

An 15: HUMAN EVOLUTION SYLLABUS  
Fall 2019

**Hours:** T TH 2:30 – 4 pm

**Units:** 3-0-6

**Room:** 104 Watson

**Instructor:** Dr. Bridget Alex

**Email:** balex@caltech.edu

**Office:** 312 Baxter

**Office Hours:** Thursdays 1-2 pm or by appointment

**Course description:** How do we know how humans evolved? This course will investigate evidence and methods used to reconstruct human evolution. We will review 8 million years of evolutionary history, focusing on the origins of defining features of our species such as bipedalism, tool use, cumulative culture, and advanced cognition. We will evaluate interpretations of the past using different lines of evidence including genetic and fossil data, the archaeological and ethnographic records, and comparisons with living primates. Theoretically, we will rely on concepts from evolutionary biology and anthropology, like adaptation, phylogenetics, life history theory, behavioral ecology, and gene-culture coevolution. The course will conclude with modern human diversity and recent evolution.

**Course goals:**

*Content:*

- Identify traits that distinguish humans from other primates
- Evaluate hypotheses for when and why these traits evolved using evidence from fossils, genetics, archaeology, ethnographic studies, and primatology
- Summarize key biological/behavioral transitions in human evolution
- Recognize major hominin taxa and artifact types

*Skills:*

- Interpret evidence and evaluate hypotheses in paleoanthropology
- Read and critique scientific research
- Distinguish, comprehend, and evaluate different sources including research papers, reviews, commentaries and news
- Propose future research

**Course format:** Meets twice weekly for 1:25 hour sessions. Lecture and class discussions. Four classes will include collaborative quizzes.

**Grading policy:** Letter or pass/fail

**Required reading:** No textbook. Readings comprise articles or book chapters posted on course website as pdfs or hyperlinks.

**Assignments summary:**

Pre-course survey.....	1 point
Introductory meeting.....	3
Journal Club Leader.....	20
Problem sets.....	40 (20 pts each)
Collaborative quizzes.....	60 (15 pts each)
Participation.....	5
Mock Research proposal	
Draft.....	10
Pitch.....	5
Final.....	20
Post-course survey.....	1
<b>Total.....</b>	<b>165</b>

**Assignments details:**

**1) Pre/post course surveys:** Before the second and after the last class meetings students will complete a survey about your understanding of course concepts. Neither survey is graded for accuracy. You will receive full credit for completing them. [1 point each]

**2) Instructor meeting:** During the first two weeks of class you will schedule a 10-minute meeting with your Instructor to introduce yourself and discuss course goals. [2 points]

**3) Journal Club Leader:** Lead a ~20 minute discussion of a recent scientific article and associated publications. Modeled after journal clubs common in research groups. [20 points]

**4) Problem sets:** Outside of class time, you will answer research questions by analyzing data from primate, archaeological, fossil, and genomic research. Collaboration permitted but not required. [2 p-sets, 20 points each]

**5) Collaborative quizzes:** There will be four in-class quizzes during the semester. The first 15 minutes you will complete the quiz alone (10 points). The next 20 minutes you will re-take the quiz in small collaborative groups (5 points). Anyone absent from class may take the quiz on their own without notes, internet, or collaboration. [4 quizzes, 15 points each]

**6) Participation:** Come to class prepared to discuss the assigned reading and completed p sets. Listen to classmates and contribute thoughtful comments, which demonstrate engagement with the assigned reading and flow of the discussion [5 points].

**7) Mock Research Proposal:** You will conceive a research project, which you would conduct if freed of the limitations imposed by time, resources, and expertise. It should be your dream project in paleoanthropology, considering all the approaches and topics we

have discussed in class. Still, it must be feasible with state-of-the-art methods and samples that are existing or attainable. The proposal will be 2 pages single-spaced, including background, question, proposed methods and significance. You will be provided feedback on a draft (*10 points*) and during a 5-minute oral pitch to the class for fictitious funding (*10 points*). The final written proposal (*20 points*) is your culminating assignment for class.

