Fall 2019

**Bio 11.07: Major Events in the History of Life & The Human Genome**

Instructor: Prof. Kevin J. Peterson, 321 LSC

Meeting time: 10A TTH 10:10 AM-12:00 PM; X hour Wednesday 3:30-4:20 PM, Room 201 LSC

Office Hours:

Monday 2:15-4:15 PM Rm 200 LSC

Tuesday 2:00-4:00 PM LSC 321

Wednesday 10:30 AM-12:30 PM 321 LSC

Friday 2:15-4:15 PM 200 LSC or by appointment

Readings: Journal articles are uploaded on Canvas.

Over the course of the last 4.5 billion years, Life has faced a number of challenges, and in response has evolved a number of remarkable innovations. These innovations are written in DNA, and thus molecular fossils for many of the major events in the history of life can be found within our very own genomes. This course will survey the human genome, and each week we will take one gene and pursue the contextual geologic and genetic fossil records of this gene to explore a major theme in Biology, whether Evolution, Information, Speciation, Communication, or Extinction.

**Schedule**

I. "Evolution: *18S rDNA* and the Genealogy of Life" (9/17-9/19)

Xhr (9/18): Cladistics and phylogenetic trees.

II. "Information: *RPS3* and Molecular Fossils of an Ancient RNA World" (9/24-10/01)

Xhr (9/25): Northern Analyses.

III. "Individualization: *ERVW-1* (*Syncytin-2*) and The Origin of Cells, Selfish Genes, and Higher Selectable Units" (10/03)

Xhr (10/02): Review for First Quiz on Event I (Evolution)

**10/03 (5:30-7:30 PM Room 100): First Quiz**

IV. "Metabolism: *SOD1*, Photosynthesis, the Rise of Atmospheric Oxygen, and the Origin of Eukaryotes" (10/08-10/10)

Xhr (10/09): Review for Second Quiz on Event II (Information) and Event III (Individualization)

**10/10 (5:30-7:30 PM Room 100): Second Quiz**

V. "Reproduction: *BRCA2*, Mitosis, and the (Convergent?) Evolution of DNA" (10/15-10/17)

Xhr (10/16): Review Session for Midterm

**TAKE HOME MIDTERM EXAMINATION AVAILABLE Wednesday October 16TH OVER EVENTS I-IV. EXAM IS DUE Wednesday October 23 RD AT 3:30PM.**

VI. "Speciation: *SOX3*, and the Origins of Sex, Sexual Selection, and Sexual-Somatic Conflict" (10/22-10/24)

Xhr (10/23): Southern analyses.

VII. "Interaction: *HOXB6* and the Cambrian Explosion of Life" (10/29-10/31)

Xhr (10/30): Gene trees.

VIII. "Regulation: *DLX5*, the Origin of Limbs, and the Terrestrialization of Planet Earth" (11/05)

Xhr (111/06): Review for Third Quiz on Events V (Reproduction), VI (Speciation) & VII (Interaction)

**11/07 (5:30-7:30 PM Room 100): Third Quiz**

IX. "Communication: *FOXP2* and the Rise of Humans and Human Language" (11/07-11/12)

(11/13): What does "race" mean to you (Discussion)?

X. "Extinction: KERATIN5/6A and the Genetic Legacies of Extinct Lineages" (11/14-11/19)

Wednesday November 20th (X-hour): Wrap-up and Review for Final.

**FINAL EXAMINATION Monday Nov 25th 3:00 PM OVER EVENTS V-X**

**Text Book**

There is no required textbook. Instead, readings for each week are posted on Canvas, as are the weekly PowerPoint presentations. Nonetheless, feel free to purchase any text book that you like or have easy access to – going over certain topics (e.g., protein synthesis, mitosis etc.) will certainly help you better understand the topic, but it should not be necessary in order to understand the intent of or the material presented within the lecture. At the end of this syllabus I also provide a recommended list of books organized by each weekly topic for you to purse at your leisure.

