Deep Time: the Science of Origins

This course muses on the nature of knowledge, the tools and history of science, and the origin of everything. In it we will explore together some of the ways we can learn about the world beyond our senses and before we existed. Together we will read about these topics, discuss and argue about them, calculate once in a while, and most important – think and write about them.

Instructors: This course will be led by Professor Tim McKay with help from graduate student instructor:

- Senay Yitbarak (Ecology and Evolutionary Biology: senay@umich.edu)
- Delaney Cargo (Ecology and Evolutionary Biology: cargod@umich.edu)
- Adam Levick (Information: adlev@umich.edu)

Behind the scenes, we will be getting support from graduate student Ann Marie Macara (Molecular, Cellular, and Developmental Biology: macara@umich.edu) and undergraduate Learning Assistant Valeria Epshteyn (epshteyn@umich.edu).

Course objectives: By the end of this course, every student should demonstrate a solid introductory understanding of three different aspects of origin science, all equally important:

- What we know: By the end of the term, you should be able to tell the scientific origin story of the Earth, of life on it, and of the cosmos at large. Among other things, you will have an appreciation for the important timescales, key events, and essential mechanisms driving this story.
- How we came to know this: Because we will approach this topic through its intellectual history, you will emerge able to tell the tale of how the human community established this scientific origin story. By learning the science in its historical context you will gain a much richer understanding of how science really works.
- Why we believe this story: Building a scientific understanding of the past requires the interpretation of evidence. We will explore both, examining the evidence and challenging its interpretation. You will emerge armed to decide for yourself which parts of this scientific origin story you believe are well established, and to appreciate where the substantial remaining mysteries lie.

Course structure: We will meet for four hours each week. On Mondays and Thursdays we will meet in a large group for an interactive lecture. On Wednesdays and Fridays we will break up into a set if five smaller group discussions.

Course policies on technology and media:

CTools: The course CTools site provides our main mode of sharing material. Except for the four books you were asked to purchase, all other readings will be made available there as PDF files. This is the place to find the course schedule, including any real-time changes to it. Announcements on this site will remind you of anything you need to know.

Email: The best way to reach your instructors is via email. We will answer as promptly as possible, but you shouldn't count on a sudden response if your message is sent outside of ordinary business hours.

Laptops in class: Our time together is limited, and we need to make the most of it. For this reason, laptops may not be used during class. For discussions, your written answers to the questions we pose, the relevant readings, and a notebook will be all you need. In lecture, the readings and your notebook should suffice. If you feel this lack of technology will pose a real impediment to your success please contact me so that we can discuss it.

Books:

There are four books to purchase - all should be easily available from online sellers. Here is the list. Feel free to buy used copies if you like, though new copies of these books are cheap. It doesn't matter what edition they are in either. I've listed the recent prices from Amazon.

We will also have a number of readings available for free online.

1. Sean Carroll - From Eternity to Here: The Quest for the Ultimate Theory of Time (ISBN-10: 0452296544, ISBN-13: 978-0452296541) $12.76
2. Janet Browne - Darwin's Origin of Species (ISBN-10: 0802143466, ISBN-13: 978-0802143464) $9.27
3. Sean Carroll – The Making of the Fittest (ISBN-10: 0393330516, ISBN-13: 978-0393330519) $13.26
4. Simon Singh – Big Bang: The Origin of the Universe (ISBN-10: 0007162219, ISBN-13: 978-0007162215) $10.24

Expectations of students: We have two major expectations from every student in this class. The first is shared: we expect everyone to be seriously engaged with class. The second is individual: we expect each of you to occasionally go off on your own and really dig into some topic of interest.
Regular engagement: As we go through the term, there are several things we expect you to do every week: participate in lecture, completing in-class quizzes, and participate in discussion, always reading in advance, occasionally writing or responding to blog posts, leading discussions, or giving presentations.

1. Participate in lecture: In lecture sessions, we will discuss the science of origins, working our way forward from the 18th century to today. During each lecture session, we will have a five minute quiz asking you to reflect on material from previous lectures. This continuous quizzing is intended to help you learn.
2. Participate in discussion: Twice a week you will meet in small groups for discussion of assigned readings and related topics. These discussions are for you, and we will ask you to prepare by writing blog posts, leading discussions, responding to blog posts, and making presentations.