### **Attendance:**

We will generate knowledge during class meetings that may not be replicated in posted materials and assigned readings. **Attending class will enhance your enjoyment and mastery of course material.** Attendance is expected and will be reflected in your class participation points. **Every student has two free “class passes”:** you can miss class up to two times without penalty, no questions asked. Just email your instructor and state you are using a “class pass” that meeting. Additionally, students may miss class for **excused absences** such as emergencies due to health and personal life, employment or graduate school interviews and athletic competitions. In this case you should provide documentation (e.g. doctor’s note) or email the Instructor to request permission prior to class. These requests will be evaluated on a case-by-case basis.

### **Late assignments:**

Written assignments are due at or before the posted deadline, unless there is an emergency. **In most cases extensions will be granted provided they are requested at least 3 days prior to the assignment due date.** Late submissions without prior permission will be penalized 2% per day. If you have technical difficulties submitting an assignment, directly email it to your instructor along with screenshots showing the file, the final time it was edited, and the technical issue preventing you from submitting the assignment.

### **Academic Integrity Policy:**

You are expected to abide by the Caltech Honor Code: “No member of the Caltech community shall take unfair advantage of any other member of the Caltech community.” In An 15, discussion and the exchange of ideas are encouraged. However, written work should reflect your own thoughts, inspired by class readings and lectures. **Problem set instructions will specify outside sources that are permitted or prohibited. You may collaborate with others, but the submitted document must be written independently. You must also state your collaborators. Quizzes taken outside of class must be completed independently without notes or internet.** You must also adhere to standard citation practices in this discipline. Properly cite any books, articles, websites, lectures, etc. that have helped you with your work.

**Accessibility and accommodations:** I am committed to providing an accessible academic setting. The Accessibility Office offers a variety of accommodations and services to students with documented disabilities. Please visit <http://cass.caltech.edu/>

SUN	MON	TUES	WED	THURS	FRI	SAT
Sep 29 <b>Week 1 Evolution</b>	30	1 <i>Intro</i>	2	3 <i>Evo Theory, Speciation</i>	4	5
6 <b>Week 2 Primates</b>	7	8 <i>Ecology</i>  Journal club (J club)	9	10 <i>Behavior</i>  J club	11	12
13 <b>Week 3 Hominin divergence</b>	14	15 <i>Foragers, WEIRD people</i>  Quiz 1	16	17 <i>LCA, first hominins</i> J club Problem set (P set) 1 post	18	19
20 <b>Week 4 Hominin radiation</b>	21	22 <i>Australopiths</i>  J club	23	24 <i>Tools, archaeology</i>  P set 1 DUE	25	26
27 <b>Week 5 Homo</b>	28	29 <i>early Homo</i>  J club	30 Midterms →	31 <i>Middle Pleistocene</i>  Quiz 2	Nov 1	2
3 <b>Week 6 Late Pleistocene</b>	4	5 <i>Neanderthals</i>  J club	6	7 <i>Denisovans, Hobbits</i>  J club P set 2 post	8	9
10 <b>Week 7 Modern behavior</b>	11	12 <i>H. sapiens</i>  J club	13	14 <i>Global dispersals</i>  P set 2 DUE	15	16
17 <b>Week 8 Global dispersals</b>	18	19 <i>Cooperation culture</i>  Quiz 3	20	21 <i>Language, symbolism,</i>  J club	22	23
24 <b>Week 9 Settling down</b>	25	26 <i>Agriculture, civilizations</i> Proposal draft DUE	27	28 Thanksgiving	29	30
Dec 1 <b>Week 10 Diversity today</b>	2	3 <i>Modern variation</i> Quiz 4	4	5 <i>Summary</i>  Proposal pitches	6	7 Study period →
8	9	10	11 Final exams →	12	13 Proposal final DUE	14

## Course Schedule

**Readings listed for a given day should be completed before the class meeting. Readings subject to change. Consult course website for up-to-date readings.**

### Week 1 – How Evolution Works

KEY CONCEPTS: theory of evolution, evolutionary forces (selection, mutation, gene flow, genetic drift), adaptation, speciation, phylogenetics, geologic timescale

KEY QUESTIONS:

- What is the theory of evolution?
- What types of evidence are used to study evolution?
- How does speciation occur?
- How are phylogenies constructed?

#### Oct 1, Class 1: Intro

##### OPTIONAL READING

For an approachable introduction or review of evolutionary theory skim book, posted as pdf. Intro, Ch 2-4, 8 most relevant to our course, though some points are out of date:

Coyne, J.A., 2009. *Why Evolution is True*, Oxford: Oxford University Press.