**Grading**

Assessment in this course is divided into exams and quizzes. First, there are two examinations, each worth 35% of your final grade. The first exam (the midterm) is an open-note open-reading take home examination that covers Events 1-4. Although open note, this exam is not to be done in collaboration with any other student(s), and you are not allowed to discuss the exam in any manner with other students (past or present). The midterm is due at the beginning of class (X-hr); late exams will be assessed a 25% penalty. The final exam, which covers Events 5-10, is an in-class exam, but like the midterm is open note, open reading, and again not done in collaboration with any other student. During both exams access to Canvas is allowed, but you are prohibited for searching for items of information on the internet (this is actually for your own benefit!).

Second, there are three quizzes each worth 10% of your grade. These are closed note, closed reading assessments that take place on Thursday evenings. Although each quiz period is two hours long, the quiz will be written as if you were taking it during X hr so I would expect you to finish it within 50 minutes. Each quiz covers slightly more material than the preceding quiz (see the syllabus for details).

Homework is not graded, but instead is intended to help you with particular subject matters, especially as it relates to specific biological techniques relevant to that's week's lecture/material. Feel free to work with friends, dorm buddies etc. on the homework.

If you have any questions at any time please ask!

**Weekly Schedule**

Each week we will have lecture on Tuesday and Thursday in the 10A time slot. During X-hr at 3:30 PM on Wednesdays we will either lecture over information required for your homework, review for a quiz or an examination, or have a discussion. On Mondays and Fridays from 2:15-4:15 PM I will hold group office hours in Room 200 of the LSC. On Tuesday afternoon from 2-4 and Wednesday morning from 10:30-12:30 I will hold individual office hours in my office Room 321 LSC. I am happy to meet with students individually at other times - email to make an appointment.

Each week's materials except the powerpoint files (for example, the homework, readings etc) will be made available by Sunday of that week. I will post the lecture pptx file by Monday night at the latest and the Wednesday X-hr file (assuming there is one) by noon of that day. If there are any problems with any of the files PLEASE EMAIL ME. Sometimes things look fine on my end but don't on yours and the only way for me to know that there is a problem is for you to let me know.

If you wish to take part in religious observance(s) that occur during this academic term that conflict with your participation in the course, please meet with me before the end of the second week of the term to discuss appropriate accommodations.

**Laptop Policy**

The use of laptops in class is perfectly fine; all I ask is that you be respectful of those around you and stay off sites that might distract not only you, but (and more importantly) those around you (e.g., Facebook, ESPN, email etc).

**Student Needs**

Students with disabilities enrolled in this course and who may need disability-related classroom accommodations are encouraged to make an appointment to see me before the end of the second week of the term. All discussions will remain confidential, although the Student Accessibility Services office (http://www.dartmouth.edu/~accessibility/facstaff/) may be consulted to discuss appropriate implementation of any accommodation requested.

I recognize that the academic environment at Dartmouth is challenging, that our terms are intensive, and that classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including: your undergraduate dean (http://www.dartmouth.edu/~upperde/), Counseling and Human Development (http://www.dartmouth.edu/~chd/), and the Student Wellness Center

(http://www.dartmouth.edu/~healthed/). Please do not hesitate to utilize these resources, and if there is anything I can do as well, come speak with me at your convenience.

The only financial commitment to this course is access to a personal computer, and if you ever are having computer problems, or the means to acquire a computer, please let me know right away.

**Study Groups**

The Tutor Clearinghouse offers study groups to students enrolled in Bio11. Study Groups offer enrolled students the opportunity to engage, in a group environment, with former students who have taken this course and done well. Study Groups meet once/week for 1.5 hours to review questions/concerns about material currently being studied. This format also allows students to develop a deeper understanding/wider perspective of the course material by engaging with others and hearing questions about the material that they, themselves, might not have considered. To learn more about the Study Group program, go to: www.dartmouth.edu/~acskills/tutors/index.html and click on the link for STUDY GROUPS. To register for a study group, go to: www.studygroups.dartmouth.edu and authenticate with your NetId and password. Then choose which study group is of interest and register. For additional support for your leaning see the Academic Skills Center at: *http://www.dartmouth.edu/~acskills/.* There is no charge to join a study group.

**Honor Principle**

Please review Dartmouth's Honor Principle (http://www.dartmouth.edu/judicialaffairs/honor/index.html). I take this principle seriously and have full faith that you do and will as well. I have strict instructions about what is versus what is not allowed with the take home midterm examination, the in-class quizzes, as well as the final. I will discuss these rules, and their rationale, in class. If you ever have any questions about the Honor Principle and my expectations please email me or stop by so we can discuss in person.

