

SEMESTER AT SEA COURSE SYLLABUS

Voyage: Fall 2014

Discipline: Biology

BIOL 1559-101: Modern Evolutionary Theory

Division: Lower

Faculty Name: John L. Dahl

Pre-requisites:

A high-school course that has covered basic molecular and cellular biology, botany, and zoology.

COURSE DESCRIPTION

The theory of evolution is a simple but elegant idea that species arose from a common ancestor and that new species continue to arise as a result of natural selection working on the biological diversity of existing populations. Evolutionary Biology is a cornerstone of modern science, and since its introduction by Charles Darwin over 150 years ago it has produced a dramatic paradigm shift in how humans view themselves and all life on the planet. The established truth of evolutionary theory has long been muddled and misinterpreted in American classrooms, which has contributed to over 40% of Americans claiming not to believe in human evolution. This course will explore the history of evolutionary theory, review scientific evidence for evolution—particularly focusing upon the explosion of insights provided by Molecular Biology in the past 20 years, discuss social implications of the theory of evolution, and examine modern challenges like infectious diseases, genetic modification of crops, and climate changes that are particularly interesting from the perspective of evolution. Several sites on the voyage will be significant with regards to the topic of Evolution. The Amazon Basin has contributed significantly to development of evolutionary theory, as did Argentina and South Africa where Darwin visited during his voyage on the *HMS Beagle*.

COURSE OBJECTIVES

1. To help students understand why it is important to understand modern evolutionary theory, what modern implications this theory has, and how it is one of the simplest and yet most powerful ideas in the history of human thought.
2. To have students understand how science operates ('scientific method') and the types of problems science can and cannot successfully address.
3. To show students the wide breadth of evidence that supports the fact of evolution by natural selection; evidence that draws from the areas of comparative anatomy, biogeography, paleontology, microbiology, and molecular biology.
4. To introduce students to the lives, life-styles, and discoveries of several historic figures that played major roles in the formulation of the evolutionary theory including Charles Darwin, Alfred Wallace, and numerous others.

5. To explore with students the impact that evolutionary theory has had on 19th -21st century world society, including the economic policy of the former USSR and fundamentalist Christian movements in the USA.
6. To provide students with a global perspective of evolutionary theory and an appreciation of the planet's biological diversity that has been made possible by evolution by natural selection.

REQUIRED TEXTBOOKS

AUTHOR: Jerry A. Coyne
TITLE: Why Evolution is True
PUBLISHER: Viking (Penguin)
ISBN #: 978-0-670-02053-9
DATE/EDITION: 2009/1st

AUTHOR: Charles Darwin
TITLE: The Voyage of the Beagle
PUBLISHER:
ISBN #:
DATE/EDITION: 2009/1st

TOPICAL OUTLINE OF COURSE

Depart Southampton- August 23:

A1- August 25: Introduction to the course and to its field program. Why understanding evolution matters- an example of disastrous crop failure in the Soviet Union

Questions to be Addressed:

- What is evolution and why do you need to know about it?
- Is evolution a fact or a theory?
- What is the evidence for evolution?

Reading Assignment:

Why Evolution is True (WEIT) Chpt. 1

Assignment Due Today:

Watch the PBS film *Evolution: Darwin's Dangerous Idea* (120 min) before next period

A2-August 27: A case for evolutionary thinking: Understanding Evolution of *Mycobacterium tuberculosis* drug resistance in Russia

Questions to be Addressed:

- Where did *M. tuberculosis* come from?
- What factors have driven the rise of drug resistance of tuberculosis?
- Is it possible to turn back the clock to bacterial sensitivity to drugs?

Reading Assignment:

Time bomb Cpt. 7 The Russian Style of TB Treatment (pdf)

Assignment Due Today:

Watch the PBS film *Evolution: Evolutionary Arms Race* (60 min) before next period

St. Petersburg: August 28- 31

A3- September 2: Biological definition of “race.” Social Darwinism. Evolution as political propaganda in Nazi Germany

Questions to be Addressed:

- Does the term “race” have any biological significance?
- What is the origin of the idea of a master (Aryan) race?
- What is eugenics philosophy?

