impact on the flora and fauna of the region; adaptations to arid landscapes; evolutionary, ecological, and conservation issues in the arid Southwest, especially relating to isolated mountain ranges; human impacts on the biota, land, and water; and how geological and climatic forces shape deserts.

Instructor(s): E. Larsen Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence, or consent of instructor

BIOS 23233. Ecology and Evolution in the Southwest: Field School. 100 Units.
This lecture/lab course is the same course as BIOS 13111, but includes a lab section preparatory to a two-week field trip at end of Spring Quarter, specific dates to be announced. Our goal in the lab is to prepare proposals for research projects to conduct in the field portion of this course. Field conditions are rugged. Travel is by twelve-passenger van. Lodging during most of this course is tent camping on developed campsites.

Instructor(s): E. Larsen Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and consent of instructor

BIOS 23242. Primate Evolution and the Roots of Human Biology. 100 Units.

The course is designed to achieve a state-of-the-art synthesis of primate evolution and human origins. An overview of the biology and evolution of the mammalian order Primates provides a broad foundation for considering the special case human evolution. Across primates as a group, the course explores and integrates comparative evidence from anatomy, physiology, behavior, chromosomal studies, and molecular genetics. Both living primates and their fossil relatives are covered, with due reference to theoretical aspects. Particular emphasis is given to evaluation of characters for inference of evolutionary relationships and to explicit examination of scaling effects of body size in between-species comparisons. Within the general framework of origins and adaptations of primates, human evolution is examined with respect to all features covered. Special features of humans are identified and related to an overview of the hominid fossil record. A specific goal of this course is to guide students to read, interpret, and synthesize scientific literature, and exercise critical thinking with respect to selected topics. As shown by examples, the course is directly relevant to the field of Darwinian medicine, which considers health and disease in relation to the evolutionary background of human biology.

Instructor(s): R. Martin Terms Offered: Spring
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20187 or BIOS 20235, or consent of instructor.

BIOS 23247. Bioarchaeology and the Human Skeleton. 100 Units.

This course is intended to provide students in archaeology with a thorough understanding of bioanthropological and osteological methods used in the interpretation of prehistoric societies by introducing bioanthropological methods and theory. In particular, lab instruction stresses hands-on experience in analyzing the human skeleton, whereas seminar classes integrate bioanthropological theory and application to specific cases throughout the world. Lab and seminar-format class meet weekly.

Instructor(s): M. C. Lozada Terms Offered: Winter. Winter 2020
Note(s): This course qualifies as a Methodology selection for Anthropology majors.
Equivalent Course(s): ANTH 38800, ANTH 28400

BIOS 23249. Animal Behavior. 100 Units.

This course introduces the mechanism, ecology, and evolution of behavior, primarily in nonhuman species, at the individual and group level. Topics include the genetic basis of behavior, developmental pathways, communication, physiology and behavior, foraging behavior, kin selection, mating systems and sexual selection, and the ecological and social context of behavior. A major emphasis is placed on understanding and evaluating scientific studies and their field and lab techniques.

Instructor(s): S. Pruett-Jones (even years), J. Mateo (odd years) Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.
Note(s): CHDV Distribution: A
Equivalent Course(s): PSYC 23249, CHDV 23249

BIOS 23252. Field Ecology. 100 Units.

Open only to students who are planning to pursue graduate research. This course introduces habitats and biomes in North America and the methods of organizing and carrying out field research projects in ecology and behavior, focusing on questions of evolutionary significance. A two-week field trip to southern Florida during the Winter/Spring Quarter break consists of informal lectures and discussions, individual study, and group research projects. During Spring Quarter, there are lectures on the ecology of the areas visited and on techniques and methods of field research. Field trip required.

Instructor(s): S. Pruett-Jones Terms Offered: Spring. This course is offered in alternate (odd) years.
Prerequisite(s): Consent of instructor

BIOS 23254. Mammalian Ecology. 100 Units.
This course introduces the diversity and classification of mammals and their ecological relationships. Lectures cover natural history, evolution, and functional morphology of major taxonomic groups. Lab sessions focus on skeletal morphology, identifying traits of major taxonomic groups, and methods of conducting research in the field. Participation in field trips, occasionally on Saturday, is required.

Instructor(s): E. Larsen Terms Offered: Spring. L. Offered every other year in odd years.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and third-year standing or consent of instructor.

BIOS 23258. Molecular Evolution I: Fundamentals and Principles. 100 Units.
The comparative analysis of DNA sequence variation has become an important tool in molecular biology, genetics, and evolutionary biology. This course covers major theories that form the foundation for understanding evolutionary forces that govern molecular variation, divergence, and genome organization. Particular attention is given to selectively neutral models of variation and evolution, and to alternative models of natural selection. The course provides practical information on accessing genome databases, searching for homologous sequences, aligning DNA and protein sequences, calculating sequence divergence, producing sequence phylogenies, and estimating evolutionary parameters.