#### Oct 3, Class 2: Evolutionary Theory and Speciation

##### BACKGROUND READING

Fuentes, A., 2018. How Humans and Apes Are Different, and Why It Matters. *Journal of Anthropological Research*, pp.151–167.

##### JOURNAL CLUB

Alex, B., 2018. Hopeful Monsters. *Discover Magazine*, Sept, pp. 62-66.

Ackermann, R.R. et al., 2019. Hybridization in human evolution: Insights from other organisms. *Evolutionary Anthropology: Issues, News, and Reviews*, 28(4), pp.189–209.

### Week 2 – Meet the Primates

KEY CONCEPTS: primate phylogeny, social structure, life history theory, ancestral/derived, homoplasy/homology

KEY QUESTIONS:

- Why study primates to understand human evolution?
- What are the major clades of primates?
- What is unique about humans compared to other primates?

### Oct 8, Class 3: Primate phylogeny and ecology

#### BACKGROUND READING

Boyd, R. & Silk, J.B., 2014. **Chapter 5 Primate Diversity and Ecology**. In *How Humans Evolved*. 7<sup>th</sup> ed. New York: WW Norton & Company. pp 109-143.

#### JOURNAL CLUB

Venditti, C., 2017. News and Views: Eating away at the social brain. *Nature Ecology & Evolution*, 1, pp.1–2.

DeCasien, A.R., Williams, S.A. & Higham, J.P., 2017. Primate brain size is predicted by diet but not sociality. *Nature Ecology & Evolution*, 1, pp.1–7.

### Oct 10, Class 4: Primate behavior

#### BACKGROUND READING

Pg 23-50. Marks, J., 2002. *What It Means to be 98% Chimpanzee*, Berkeley: University of California Press.

#### JOURNAL CLUB

Kühl, H.S. et al., 2016. Chimpanzee accumulative stone throwing. *Nature Scientific Reports*, pp.1–8.

“Ritualized behavior? Chimps all throw rocks at the same tree” *Ars Technica*. 3/2/2016. <https://arstechnica.com/science/2016/03/ritualized-behavior-chimps-all-throw-rocks-at-the-same-tree/>

“Is this proof chimps believe in God? Scientists baffled by footage of primates throwing rocks and ‘building shrines at sacred tree’ for no reason” *The Daily Mail*. 3/3/2016. <http://www.dailymail.co.uk/sciencetech/article-3475816/Is-proof-chimps-believe-God-Scientists-baffled-footage-primates-throwing-rocks-building-shrines-sacred-tree-no-reason.html>

### Week 3 – Hominin divergence: From what to what in human evolution

KEY CONCEPTS: forager ecology, last common ancestor, genetic dating, chronometric dating, hominin divergence, bipedalism

#### KEY QUESTIONS:

- What characterizes human socioecology?
- What features were likely present in our last common ancestor with chimpanzees and the earliest hominins?
- How do we date evolutionary events?
- What are evolutionary hypotheses for the origins of bipedalism?

### **Oct 15, Class 5: Representative Modern Humans**

#### BACKGROUND READING

Henrich, J., Heine, S.J. & Norenzayan, A., 2010. The weirdest people in the world? *Nature*, 466, p.29.

Marlowe, F.W., 2005. Hunter-gatherers and human evolution. *Evolutionary Anthropology: Issues, News, and Reviews*, 14(2), pp.54–67.

#### COLLABORATIVE QUIZ 1

### **Oct 17, Class 6: LCA and putative hominins**

#### BACKGROUND READING

Chapter 2, “Understanding Apes: How We Became Biped.” Lieberman, D.E. 2013. *The Story of the Human Body*. New York: Pantheon Books.

Alex, A. & Moorjani, P. 2017. DNA dating: How molecular clocks are refining human evolution’s timeline. *The Conversation*. 4/6/2017

#### JOURNAL CLUB

Grabowski, M., Hatala, K.G. & Jungers, W.L., 2018. Body mass estimates of the earliest possible hominins and implications for the last common ancestor. *Journal of Human Evolution*, 122, pp.84–92.

