

Biology 101: Origins of Life



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Origins of Life

Unit 1 – At a Glance

In this unit, we'll explore the fundamentals of evolutionary biology. We'll start with a look at the development of one of the cornerstone ideas in modern biology – evolution – and follow the progression of this idea in the work of Charles Darwin in the 1800s in Victorian England. We'll examine the “how” of evolution by looking at the principals of genetics and inheritance. We'll follow case studies that show evolution in action today.

Note: each documentary or chapter has a study guide. Use the study guide as you view or read the material. Use your study guide to study for the exam.

UNIT 1	✓
<i>Documentary:</i> Darwin's Dangerous Idea	
Reading: Chapter 1 in BioAnth: Origins of Evolutionary Thought	
Reading: Chapter 2 in BioAnth: Genetics – Cells & Molecules	
Reading Chapter 3 in BioAnth: Genetics – From Genotype to Phenotype	
<i>Documentary:</i> Evolutionary Arms Race	
Reading Chapter 4 in BioAnth: The Forces of Evolution and the Formation of Species	
<i>Documentary:</i> Why Sex?	
EXAM 1 MONDAY SEPT. 28 from 5:30 to 6:45 PM in Sweeney Hall 120: Unit 1	

Darwin's Dangerous Idea
Viewing Guide

READ THROUGH THESE QUESTIONS BEFORE YOU START THE DOCUMENTARY!

PROLOGUE & COMMON ANCESTRY

1. Early in the video, Daniel Dennett states, "If I were to give a prize for the best idea any body ever had, I'd give it to Darwin for the idea of natural selection." What did Darwin's idea unite?
2. What were the consequences of Darwin's idea on British society?
3. Darwin experienced a major earthquake in South America during his travels on the Beagle. What impact did this have on his views (pay very close attention to the episode where he presents a paper to one of the royal scientific societies)?
4. What was the error Darwin made with respect to the finches he collected on the Galapagos? Why was this significant?
5. When Darwin realizes he needs birds from the Galapagos with better records than what he kept, he goes to Captain Fitzroy to ask to see his collection. How do Darwin and Fitzroy differ on their views of the finches and why they are important?

6. In looking over the bones on the table, Darwin ponders if the globe has undergone such profound changes in its history geologically, surely all living creatures must have changed with it to adapt to their new conditions. Or otherwise they would have perished. He says there must be a new law which does what?

7. Later, in the pool room with his brother, Darwin suggests that perhaps there is a tree of life. What is this tree of life? What is the “bottom line” of his idea?

ECUADOR AND THE TREE OF LIFE

1. Chris Schneider (Boston University) conducts research in Ecuador near base of Andes mountains and further upland. What does he hope to discover?

2. What observations did Darwin make on the finches he brought back from the Galapagos? What was Darwin's thinking regarding the origin of these different finches?

3. What does the example of the adaptations of the praying mantis illustrate with regards to natural selection and the evolution of such extreme adaptations?

4. Tom Smith's research on hummingbirds in the Andes points to a very key event (or series of events) that can lead to the emergence of a new species. What is this?

5. When are animals considered new species?

6. The scientists are looking at color, beak length, and wing span in highland and lowland birds. What other tool do they have available to them that Darwin did not?
7. What determines the traits of all living things? What can result in new traits?
8. How is it that organisms that are so different can be related?

NATURAL SELECTION

This chapter begins with Charles and his brother riding to dinner, and encountering an angry mob of people who begin to stone their carriage. Erasmus remarks, "Too many people, and not enough food." This is the basis for showing how Thomas Malthus' *Population Commerce and Agriculture* had a profound effect on Darwin's thinking. The premise of Malthus is that humans can double their numbers every 25 years. But as Erasmus points out, we don't – the struggle for resources slows growth. Death, disease, war, and famine check human populations.

1. How did Darwin take this idea and applying it to the natural world?
2. Darwin's work began with what observation?
3. What is Darwin's Natural Selection?

MUTATION AND HIV

1. Darwin didn't actually see natural selection in action. But we can today – where is this happening?

2. HIV has the capacity to evolve, no matter what you give it. Michael Saags has seen HIV evolve into new varieties over the last several years. The virus is constantly changing, subject to the forces of natural selection in the environment of the patient's body. Watch the animation carefully! What is happening to HIV once inside a patient's white blood cells? How does drug resistance happen?