Reading Assignment:

WEIT Chpt. 8, p. 212-216

Assignment Due Today:

Watch the movie *The Genius of Darwin*, pt 2 (first 30 min) and the movie *GATTACA* (106 min) before arriving in Hamburg

Hamburg: September 4-7

A4- September 8: Attempts to classify life’s diversity. The work of Linnaeus, Whittaker, and Woese. Beneath life’s diversity: the unit of the Cellular Theory of Life. Review of basic cell and molecular biology.

Questions to be Addressed:

- What characteristics have been used to group living things?
- How do you read and reconstruct phylogenetic trees?
- What are molecular similarities between all living things?

Reading Assignment:

Chpt. on diversity from a gen. biology text book (pdf)

Chpt. on classification from a gen. biology text book (pdf)

Assignment Due Today:

Watch the movie *Life on Earth*; episodes 3 and 6 (55 min each) before next period

A5-September 10: Basic evolutionary theory of Darwin: Diversity in populations and Natural selection and adaptation.

Questions to be Addressed:

- How do artificial and natural selection differ?
- What does the history of life on planet Earth look like?
- What are some of the most amazing evolutionary adaptations?

Reading Assignment:

WEIT Chpt. 5

Assignment Due Today:

Quiz #1

Watch the movie *Life on Earth*; episodes 7 (55 min) before next period

Antwerp: September 11-13

Le Havre: September 14-15

A6- September 17: Diversity in populations (variation). Species and Speciation . Monoculture and the Irish Potato Famine: cases of missing genetic variation

Questions to be Addressed:

- What drives variation in species?
- Of what value is biological diversity to humans?
- What are different types of speciation?
- Is the term “species” applicable to all living things?

Reading Assignment:

WEIT Chpt. 5

Assignment Due Today:

Watch the movie *When Ireland Starved* (98 min) before arriving in Dublin

Dublin: September 19-22

A7-September 23: Origin of Life, Cambrian Explosion

Questions to be Addressed:

- What are different theories for the origin of life?
- How has life altered the planet?
- How did multicellular life begin?

Reading Assignment:

None

Assignment Due Today:

Watch the movie *Life on Earth* episode 1 (55 min) before the next period

A8- September 25: Age of Earth and the fossil record; Moroccan trilobites

Questions to be Addressed:

- What is a “missing link” and is it necessary to support the theory of evolution?
- How are fossils made and do they show gradual change?
- What are some of the most amazing fossil finds and what do they tell us?

Reading Assignment:

WEIT Chpt 2

Assignment Due Today:

Watch the movie *Life on Earth* episodes 5 and 8 (55 min each) before arriving in

Morocco.

Lisbon: September 26-27

In transit: September 28

Cadiz: September 29-30

Study day: October 1

Casablanca: October 2-5

A9- October 7: Molecular evidence of evolution

Questions to be Addressed:

- Does genome size matter?
- What is a “molecular clock”?
- Does non-coding DNA have evolutionary significance?

Reading Assignment:

None

Assignment Due Today:

Watch the movie *Journey of Man* (120 min) before next class period

Study Day: October 9

A10- October 10: HIV: the origin and evolution of a virus

Questions to be Addressed:

- Where did HIV come from?
- Why is it so hard to stop HIV?
- Why are some people naturally immune to HIV disease (AIDS)?

Reading Assignment:

Chpt. 1 from *Evolutionary Analysis* 4th edition (pdf copy)

Assignment Due Today:

Watch the movie *Origin of AIDS* (92 min) before the next period

A11- October 12: Population Genetics – Hardey-Weinberg equilibrium, Migration, Genetic Drift and Genetic Shift

Questions to be Addressed:

- Is evolution just a random process?
- What causes changes in gene frequencies?
- Why is it so hard to come up with an effective flu vaccine?
- How are malaria, genetic drift, and human migration all related?

Reading Assignment:

WEIT Chpt. 7

Assignment Due Today:

Quiz #2

Watch the film *American Experience: Influenza* (52 min) before the next class period

Takoradi: October 14-15

Tema: October 16-17

Study Day: October 18

A12- October 19: Human Evolution

Questions to be Addressed:

- Did humans evolve from chimpanzees?
- Who was “Mitochondrial Eve”?
- Do evolutionary forces drive the formation of culture and language?