**Bio11 Spaces**

It is important for me to emphasize that ALL Bio11 spaces, whether the classroom, study group rooms, group study sessions, or my office, respects all people including race, ethnicity, gender expression, gender identity, sexual orientation, socio-economic background, age, religion, body shape, size, and ability. Violations of this policy will not be tolerated.

**Summer Fun-Time Reading List**

A few recommended summer fun-time reads that inspired this course (more topic-specific orientated books are given for each major event below):

Davies, K. (2001). *Cracking the Genome: Inside the Race to Unlock Human DNA*. The Johns Hopkins University Press. Baltimore. An interesting account of the race to sequence the (a) human genome.

http://www.amazon.com/Cracking-Genome

Ridley M. (1999, reprinted 2006). *Genome: The Autobiography of a Species in 23 Chapters*. HarperCollins. New York. One of my all-time favorite science reads and the ultimate inspiration for this course.

http://www.amazon.com/Genome-Autobiography-Species-23-Chapters

Lane, N. (2009). *Life Ascending: The Ten Great Inventions of Evolution.* W.W. Norton & Company. New York. Not one of my favorites, but the comparisons and contrasts both between his events and his perspective versus mine on the events we agree upon are somewhat interesting.

http://www.amazon.com/Life-Ascending

Smith J. M. & Szathmary E. (1999). *The Origins of Life: From the Birth of Life to the Origins of Language.* Oxford University Press. Oxford. Again, not one of my favorites but does cover many of the same events, but from a very different perspective.

http://www.amazon.com/Origins-Life

**I. Evolution**

Darwin (1859). *On the Origin of Species: A Facsimile of the First Edition.* Harvard University Press (1964). There are many MANY really great books on evolution, but the only must-read is the first and still the best.

https://www.amazon.com/Origin-Species

Shilts R. (1987). *And the Band Played On: Politics, People, and the AIDS Epidemic.* St. Martins Griffin, New York (20th Anniversary Edition, 2007). A magisterial account of the early history of the AIDS epidemic.

https://www.amazon.com/Band-Played-On

Weiner, J. (1995). *The Beak of the Finch.* Vintage. Weiner depicts the monumental efforts of Peter and Rosemary Grant on the evolution of the finches of the Galapagos Islands. A very worthwhile read.

https://www.amazon.com/Beak-Finch

**II. Information**

Judson H. F. (1996). *The Eighth Day of Creation: Makers of the Revolution in Biology.* Cold Spring Harbor Laboratory Press. Cold Spring Harbor. A remarkable read into some of the most remarkable people discovering utterly remarkable things about the underlying mechanisms of Life.

http://www.amazon.com/Eighth-Day-Creation

**III. Individualization**

Skloot R. (2011). *The Immortal Life of Henrietta Lacks*. Broadway Books. One of the better reads of the past few years, Skloot traces the history of the development of HeLa cells, one of the most important biomedical developments of the past 50 years, but also the immortal cells from a woman who died from cervical cancer, and who had no say into the development of this cell line. Skoot explores in great detail the ethics behind these decisions, and the impact they have had on the Lacks family. I highly recommend this book.

http://www.amazon.henrietta_lacks

**IV. Metabolism**

Knoll A. H. (2003). *Life On a Young Planet: The First Three Billion Years of Evolution on Earth.* Princeton University Press. Princeton and Oxford. A delightful read on life's "early days" (i.e., the first three billion years) on Earth.

http://www.amazon.com/Life-Young-Planet

Lane N. (2004). *Oxygen: The Molecule that Made the World.* Oxford University Press. Oxford. A fascinating foray into one of the most important, and - at least at the beginning - one of the rarest molecules on Earth

https://www.amazon.com/Oxygen

**V. Reproduction**

Davies K. & White M. (1996). *Breakthrough: The Race to Find the Breast Cancer Gene*. Wiley. New York. A worthwhile read just to explore the science and person behind the gene, Prof. Mary-Claire King.

http://www.amazon.com/Breakthrough-Race-Find-Breast-Cancer

Mukherjee, S. (2011). *The Emperor of all Maladies: A Biography of Cancer.* Scribner. A deeply personal perspective on the history of cancer and its impact on humans and human history over the past several millennia.