3. Dan Dennett states that the process of natural selection feeds on _____
_____.

4. In 1997, Veronica Miller (Goethe University, Germany) made a major discovery. Describe what she found.

5. What had happened in Miller's patient? (Watch the animation very carefully!)

COMPLEXITY

1. Richard Owens and Darwin disagreed over why vertebrate animals had the same patterns in limbs, back bone, etc. What was Owen's view? What was Darwin's view?

HOW THE EYE EVOLVED

1. What is the main difference between the way a designer would design something and the way that nature designs something?

2. What are some examples of imperfections in the "design" of the human eye?

3. Dan-Eric Nilsson's model shows how a primitive eye spot could evolve through intermediate stages to become a complex, human-like eye in less than ½ million years. What is his approach to demonstrating how an eye could have evolved from simple to complex through natural selection? What stages did he model?

GOD

1. What did Annie's death do to Darwin's thinking?

A SCIENTIST DISCUSSES RELIGION

1. What is Ken Miller's philosophy regarding evolution and God?

THE HUMAN QUESTION

1. This chapter contains the following very famous historical quotes. Who said them?

"I wonder Mr. Huxley is it through your grandfather or your grandmother that you claim descent from an ape?"

"If the question is put to me would I rather have a miserable ape for a grandfather or a man, highly intelligent, possessed of great means of influence and yet who employed these faculties and that influence for the mere purpose of introducing ridicule into a grave scientific discussion, I unhesitatingly affirm my preference for the ape!"

HUMANS AND THE TREE OF LIFE

1. How closely related is the DNA of humans and chimps? How do we know this?

2. Ken Miller notes that we share three major attributes with our primate relatives – DNA, morphology, and blood type. He notes that there are also striking differences, and that the line of evolution that led to us was due to an explosive development of mental capacity. What did natural selection favor in the evolution of humans?

EPILOGUE

1. Where is Darwin buried?

BIO ANTH: CHAPTER 1 READING GUIDE

Note: read pages 22 – 31. There is a particularly good summary of Darwin's theory on pages 29 and 30. The rest of the chapter is interesting, but optional.

1. How old was Darwin when he first embarked on his voyage on the H.M.S. Beagle?
2. How long did this voyage last?
3. Of all of his ports of call on this voyage, which one in particular had a profound influence in Darwin?
4. What was so unusual about the finches on the Galapagos? Why did these birds eventually provide Darwin with a key piece of evidence for his theory? What did he surmise?
5. What is adaptive radiation?
6. What is natural selection?
7. Who was Alfred Russel Wallace?

8. In explaining his theory of evolution by natural selection, Darwin had three observations and two deductions (pp. 29-30). What were these?

9. Why is the expression “survival of the fittest” not a good definition of natural selection?

10. What three preconditions must be met for natural selection to work?

11. Give a good definition of evolution (in the biological sense).

BIO ANTH: CHAPTER 2 READING GUIDE

Note: there is a lot of detail in this chapter. If you've had Bio 10 or Bio 21 (or any other general biology course), this should look familiar. Use the information in pages 45 – 62 to define the following terms or functions, or to answer general questions. Focus your attention on looking for the information to answer the questions – you do not need to read the chapter line by line (unless, of course, you either do not understand something or you find something interesting!) Spend sometime going through the animations on the web (links are given below) – this will greatly help your understanding.

Suggested supplementary material: CD-ROMs on DNA are available on the computers (or for checkout) from the Lab.

The Cell (p. 40)

1. What is a prokaryote?
2. What is a eukaryote?
3. What are somatic cells?
4. What are sex cells?

Cell Anatomy (pp. 41-43)

5. What is DNA?
6. What is a nucleotide?
7. What is a base? Name some bases.

8. What are the 3 functions of DNA?

DNA Function I: Replication (p. 45)

9. In general terms, how does DNA replicate?

DNA Function II: Protein Synthesis (p. 46-51)

10. What are some different types of proteins?

11. Proteins are complex molecules made up of smaller molecules known as _____.

12. These are considered the building blocks of proteins.

13. A typical protein may be made up of a chain of _____; such a chain can also be called a _____.

14. What is the genetic code?

15. What is a codon?

16. What is a gene?

DNA Structure II: Chromosomes and Cell Division (p. 51-59)

You will need to have a general understanding of mitosis and meiosis. In addition to the information in Chapter 3, check out the following:

http://www.biology.arizona.edu/cell_bio/tutorials/cell_cycle/cells3.html

<http://www.pbs.org/wgbh/nova/baby/divide.html>

17. Fun factoid: how many feet of DNA is in the nucleus of each somatic cell in your body?

18. What is mitosis?

19. What is meiosis?

20. What is the main distinction between mitosis and meiosis?

21. What is a chromosome?

22. The total number of chromosomes in each somatic cell is called the

_____ (p. 58). Sex cells have only half as many chromosomes as somatic cells (one copy of each chromosome), so that total number of chromosomes in a sex cell is known as the _____. In a diploid cell, the members of each pair of chromosomes are known as _____.