Reading Assignment:

WEIT Chpt. 8

Assignment Due Today:

Watch the PBS movie *Evolution: The Mind’s Big Bang* (55 min) before arriving in

Tema

A13- October 21: Evolution in culture, art, film, and literature

Questions to be Addressed:

- How has human evolution been portrayed by Hollywood?
- What did paleoartists like Charles Knight contribute to public perception of evolution?
- What evolutionary themes appeared in the dystopian novels of H.G. Wells?

Reading Assignment:

A select chapter from *Galapagos* by Kurt Vonnegut

Assignment Due Today:

Watch the movie *The Island of Dr. Moreau* (99 min) before next period

Study Day: October 22

A14- October 24: Extinction

Questions to be Addressed:

- How many massive extinctions have occurred in Earth’s history and why?
- Are humans driving the next great extinction?
- Why do individuals die?

Reading Assignment:

Nature article: The African coelacanth genome provides insights into tetrapod evolution. *Nature* (2013) 496: 311

WEIT Chpt. 3

Assignment Due Today:

Watch the movies *The Day the Earth Nearly Died* (49 min) and *Evolution: Extinctions* (55 min) before arriving in Cape Town

Cape Town: October 25-29

Study Day: October 30

A15- November 1: Evolution of whales; Evolution of “zombie” parasites

Questions to be Addressed:

- What are vestigial organs and what do they tell us about evolution?
- Why would mammals return to the sea?
- Can parasites alter behavior of an infected host to help spread the parasite?

Reading Assignment:

Selected chapter from *World War Z* (pdf)
WEIT Chpt. 2

Assignment Due Today:

None

Study Day: November 3

A16-November 4: Overview of Charles Darwin and the world circumnavigating voyage of HMS Beagle

Questions to be Addressed:

- What did Darwin discover on his voyage and how did the voyage change him?
- What was the real mission of the HMS Beagle?
- Was Darwin’s ideas of evolution really so new and why was there initially so much resistance to them by society?

Reading Assignment:

None

Assignment Due Today:

Watch the movie *Creation* (108 min) before the next class period

A17-November 6: Biogeography: the study of the distribution of species on Earth

Questions to be Addressed:

- What was so special about the Galapagos Islands?
- What is convergent evolution?
- How do island ecologies support the theory of evolution?

Reading Assignment:

WEIT Chpt. 4

Assignment Due Today:

Quiz #3

Watch the movie *Darwin’s Secret Notebooks* (50 min) before next class

Study day: November 7

A18- November 9: Evo-Devo: the evolution of development

Questions to be Addressed:

- What is a genetic tool kit?

- How could the great diversity of animals evolve from a common ancestor?
- What do you have in common with a fruit fly and what are hox genes?

Reading Assignment:

WEIT Chpt. 7

Assignment Due Today:

Watch the movie *Evolution: Great Transformations* (55 min) before next period

Buenos Aires: November 11-15

A19- November 16: Evolution and Sex: evolutionary reasons for sex and sexual selection

Questions to be Addressed:

- What evolutionary advantage can exist for the peacock's tail?
- What advantages and disadvantages does sexual reproduction provide?
- Do bacteria have sex?

Reading Assignment:

WEIT Chpt. 6

Assignment Due Today:

Watch the movie *Evolution: Why Sex?* (55 min) before next period

A20- November 18: Evolution of Social Behavior

Questions to be Addressed:

- What is inclusive fitness and kin selection?
- Does evolution drive the formation of altruistic social systems?
- What is a social cheater?

Reading Assignment:

None

Assignment Due Today:

None

Rio de Janeiro: November 19-21

Study day: November 22

A21- November 24: Current societal issues involving evolution

Questions to be Addressed:

- Are genetically-modified organisms (GMOs) health for consumption?
- Are use of GMOs ethical?
- How has forensic science called into question the death penalty?

Reading Assignment:

Assignment Due Today:

Quiz #4

Watch the movie *The World According to Monsanto* (108 min) before next class

Study day: November 26

A22- November 27: The debate over “Scientific Creationism” and Intelligent Design

Questions to be Addressed:

- What are creationist arguments look like?
- Does accepting the theory of evolution require one to become an atheist?
- Why is the theory of evolution such an emotionally charged issue for so many?