Instructor(s): M. Kreitman Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20187 or BIOS 20235 and two quarters of calculus, or consent of instructor.
Equivalent Course(s): EVOL 44001, ECEV 44001

BIOS 23261. Invertebrate Paleobiology and Evolution. 100 Units.
This course provides a detailed overview of the morphology, paleobiology, evolutionary history, and practical uses of the invertebrate and microfossil groups commonly found in the fossil record. Emphasis is placed on understanding key anatomical and ecological innovations within each group and interactions among groups responsible for producing the observed changes in diversity, dominance, and ecological community structure through evolutionary time. Labs supplement lecture material with specimen-based and practical application sections. An optional field trip offers experience in the collection of specimens and raw paleontological data. Several "Hot Topics" lectures introduce important, exciting, and often controversial aspects of current paleontological research linked to particular invertebrate groups. (L)

Instructor(s): M. Webster Terms Offered: Autumn
Prerequisite(s): GEOS 13100 and 13200, or equivalent. Students majoring in Biological Sciences only; Completion of the general education requirement in the Biological Sciences, or consent of instructor.
Equivalent Course(s): GEOS 26300, GEOS 36300, EVOL 32400

BIOS 23262. Mammalian Evolutionary Biology. 100 Units.
This course examines mammalian evolution-the rise of living mammals from ancient fossil ancestors stretching back over 300 million years. Lectures focus on the evolutionary diversification of mammals, including anatomical structure, evolutionary adaptations, life history, and developmental patterns. Labs involve detailed comparative study of mammalian skeletons, dissection of muscular and other systems, trips to the Field Museum to study fossil collections, and studies of human anatomy at the Pritzker School of Medicine. Students will learn mammalian evolution, functional morphology, and development, and will gain hands-on experience in dissection. Taught by instructors who are active in scientific research on mammalian evolution, the course is aimed to convey new insights and the latest progress in mammalian paleontology, functional morphology, and evolution. Prerequisite(s): Second-year standing and completion of a Biological Sciences Fundamentals sequence; or GEOS 13100-13200 or GEOS 22300, or consent of instructors.

Instructor(s): Z. Luo, K. Angielczyk Terms Offered: Autumn. L.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20187 or BIOS 20235; or GEOS 13100-13200 or GEOS 22300, or consent of instructors.
Equivalent Course(s): EVOL 31201, ORGB 31201

BIOS 23266. Evolutionary Adaptation. 100 Units.

This course deals with the adaptation of organisms to their environments and focuses on methods for studying adaptation. Topics include definitions and examples of adaptation, the notion of optimization, adaptive radiations, the comparative method in evolutionary biology, and the genetic architecture of adaptive traits. Students will draw on the logical frameworks covered in lecture as they evaluate primary papers and prepare two writing assignments on an adaptive question of their choice.

Instructor(s): C. Andrews   Terms Offered: Autumn
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20187 or BIOS 20235 or consent of instructor.

BIOS 23289. Marine Ecology. 100 Units.

This course provides an introduction into the physical, chemical, and biological forces controlling the function of marine ecosystems and how marine communities are organized. The structures of various types of marine ecosystems are described and contrasted, and the lectures highlight aspects of marine ecology relevant to applied issues such as conservation and harvesting.

Instructor(s): T. Wootton   Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and prior introductory course in ecology or consent of instructor.
Equivalent Course(s): ENST 23289

BIOS 23404. Reconstructing the Tree of Life: An Introduction to Phylogenetics. 100 Units.

This course is an introduction to the tree of life (phylogeny): its conceptual origins, methods for discovering its structure, and its importance in evolutionary biology and other areas of science. Topics include history and concepts, sources of data, methods of phylogenetic analysis, and the use of phylogenies to study the tempo and mode of lineage diversification, coevolution, biogeography, conservation, molecular biology, development, and epidemiology. One Saturday field trip and weekly computer labs required in addition to scheduled class time. This course is offered in alternate (odd) years.

Instructor(s): R. Ree.   Terms Offered: Autumn. L.
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence or consent of instructor
Note(s): This course is offered in alternate (odd) years.
Equivalent Course(s): EVOL 35401

BIOS 23406. Biogeography. 100 Units.

This course examines factors governing the distribution and abundance of animals and plants. Topics include patterns and processes in historical biogeography, island biogeography, geographical ecology, areography, and conservation biology (e.g., design and effectiveness of nature reserves).