23. What are alleles? Give an example.

24. What does homozygous mean?

25. What does heterozygous mean?

26. What is crossing over? When does it occur? Why is crossing over so important with respect to natural selection? (p. 61)

BIO ANTH: CHAPTER 3 READING GUIDE

Note: there is a lot of detail in this chapter as well. If you've had Bio 10 or Bio 21 (or any other general biology course), this should look familiar. Use the information in pages 74 – 87 to define the following terms or functions, or to answer general questions. Focus your attention on looking for the information to answer the questions – you do not need to read the chapter line by line (unless, of course, you either do not understand something or you find something interesting!)

Suggested supplementary material: CD-ROMs on Genetics are available on the computers (or for checkout) from the Lab.

From Genotype to Phenotype (p. 70)

1. What are structural genes?
2. What is a phenotype?
3. What is a genotype?

The ABO Blood Type System (p. 71-72)

4. What is the ABO blood type system? Know the difference between ABO phenotype and ABO genotype.
5. What does recessive mean? Give an example with ABO.
6. What does dominant mean? Give an example with ABO.
7. What does co-dominant mean? Give an example with ABO.

Mendelian Genetics (p. 73)

8. What is blending inheritance?

9. What is particulate inheritance?

Mendel's Postulates (p. 75-78)

10. What are Mendel's postulates?

Mutation (p. 78-79)

11. What is a mutation?

12. Why is a mutation in a sex cell particularly important?

13. What is a point mutation? Give an example.

Trinucleotide Repeat Diseases (p. 79-80)

14. What is an insertion mutation? Give an example.

15. What is a deletion mutation?

Mutations: Bad, Neutral, and Good (p. 80-82)

16. Are the vast majority of mutations bad, neutral or good?

17. Mutations are the ultimate source of what?

18. Without mutations, there could be no _____.

The Evolutionary Arms Race
Viewing Guide

NEWTS, SNAKES AND CO-EVOLUTION

1. The skin glands of the _____ secrete one of the most toxic poisons known to nature. When ingested, the toxin can paralyze within minutes and shutdown organ systems within hours.
2. What is responsible for the newt's extreme toxicity?
3. What happens as the snakes get better at resisting the effects of the toxin?
4. Describe the Brodies' lab experiments. What did they do and what did they find.

MICROSCOPIC PREDATORS

5. Today, the only predator left to fear is what?

THE TUBERCULOSIS EPIDEMIC

6. Tuberculosis is caused by what?
7. Alexandr "Sasha" Belevich is an inmate in a prison in Tomsk who was first diagnosed with TB during his first prison term. He received antibiotics and he improved. But after his release, he stopped getting treatment. His TB returned, but the second time around he did not respond to treatment. What happened?
8. Why is the prison system is the ideal incubator for studying drug resistant strains of TB?
9. How is Barry Kreiswirth using the DNA from TB bacteria to study the spread of this disease?
10. What other bacteria have developed drug resistant strains?
11. What is causing drug resistance in strains? What is the ultimate consequence of this?

DOMESTICATING GERMS

12. Paul Ewald's idea for "domesticating" germs suggests that if we can drive microbes to evolve drug resistance, then _____

13. Disease organisms evolve to be more or less harmful depending on how they are spread. Microbes that depend on close contact between people tend to be _____.
14. What is an example of a virus that depends on fairly healthy people (i.e., those who can move around) to be transmitted? _____
15. Is this virus considered very harmful? _____
16. Microbes that are transmitted by insects or tainted food or water tend _____

17. What are some examples of waterborne bacteria?
18. Are these bacteria considered very harmful?
19. Describe Ewald's experiment on cholera bacteria from South America. What was he measuring? What did he find?

SURVIVAL OF THE WILD CATS

20. What did Stephen O'Brien discover when he began to screen thousands of biological specimens from non-domestic (= wild) cats for FIV?