#### PROBLEM SET 1 POSTED

### **Week 4 – Hominin radiation**

KEY CONCEPTS: Australopiths, paleodiet, isotopic analysis, lithic analysis, Lower Paleolithic

#### KEY QUESTIONS:

- Who were the Australopiths?
- How do we reconstruct lifestyles of Australopiths?
- What can we learn about human evolution from stone tools?

### **Oct 22, Class 7: The era of Australopiths**

#### BACKGROUND READING

Pg 114-129. Stringer, C. & Andrews, P., 2011. *The Complete World of Human Evolution*, London: Thames and Hudson.

#### JOURNAL CLUB

Joannes-Boyau, R. et al., 2019. Elemental signatures of *Australopithecus africanus* teeth reveal seasonal dietary stress. *Nature*, 572, pp.112-115.

Tacail, T. et al., 2019. Calcium isotopic patterns in enamel reflect different nursing behaviors among South African early hominins. *Science Advances*, 5, p.eaax3250.

## Oct 24, Class 8: Tool-making and the archaeological record

### BACKGROUND READING

“Stone Cold Science.” B. Alex. *Discover Magazine*, pp. 64-68. 11/2017.

Shea, J.J., 2017. Occasional, obligatory, and habitual stone tool use in hominin evolution. *Evolutionary Anthropology*, 26(5), pp.200–217.

### PROBLEM SET 1 DUE / DISCUSSED

## Week 5 – The Genus *Homo*, the first hunter-gatherers

KEY CONCEPTS: *Homo erectus*, *Homo heidelbergensis*, *Homo floresiensis*, *Homo naledi*, dispersal, glacial periods, paleoenvironmental reconstructions

### KEY QUESTIONS:

- How did *Homo erectus* double in body and brain size ~2 Ma?
- What new behaviors emerged with *Homo erectus*?
- What evolutionary changes occurred during the Middle Pleistocene?
- How do we reconstruct paleoenvironment?

## Oct 29, Class 9: *Homo erectus* the trailblazer

### BACKGROUND READING

Anton, S.C., Potts, R. & Aiello, L.C., 2014. Evolution of early Homo: An integrated biological perspective. *Science*, 345(6192), pp.1236828–1236828.

### JOURNAL CLUB

Bramble, D.M. & Lieberman, D.E., 2004. Endurance running and the evolution of Homo. *Nature*, 432, pp.345–352.

Pickering, T.R. & Bunn, H.T., 2007. The endurance running hypothesis and hunting and scavenging in savanna-woodlands. *Journal of Human Evolution*, 53(4), pp.434–438.

Lieberman, D.E. et al., 2007. The evolution of endurance running and the tyranny of ethnography: A reply to Pickering and Bunn (2007). *Journal of Human Evolution*, 53(4), pp.439–442.



## Oct 31, Class 10: Middle Pleistocene

### BACKGROUND READING:

“Meet *Homo naledi*: The Mysterious Human Cousin,” B. Alex. *Discover*. August 6, 2019. <http://blogs.discovermagazine.com/crux/2019/08/06/meet-homo-naledi-the-mysterious-human-cousin/#.XZEC2CVrz5A>

Buck, L.T. & Stringer, C.B., 2016. Homo, Diversification of. In *Encyclopedia of Evolutionary Biology*. Elsevier Ltd., pp. 225–235.

### COLLABORATIVE QUIZ 2

## Week 6 – Late Pleistocene Contemporaries

KEY CONCEPTS: *Homo neanderthalensis*, Denisovans, *Homo floresiensis*, ancient DNA, hybridization, Middle Paleolithic

### KEY QUESTIONS:

- Which other lineages of humans coexisted with *Homo sapiens*?
- How did modern humans compare to Neanderthals and Denisovans in terms of morphology, behavior, and genetics?
- What questions can and cannot be answered by aDNA?

## Nov 5, Class 11: Neanderthals

### BACKGROUND READING

Roebroeks, W. & Soressi, M., 2016. Neandertals revised. *Proceedings of the National Academy of Sciences*, 113(23), pp.6372–6379.

### JOURNAL CLUB

Duveau, J. et al., 2019. The composition of a Neandertal social group revealed by the hominin footprints at Le Rozel (Normandy, France). *Proceedings of the National Academy of Sciences*, 116(39), pp.19409–19414.