Instructor(s): B. Patterson (odd years, lab). L., Heaney (even years, discussion)   Terms Offered: Winter
Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence and a course in either ecology, evolution, or earth history; or consent of instructor
Equivalent Course(s): GEOG 35500, EVOL 45500, GEOG 25500, ENST 25500

UChicago Geophysical Sciences courses

The fundamental sequence for the geophysical sciences is the same for all those interested in a geophysical degree.

As a paleontologist/evolutionary biologist, you'd probably be interested in taking courses from List 1 which cover the physical and biological aspects of the field of study. The course catalog for Geophysical Sciences does give a sample set of courses to take for a specialization in paleontology, though you can create your own set of courses that best cover your interests.

GEOS 21000. Mineralogy. 100 Units.

This course covers structure, chemical composition, stability, and occurrence of major rock-forming minerals. Labs concentrate on mineral identification with the optical microscope. (L)

Instructor(s): A. Campbell   Terms Offered: Winter. Offered every other year.
Equivalent Course(s): GEOS 31000

GEOS 24300. Paleoclimatology. 100 Units.

This class will cover the theory and reconstruction of the evolution of Earth's climate through geologic time. After reviewing fundamental principles that control Earth's climate, the class will consider aspects of the climate reconstructions that need to be explained theoretically, such as the faint young sun paradox, snowball Earth episodes, Pleistocene glacial / interglacial cycles, and long-term Cenozoic cooling. Then we will switch to a temporal point of view, the history of Earth's climate as driven by plate tectonics and biological evolution, and punctuated by mass extinctions. This will allow us to place the theoretical ideas from the first part of the class into the context of time and biological progressive evolution.

Terms Offered: Winter
Prerequisite(s): One quarter of chemistry
Note(s): D. Archer
Equivalent Course(s): GEOS 34300

GEOS 26100. Phylogenetics and the Fossil Record. 100 Units.

Phylogenies are branching diagrams that reflect evolutionary relationships. In addition to providing information on the history of life, phylogenies are fundamental to modern methods for studying macroevolutionary and macroecological pattern and process. In the biological sciences, phylogenies are most often inferred from genetic data. In paleobiology, phylogenies can only be inferred from the fossilized remains of morphological structures, and collecting and analyzing morphological data present a different set of challenges. In this course, students will study both traditional and state-of-the-art approaches to inferring phylogenies in the fossil record, from data collection to interpretation. Lectures will explore the statistical underpinnings of phylogenetic methods, as well as their practical implementation in commonly used software. Topics will include: identifying and coding morphological characters, models of morphological evolution, parsimony, maximum likelihood, and bayesian methods, supertree approaches, and integrating time into phylogenetic inference. Fifty percent of the final assessment will come from a research paper due at the end of the quarter.

Instructor(s): G. Slater   Terms Offered: Autumn. Course is offered every other year. Not offered in 2019-20
Prerequisite(s): BIOS 20197 or equivalent.
Equivalent Course(s): GEOS 36100

GEOS 26300. Invertebrate Paleobiology and Evolution. 100 Units.

This course provides a detailed overview of the morphology, paleobiology, evolutionary history, and practical uses of the invertebrate and microfossil groups commonly found in the fossil record. Emphasis is placed on understanding key anatomical and ecological innovations within each group and interactions among groups responsible for producing the observed changes in diversity, dominance, and ecological community structure through evolutionary time. Labs supplement lecture material with specimen-based and practical application sections. An optional field trip offers experience in the collection of specimens and raw paleontological data. Several "Hot Topics" lectures introduce important, exciting, and often controversial aspects of current paleontological research linked to particular invertebrate groups. (L)

Instructor(s): M. Webster   Terms Offered: Autumn
Prerequisite(s): GEOS 13100 and 13200, or equivalent. Students majoring in Biological Sciences only; Completion of the general education requirement in the Biological Sciences, or consent of instructor.
Equivalent Course(s): GEOS 36300, EVOL 32400, BIOS 23261

GEOS 26600. Geobiology. 100 Units.

Geobiology seeks to elucidate the interactions between life and its environments that have shaped the coevolution of the Earth and the biosphere. The course will explore the ways in which biological processes affect the environment and how the evolutionary trajectories of organisms have in turn been influenced by environmental change. In order to reconstruct the history of these processes, we will examine the imprints they leave on both the rock record and on the genomic makeup of living organisms. The metabolism and evolution of microorganisms, and the biogeochemistry they drive, will be a major emphasis.

Instructor(s): M. Coleman, J. Waldbauer
Prerequisite(s): GEOS 13100-13200-13300 or college-level cell & molecular biology
Equivalent Course(s): GEOS 36600, ENSC 24000

GEOS 26650. Environmental Microbiology. 100 Units.