Biweekly assignments: This course is structured as a set of six roughly two week long modules. At the end of each, we will offer you the opportunity to explore what we've been learning more deeply in a "biweekly assignment". Each of these biweeklies will come in several flavors; some purely written, others involving calculations or various forms of creative expression.

Evaluation and grading: There will be two very different kinds of evaluation happening in this class. The first kind is for you – we want you to reflect carefully on what you learn and how this changes your thinking about origins during the class. To help you do this, we will begin by asking you to write about your starting place, and will return to this at the end of the class.

The second kind of evaluation will generate your official grade. Grading in this course will be done in an unusual game-inspired way.

Earning the grade you want: The central idea of grading for this class is that, within limits, you can choose what grade you want, and earn it the way that you want to. Everyone in this class starts with zero points. Every assignment you do can only add to your point total, you can never lose points. Also, there are many opportunities to earn points, and many different ways to do it. All we require for you to do well in this class is that you do a lot of different things well

Ways to earn points:

- Participate fully in a week of activities: For each week in which you complete all the required activities, you'll earn a weekly engagement badge. These badges are worth points toward the grade you want. Partial weeks don't earn points. If you miss out on some piece and don't get a badge that week, there are always other ways to earn points. Regular engagement is also a social expectation: both your instructors and your peers will expect you to participate. Your reputation will suffer if you don't.
- Complete biweekly assignments: When you choose to do a biweekly assignment, and do it well enough, you will earn a biweekly badge, again worth points. Each biweekly will be carefully graded – high quality work will earn biweekly bonus points. If a biweekly assignment is not good enough to earn a badge, you will have one chance to revise, using the comments from your grader to inform your changes. If the revised version is adequate, you will receive badge and bonus points for it as above.
- Assignments By Choice (ABCs): During the term, we will post a variety of 'extra' assignments. You don't *have* to do *any* of these, but you can always choose to. Each will require you to do something outside of class, learn from it, and report back what you learn in both written and oral form. ABCs will each have their own point system.

Point values:

- Weekly participation badges: 4000 points per week for the first six weeks, then 2000 points per week for the last six weeks
- Biweekly badges: 8000 points each
- Biweekly bonus points: 0-7000 points (good enough work will receive 0, once-in-a-lifetime work will receive 7000, better-than-average might get a few thousand)
- Assignments by choice: various, from 1000 points to 40000 points

Grading scale (there is no *upper* limit on how many points you could get):

- A: More than 100000
- A-: 95000 – 100000
- B+: 90000 – 95000
- B: 85000 – 90000
- B-: 80000 – 85000
- C+: 75000 – 80000
- C: 70000 – 75000
- C-: 65000 – 70000
- D: 55000 – 65000
- E: Less than 55000

Three different ways to get an A:

- Strategy 1: 105000 points (The standard approach with very good work…)
    - Participate fully for all 12 weeks: this earns you 6x4000 + 6x2000 = 36000 points
    - Complete all six of the biweekly assignments: badges earn 6x8000 = 48000 points, plus perhaps half credit for the bonus points 6x3500 = 21000 points
- Strategy 2: 100000 points (Focus your effort, get a few weeks off…)
    - Participate fully for all 12 weeks: this earns you 6x4000 + 6x2000 = 36000 points
    - Complete four of the six biweekly assignments: badges earn 4x8000 = 32000 points, but do them exceptionally well, and get most of the available credit for the bonus points 4x6000 = 24000 points
    - Do a several medium-size ABCs to earn at least 8000 points.
- Strategy 3: 100000 points (go your own way, doing non-standard things)
    - Participate fully for 8 weeks during the term: 6x4000 + 2x2000 = 28000 points
    - Complete four biweeklies, and do them well: 4x8000 + 4x2500 = 42000 points
    - Do several small and at least one large ABC to earn at least 30000 points
- Strategy 4: Whatever you come up with…

How to get an A+:

A grade of A+ in LSA is reserved for exceptional performance, and in this class it cannot be earned based on points alone. Instead, the instructional team for the class will meet at the end of the term to decide whether any of the students who have earned A grades by points have truly excelled in their participation and individual work. If so, these students, never more than a few, will receive A+ grades.

Late work policy: All work must be turned in online so that it is received by instructors on time. Nothing will be accepted late. If the dog eats your homework, this course provides many different ways to make up the points you have lost.