Trinkaus, E., Samsel, M. & Villotte, S., 2019. External auditory exostoses among western Eurasian late Middle and Late Pleistocene humans M. D. Petraglia, ed. *PLOS ONE*, 14(8), p.e0220464.

## Nov 7, Class 12: Denisovans and Hobbits

### BACKGROUND READING

“Meet the Denisovans.” B. Alex. *Discover Magazine*. 12/2016.

### JOURNAL CLUB

Gokhman, D. et al., 2019. Reconstructing Denisovan Anatomy Using DNA Methylation Maps. *Cell*, 179(1), pp.180–192.e10.

John Hawks weblog, “Can methylation of DNA in ancient bones really predict the morphology of Denisovans?” <http://johnhawks.net/weblog/reviews/epigenetics/denisova-methylation-morphology-2019.html>

PROBLEM SET 2 POSTED

### **Week 7 – Modern Human Origins and Spread**

KEY CONCEPTS: *Homo sapiens*, Upper Paleolithic, dispersals, population history

KEY QUESTIONS:

- What morphological, behavioral or genetic traits distinguish *Homo sapiens*?
- How do we define modern humans?
- When did modern humans spread to different parts of the planet? What biological and cultural adaptations were necessary?
- What are hypotheses for the extinctions of non-*sapiens* human lineages?

**Nov 12, Class 13: *Homo sapiens***

BACKGROUND READING  
TBD

JOURNAL CLUB  
TBD

**Nov 14, Class 14: Global dispersals and extinctions**

BACKGROUND READING  
“The World is Our Niche,” B. Alex *Discover*. April 2019.  
<http://discovermagazine.com/2019/april/the-world-is-our-niche>

Nielsen, R. et al., 2017. Tracing the peopling of the world through genomics. *Nature*, 541(7637), pp.302–310.

PROBLEM SET 2 DUE / DISCUSSED

### **Week 8 – Modern behavior**

KEY CONCEPTS: modern behavior, cumulative culture, gene-culture coevolution, cooperation, language, art, religion

KEY QUESTIONS:

- When and why did humans gain the capacity for symbolic thought?

- How does human language differ from animal communication systems? How can we study the evolution of language?
- How has culture shaped human evolution?
- What are evolutionary explanations for art and religion?

### **Nov 19, Class 15: Cooperation and culture**

BACKGROUND READING  
TBD

QUIZ 3

### **Nov 21, Class 16: Language and symbolism**

BACKGROUND READING  
Fitch, W.T., 2017. Empirical approaches to the study of language evolution. pp.1–31.

JOURNAL CLUB  
TBD

## **Week 9 – Settling down: agriculture and civilizations**

KEY CONCEPTS: domestication syndrome, cultivation, agriculture, civilization

KEY QUESTIONS:

- What changes do species undergo during the domestication process?
- What were the causes and consequences of humans adopting agriculture?

### **Nov 26, Class 17: From foragers to farmers**

BACKGROUND READING  
Diamond, J., 2002. Evolution, consequences and future of plant and animal domestication. *Nature*, 418, pp.700–707.

Dugatkin, L. & Trut, L., 2017. How to Tame a Fox and Build a Dog. *American Scientist*, 105(4), pp.240. <https://www.americanscientist.org/article/how-to-tame-a-fox-and-build-a-dog>

PROPOSAL DRAFT DUE

### **Nov 28, No class: Thanksgiving**

## **Week 10 – Human diversity today**

KEY CONCEPTS: genetic ancestry, race, population genetics, recent evolution, evolution understanding/acceptance in America

**KEY QUESTIONS:**

- What traits are shared by all living humans?
- How do living human populations differ at a biological level?
- Do ethnicity, ancestry, and race have biological meanings?
- What are examples of recent human adaptations?
- What are barriers to understanding and accepting human evolution?

**Dec 3, Class 18: Variation among living humans**

## BACKGROUND READING

Chapter 6, “Race and Ancestry: How Our Genes Connect and Divide Us.” In *DNA is not destiny*, Heine, S.J., 2017. New York: W.W. Norton & Company.

## QUIZ 4

**Dec 5, Class 19: Wrap Up**

## PROPOSAL PITCHES

**Friday Dec 13 Final Proposal DUE**