The objective of this course is to understand how microorganisms alter the geochemistry of their environment. The course will cover fundamental principles of microbial growth, metabolism, genetics, diversity, and ecology, as well as methods used to study microbial communities and activities. It will emphasize microbial roles in elemental cycling, bioremediation, climate, and ecosystem health in a variety of environments including aquatic, soil, sediment, and engineered systems.

Instructor(s): M. Coleman   Terms Offered: Autumn
Prerequisite(s): CHEM 11100-11200 and BIOS 20186 or BIOS 20197 or BIOS 20198
Equivalent Course(s): GEOS 36650, ENSC 24500

GEOS 26905. Topics in Conservation Paleobiology. 100 Units.

Paleobiological data from very young sedimentary records, including skeletal 'death assemblages' actively accumulating on modern land surfaces and seabeds, provide unique information on the status of present-day populations, communities, and biomes and their responses to natural and anthropogenic stress over the last few decades to millennia. This course on the emerging discipline of 'conservation paleobiology' uses weekly seminars and individual research projects to introduce how paleontologic methods, applied to modern samples, can address critical issues in the conservation and restoration of biodiversity and natural environments, including such basic questions as 'has a system changed, and if so how and when relative to suspected stressors?'. The course will include hands-on experience, either in the field or with already-collected marine benthic samples, to assess societally relevant ecological change in modern systems over time-frames beyond the reach of direct observation. Enrollment limited.

Instructor(s): S. Kidwell   Terms Offered: Winter
Prerequisite(s): Additional Notes For undergraduates: completion of GEOS 13100-13200-13300 or equivalent or completion of a 20000 level course in Palentology.
Equivalent Course(s): GEOS 36905, EVOL 36905

GEOS 27300. Biological Evolution-Advanced. 100 Units.

This course is an overview of evolutionary processes and patterns in present-day organisms and in the fossil record and how they are shaped by biological and physical forces. Topics emphasize evolutionary principles. They include DNA and the genetic code, the genetics of populations, the origins of species, and evolution above the species level. We also discuss major events in the history of life, such as the origin of complex cells, invasion of land, and mass extinctions.

Aimed at GEOS and ENSC majors, this course differs from GEOS 13900 in requiring a term paper, topic chosen from a list provided by the instructor (L).

Instructor(s): D. Jablonski   Terms Offered: Winter
Prerequisite(s): Prerequisite(s): BIOS 10130; No Biological Sciences majors except by petition to the BSCD Senior Advisers.
Note(s): Terms Offered: Winter

GEOS 28300. Principles of Stratigraphy. 100 Units.

This course introduces principles and methods of stratigraphy. Topics include facies analysis, physical and biostratigraphic correlation, and development and calibration of the geologic time scale. We also discuss controversies concerning the completeness of the stratigraphic record; origin of sedimentary cycles; and interactions between global sea level, tectonics, and sediment supply. (L)

Instructor(s): S. Kidwell   Terms Offered: Autumn
Prerequisite(s): GEOS 13100-13200 or equivalent required; GEOS 23500 and/or 28200 recommended
Note(s): This course is offered in alternate years.
Equivalent Course(s): GEOS 38300

GEOS 29001. Field Course in Geology. 100 Units.

Students in this course visit classic locations to examine a wide variety of geological environments and processes, including active tectonics, ancient and modern sedimentary environments, and geomorphology.

Prerequisite(s): GEOS 13100-13200 and consent of instructor
Note(s): Interested students should contact the departmental counselor.
Equivalent Course(s): GEOS 39001

GEOS 29002. Field Course in Modern and Ancient Environments. 100 Units.

This course uses weekly seminars during Winter Quarter to prepare for a one-week field trip over spring break, where students acquire experience with sedimentary rocks and the modern processes responsible for them. Destinations vary; past trips have examined tropical carbonate systems of Jamaica and the Bahamas and subtropical coastal Gulf of California. We usually consider biological, as well as physical, processes of sediment production, dispersal, accumulation, and post-depositional modification.

Instructor(s): S. Kidwell, M. LaBarbera   Terms Offered: Winter
Note(s): Organizational meeting and deposit usually required in Autumn Quarter; interested students should contact an instructor in advance.
Equivalent Course(s): GEOS 39002, ENSC 29002

GEOS 28000. Introduction to Structural Geology. 100 Units.

This course explores the deformation of the Earth materials primarily as observed in the crust. We emphasize stress and strain and their relationship to incremental and finite deformation in crustal rocks, as well as techniques for inferring paleostress and strain in deformed crustal rocks. We also look at mesoscale to macroscale structures and basic techniques of field geology in deformed regions.

Instructor(s): D. Rowley   Terms Offered: Winter
Prerequisite(s): GEOS 13100
Note(s): This course is offered in alternate years.
Equivalent Course(s): GEOS 38000