

## **Deep Time: the Science of Origins: v1.1**

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 instructors Uriah Israel, James Robinson, Brandon Yik, and Alex Golden, GradeCraft partners Marie Hooper and Caitlin Holman, course designer Marybeth Bauer, and undergraduate learning assistants Neha Srinivasan and Nita Kedharnath.

**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 Monday and Wednesday afternoons we will meet in a large group for an interactive lecture. On Wednesday and Friday mornings we will break up into a set of smaller student and GSI led group discussions.

### **Course policies on technology and media:**

**Canvas:** The course Canvas site provides our main mode of sharing material. Except for a few books you will be 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, usually within 24 hours, but you should expect a delayed 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. Believe it or not, the two Sean Carroll books are by different Sean Carrolls...

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 topics of interest. The entire purpose of this course is to provide a strong framework within which we can explore together the science of origins and the origins of science.

Regular engagement: As we go through the term, there are several things we expect you to be doing every week: participating in lecture and discussion, completing in-class activities, always reading in advance, occasionally writing blog posts, leading discussions, and giving presentations.

1. Participate in lecture: In lecture sessions, we will discuss the science of origins, working our way forward from the 17<sup>th</sup> century to today. During each lecture session, we will organize various activities designed to engage you with the material.
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 once a week, leading discussions, contributing to these discussions, and making presentations.

Triweekly assignments: This course is structured as a set of four roughly three week long modules. During each, we will offer you the opportunity to explore the topics we've touched on more deeply in a "triweekly assignment". Each of these triweeklies will offer up a number of

choices, usually involving work done in a number of different styles; some purely written, others involving calculations or various forms of creative expression. You should pursue choices which excite you – this will lead to better work and greater contributions to the class.

**Evaluation and grading:** There will be two very different kinds of evaluation happening in this class.

The first will be done by you, 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 “gameful” way using the Gradecraft system.

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 very well.

To receive any grade above B+ you have to do two things. First, you have to earn enough points. But merely earning points isn't enough: you also have to unlock the A – to demonstrate that all of that work you've done adds up to something more than just a lot of points. To unlock an A you'll have to complete a final assignment explaining how the body of work you've done during the term fits together into a coherent whole – you have to make the case for your A. Anyone who receives enough points but doesn't successfully unlock the A will receive a B+ grade.

Ways to earn points:

- Participate fully in a week of activities: For each full week in which you complete all the required activities, you'll earn weekly engagement points. Partial weeks don't earn points. If you miss out on some piece and don't get points that week, there are always other ways to earn them. Regular engagement is really more of a social expectation: both your instructors and your peers will expect you to participate and benefit from what you contribute. When you don't participate, your peers are harmed, and your reputation as a member of the community suffers. This is much more important than losing points.
- Complete triweekly assignments: Each triweekly assignment can earn base and possibly bonus points. To earn base points, you must turn in complete, engaged, and original work which meets the requirements. If you participate in a round of peer review and revision, using insights from your classmates and graders, you will have the chance to earn bonus points as well. To access this revision process, you must turn in your complete assignment on the triweekly draft dates – one week before the final due dates. Triweeklies turned in for the first time on the final dates can only earn base points.
- 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 written and oral form to both your instructors and your peers. ABCs will each have their own point system and will be collected for grading on a weekly basis.

Point values:

- Weekly participation badges: 10,000 points per week for the first six weeks, then 5,000 points per week for the last seven weeks.
- Triweekly badges: 30,000 points each
- Triweekly revision/bonus points: 0-20,000 points. You can unlock these points by participating in a round of peer review and revision. Very good, responsibly revised triweekly assignments will receive 5,000 bonus points, once-in-a-lifetime completely reimagined work will receive 20,000, top quartile work might get 10,000.
- Assignments by choice: various, from 1,000 points to 120,000 points

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

- A: More than 250,000
- A-: 230,000 – 250,000
- B+: 210,000 – 230,000
- B: 190,000 – 210,000
- B-: 170,000 – 190,000
- C+: 150,000 – 170,000
- C: 130,000 – 140,000
- C-: 110,000 – 130,000
- D: 90,000 – 110,000
- E: Less than 90,000

Three different ways to just get into the A-/A range:

- Strategy 1: 235,000 points (The standard approach with very good work...)
  - Participate fully for all 13 weeks: this earns you  $6 \times 10,000 + 7 \times 5,000 = 95,000$  points
  - Complete all four of the triweekly assignments and earn  $4 \times 30,000 = 120,000$  points, plus perhaps partial credit for the revision bonus points  $4 \times 5,000 = 20,000$  points
- Strategy 2: 240,000 points (Focus your effort, get a few weeks off...)
  - Participate fully for all 12 weeks: this earns you  $6 \times 10,000 + 7 \times 5,000 = 95,000$  points
  - Complete three of the four triweekly assignments: badges earn  $3 \times 30,000 = 90,000$  points, but do them exceptionally well and revise carefully to get most of the available bonus points  $3 \times 10,000 = 30,000$  points
  - Do a several medium-size ABCs to earn at least 25,000 points.
- Strategy 3: 250,000 points (go your own way, doing non-standard things)
  - Participate fully for 8 weeks during the term:  $6 \times 10,000 + 2 \times 5,000 = 70,000$  points

- Complete three of the four triweekly assignments: badges earn  $3 \times 30,000 = 90,000$  points, but do them well, and get many of the bonus points  $3 \times 10,000 = 30,000$  points
- Do several small and at least one large ABC to earn at least 60,000 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.