https://www.amazon.com/Emperor-All-Maladies

Watson, J. D. (1968). *The Double Helix: A Personal Account of the Discovery of the Structure of DNA*. Touchstone. New York. The infamous book by one of the co-discovers of DNA. Although a highly personal and readable account of the discovery, it generated intense ire in Watson's colleagues and, in particular, his co-discoverer Francis Crick, especially for Watson's inflammatory remarks about Dr. Rosalind Franklin.

https://www.amazon.com/Double-Helix

**VI. Speciation**

Birkhead T. (2000). *Promiscuity: An Evolutionary History of Sperm Competition*. Harvard University Press. Cambridge. A curious and, at times, hysterically funny examination of the ridiculousness of sex.

http://www.amazon.com/Promiscuity

Ridley M. (1993). *The Red Queen: Sex and the Evolution of Human Nature*. Penguin Books. New York City. A somewhat outdated book but still an excellent read about the origins and maintenance of sexual reproduction.

http://www.amazon.com/Red-Queen

**VII. Interaction**

Carroll S. (2006). *Endless Forms Most Beautiful: The New Science of Evo Devo.* W. W. Norton and Co. New York, London. An excellent introduction to the science of evolutionary developmental biology including a good overview of *Hox* genes.

http://www.amazon.com/Endless-Forms-Most-Beautiful

Gould S. J. (1989). *Wonderful Life: The Burgess Shale and the Nature of History.* W. W. Norton and Co. New York, London. For me, this was the tipping point between attending medical school or becoming a paleontologist – after I read this book I knew that paleontology is what I had to do. Highly controversial, it set the research agenda into the origin of animals for decades to come.

http://www.amazon.com/Wonderful-Life

## VIII. Regulation

Raff, R. (1996). *The Shape of Life: Genes, Development and the Evolution of Animal Form.* University of Chicago Press, Chicago. A panoramic perspective on the field of evolutionary developmental biology by one of the field's pioneers. A highly readable and very enjoyable book.

https://www.amazon.com/Shape-of-Life

Carroll, S. B. (2016). *The Serengeti Rules: The Quest to Discover How Life Works and Why it Matters.* Princeton University Press, Princeton NJ. Carroll demonstrates that the rules that apply to gene regulation in bacteria extend throughout all of life including the regulation of animal numbers in the Serengeti. A very interesting and enjoyable read.

https://www.amazon.com/Serengeti-Rules

## IX. Communication

Pinker S. (1994). *The Language Instinct.* William Morrow and Co. New York. A fascinating read into one of life's more remarkable evolutionary innovations.

http://www.amazon.com/Language-Instinct

Reich D. (2018). *Who We Are and How We Got Here: Ancient DNA and the New Science of Human Past*. Pantheon Books, New York. An interesting first person account of Reich's research into ancient DNA and how it impacts our understanding of recent human history.

https://www.amazon.com/WhoWeAre

Wade N . (2006). *Before the Dawn: Recovering the Lost History of our Ancestors*. Penguin Books. A somewhat outdated but still interesting account of the earliest days of our ancestors.

http://www.amazon.com/Before-Dawn

## X. Extinction

Alvarez, W. (1997). *T. rex and the Crater of Doom.* Princeton University Press, Princeton. A delightful first-person account of one of the most important discoveries of the 20th century, geological or otherwise.

https://www.amazon.com/Rex-Crater-Doom

Flannery, T. (2002). *The Eternal Frontier: An Ecological History of North American and Its Peoples.* Grove Press. A fascinating account of the history of North America over the last 65 million years.

http://www.amazon.com/eternal-frontier

Pääbo, S. (2015). *Neanderthal Man: In Search of Lost Genomes*. Basic Books. Although I did not care much for this book, Pääbo is "the man" when it comes to sequencing extinct genomes and this is a lucid description of the years of painstaking work to achieve this monumental accomplishment.

http://www.amazon.com/Neanderthal-Man-Search-Lost-Genomes

Papagianni, D. & Morse, M. A. (2015). *The Neanderthals Rediscovered: How Modern Science is Rewriting their Story* (Revised and Expanded Edition). Thames & Hudson. An outstanding treatment of our dearly-departed cousins.

http://www.amazon.com/Neanderthals-Rediscovered