Reading Assignment:

WEIT Preface and Introduction

Assignment Due Today:

Watch the films *Judgment Day: Intelligent Design on Trial* (110 min) and *American Experience: The Monkey Trial* (90 min) before the next period

A23- November 29: (Enter the Amazon) Coevolution , Wallace and Bates explorations of the Amazon, and Sociocultural Evolution

Questions to be Addressed:

- What kinds of symbiotic relationships can co-evolution provide for?
- How do plants and animals influence one another’s evolution?
- What are the “ghosts of co-evolution”?
- How has evolutionary theory been applied to the study of human culture?

Reading Assignment:

Select chapter from *River of Doubt: Theodore Roosevelt’s Darkest Journey*

Assignment Due Today:

Quiz #4

Watch the movies *The Emerald Forest* (110 min) and *Titanboa* (53 min) before arriving in Manaus

Study day: November 30

Manaus: December 1-4

Study day: December 5

December 6: Exit Amazon

A24-December 7: Evolution and Ethics

Questions to be Addressed:

- “Why should the fifth ape love thy neighbor?”
- Can evolution produce altruistic behavior?
 - What is “the selfish gene” and can it be responsible for kindness? (Why do people donate blood?)

Reading Assignment:

WEIT Chpt. 9

Assignment Due Today:

Watch the film *The Genius of Darwin*, pt 2 (last 30 min), the PBS film *Evolution: What about God?*(55 min), and *Richard Dawkins presents The Genius of Darwin* part 1 and part 3 before the final exam

Study day: December 9

A25 – December 10: Final Exam

FIELD WORK

Field lab attendance is mandatory for all students enrolled in this course. Please do not book individual travel plans or a Semester at Sea sponsored trip on the day of our field lab.

***FIELD LAB** (At least 20 percent of the contact hours for each course, to be led by the instructor.)*

Idea #1: visit a zoo and a botanical garden in **Belgium**. The day of the field lab would begin at the **Antwerp Zoo**, which is one of the oldest zoos in the world (founded in 1843) and within walking distance of the ship. A visit to the zoo would include a focused study of two areas (the monkey and reptile houses). Following this visit the students will take a 36 km (30 min bus ride) from the zoo to the **National Botanic Garden of Belgium** on the northern side of Brussels. The group will be led on a 2 hour tour of “The Evolution House” (one of several greenhouses in the giant Plant Palace) that spans 500 million years of plant evolution from the Jurassic period to the present. <http://www.br.fgov.be/PUBLIC/GENERAL/universities.php>

Within 5 days of the visit, a 1000 word report on the topic “How a visit to a zoological and botanical garden enhanced my understanding of the evolutionary process”. Participation in the zoo visit and the quality of this report will constitute 20% of the student’s course grade.

Idea #2: Visit two sites in Cape Town South Africa. First visit will be to the Iziko Museum of South Africa, which has several exhibits of great interest including one of the world’s best exhibits on sharks (with a life-size model of the Megatooth Shark – likely the largest predator to ever exist on earth), a cast of the first coelacanth discovered, a whale skeleton collection, and an exhibit of Charles Darwin’s visit to Cape Town on his voyage on the Beagle. Perhaps the greatest attraction, however, is the collection of fossilized Karoo reptile-mammalian creatures that predate the dinosaurs by 100 million years and were eradicated during the Massive Permian Extinction. South Africa contains some of the best Permian rock formations in the world and our visit to the museum will be guided by Dr. Roger Smith who is the curator of the Karoo Paleontology exhibit in the museum and is considered a world expert on Permian vertebrate land animals. <http://www.iziko.org.za/museums/exhibitions/south-african-museum>

The second part of the field lab will involve a trip to the Two Oceans Aquarium which is 4 km distant in Cape Town. This aquarium highlights the Atlantic and the Indian Oceans of which South Africa sits juxtaposed to each. Students will be encouraged to observe examples of convergent evolution between species of the two oceans on display at the aquarium and record adaptations for numerous fish and invertebrates that foster evolutionary fitness for their unique environments.

Within 5 days of the visit, a 1000 word report on the topic “How visits to a paleontological or aquarium enhanced my understanding of the evolutionary process”. Students will be encouraged to include both drawings and photos in their reports. Participation in the Field Lab and the quality of this report will constitute 20% of the student’s course grade.

FIELD ASSIGNMENTS

- Students will keep a field journal of their experiences throughout the voyage with the intent of recording in drawings and descriptions flora and fauna they witness throughout the voyage. The purposes of this will to simulate the experience Charles Darwin had in his

historic voyage, to train students in the skills of naturalistic observations, and to allow students to develop their skills in scientific illustration.

- Towards the conclusion of the course (following immediately after the fifth quiz on Dec. 8th), students will orally present short power point presentations in which they show 2-4 slides containing photos of images they took during the entire length of the trip that illustrates some evolutionary principle/observation. During these short presentations, students will also point out some problem they observed during the trip that has some kind of evolutionary significance.

METHODS OF EVALUATION / GRADING RUBRIC

Teaching Methods:

Lectures and discussions will be the primary formats for delivering content in class and will be interspersed with application-related experiences and small group work. Student work will include small group projects and attendance and participation is expected for each lecture period.

Readiness concept: The responsibility to learn is fundamentally that of the student. In order to succeed in a new subject, students must be actively engaged in the process of learning. Preparation for each class is essential and requires that each student read the assigned readings, have deeply processed issues, and be able to express a point of view.

Course requirements and Evaluation:

Final course grade will be based upon the following percentages:

5 quizzes (10% each). Each quiz will consist of multiple choice, true/false, and short essays

Completed field and film journal (25%)

Student paper based upon field lab (20%)

Student final oral presentation on evolution - to be held during the Final exam period (5%)

Grade will be determined based upon the following final percentages of possible points:

A+	100 - 97.6%
A	97.5 - 92.6%
A-	92.5 - 90.0%
B+	89.9 - 87.6%
B	87.5 - 82.6%
B-	82.5 - 80.0%
C+	79.5 - 77.6%
C	72.6 - 77.5%
C-	72.5 - 70.0%
D+	69.9 - 67.6%
D	67.5 - 62.6%
D-	62.5 - 60.0%
F	59.9% and below.

RESERVE LIBRARY LIST

AUTHOR: Charles Darwin

TITLE: Origin of the Species by Means of Natural Selection
PUBLISHER:
ISBN #:
DATE/EDITION: (currently in SAS stacks)

AUTHOR: Richard Dawkins
TITLE: The Selfish Gene
PUBLISHER:
ISBN #:
DATE/EDITION: (currently in SAS stacks)

AUTHOR: Candice Millard
TITLE: River of Doubt: Theodore Roosevelt's Darkest Journey
PUBLISHER: Broadway Books
ISBN #: 0767913736
DATE/EDITION: 2005/1st paperback edition (currently in SAS stacks)

AUTHOR: Richard Milner
TITLE: Darwin's Universe; Evolution from A to Z
PUBLISHER: University of California Press
ISBN #: 0520243765
DATE/EDITION: 2009/1st (\$47 from Amazon)

ELECTRONIC COURSE MATERIALS

AUTHOR: Scott Freeman and Jon Herron
CHAPTER TITLE: Chapter 1: A Case for Evolutionary Thinking: Understanding HIV
BOOK TITLE: Evolutionary Analysis (4th edition)/ Pearson Prentice Hall publisher
ISBN #: 0132275848
PAGES: 3-36

ADDITIONAL RESOURCES

Students will have access to the following DVD movies via onboard CCTV. Watching these movies will be a required part of course activities:

Evolution: Darwin's Dangerous Idea
Evolution: Evolutionary Arms Race
Evolution: Great Transformations
Evolution: Why Sex?
Evolution: What About God?
Evolution: Extinctions
Evolution: The Mind's Big Bang
The World According to Monsanto
The Genius of Darwin
The World According to Monsanto

GATTACA

Creation

American Experience: Influenza

American Experience: The Monkey Trial

Judgment Day: Intelligent Design on Trial

End of the Line

Journey of Man

Origin of AIDS

The Island of Dr. Moreau

The Day the Earth Nearly Died

Darwin's Secret Notebook

Titanboa

When Ireland Starved

The Emerald Forest

Life on Earth

HONOR CODE

Semester at Sea students enroll in an academic program administered by the University of Virginia, and thus bind themselves to the University's honor code. The code prohibits all acts of lying, cheating, and stealing. Please consult the Voyager's Handbook for further explanation of what constitutes an honor offense.

Each written assignment for this course must be pledged by the student as follows: "On my honor as a student, I pledge that I have neither given nor received aid on this assignment." The pledge must be signed, or, in the case of an electronic file, signed "[signed]."