21. Despite the cats being infected with FIV, they weren't getting sick. Why?
22. The experience with the wild cats convinced O'Brien that there must be people endowed with mutations that protect them from HIV. As a result of studying the DNA of about 10,000 people at high risk for HIV, what did he discover?
23. What effect does this mutation have on HIV? In what people is this mutation found?
24. This mutation may have enabled people to survive one of the most catastrophic epidemics in human history. What was this epidemic and when did it happen?

SYMBIOSIS AND LEAFCUTTER ANTS

25. What is symbiosis? What are the examples of symbiosis mentioned in the documentary?
26. Cameron Currie collected leaf-cutter ant colonies and cultured 1500 fungus samples (created by the leaf-cutter ants). When he removed the ants from the colony, what happened?
27. How is it that ants are able to keep their "gardens" pest-free?

GOOD GERMS

28. What did the study of Pediatrician Erika von Mutius show with respect to exposure to microbes and susceptibility to allergies and asthma?

BIO ANTH: CHAPTER 4 READING GUIDE

HOW EVOLUTION WORKS

1. Natural selection operates on the _____ of an individual organism.
2. Can individual organisms evolve?
3. Can populations evolve?
4. What is directional selection? Give an example of this.
5. What is stabilizing selection? Give an example of this.
6. What is gene flow?
7. What is genetic drift? In what circumstances is genetic drift most powerful?

8. What is founder effect?

9. What are some examples of genetic drift and/or founder effect (see p. 99-109)

10. What is a genetic bottleneck?

11. What is sexual selection? What is sexual dimorphism?

CLASSIFICATION AND EVOLUTION

12. What is the name of the person who established a hierarchy of categories to classify all living things?

13. The only “natural” category is the _____.

14. To what kingdom, phylum, class, order, family, genus, and species do humans belong? (fill in table below)

Kingdom: _____

Phylum: _____

Class: _____

Order: _____

Family: _____

Genus: _____

Species: _____

15. What is the principle of homology? Give an example of traits that are homologous.

16. What does it mean when we say traits are analogous? Give an example.

Note: read to page 112 until “The Tempo of Speciation” (then skip the rest of the chapter).

17. What is a species?

18. What is the biological species concept? What is at the “heart” of this concept?

19. What is the evolutionary species concept? Why is this useful in the study of fossils?

20. What is a reproductive isolating mechanism?

21. What are 4 reproductive isolating mechanisms that prevent mating? (see table 4.2)

22. What are 5 reproductive isolating mechanisms that occur after mating? (see table 4.2)

23. What is anagenesis? What is cladogenesis?

24. What is allopatric speciation?

Why Sex?
Viewing Guide

LESBIAN LIZARDS

1. What is so unusual about the reproductive strategy of the lizards that Jerry Johnson studies?
2. Are the offspring genetically different from their mother?
3. Which is more common in animals – sexual reproduction or asexual reproduction?

THE ADVANTAGE OF SEX

4. Robert Vrijenhoek studies minnows in small pools (ponds) in Sonora, Mexico. Early on, he discovered that 40% of the minnows in these pools were heavily infected with a parasite that causes black spot disease. The rest seemed relatively unaffected. When he brought them back to the lab and started counting the spots, what did he find and why was this so perplexing?
5. According to the Red Queen Hypothesis, organisms have to keep evolving to respond to what?
6. Why are cloned fish an easy target for the parasites?

7. Why are the sexual fish a more challenging target for the parasites?
8. After the minnows began returning to the ponds following a drought in Sonora, V noticed that the sexual fish were being hit by parasites particularly hard. In the process of colonization, what had happened to these fish?
9. Sex generates _____ among offspring.

THE PEACOCK'S TAIL

10. What are some of the "wild extravagances" that Charles Darwin struggled with? Are these found in both sexes?
11. What two strategies did Darwin see at work in the courtship idiosyncrasies of different species? Collectively, these idiosyncrasies are what kind of selection?
12. To understand how the peacock's tail evolved and what its relationship is to female choice, Marion Petrie did three experiments. What were these experiments and what did they demonstrate?

SONGBIRDS AND MONOGAMY

13. Monogamy, in the animal world, has some tradeoffs. Why would female songbirds cheat?

14. What selective force resulted in a reversal of roles in male and female jacanas?

15. As a result of this reversal of roles in males and females, what are some of the features that are now seen female jacanas?

Chimpanzees and Bonobos

16. Chimpanzees and bonobos live in similar jungles in equatorial Africa. They look alike, live in the same size communities, and eat similar foods. What is their one major behavioral difference?

17. What has allowed bonobos to establish such peaceful relations ("sex" is the obvious answer; what is behind this sex, however?)

18. Why have bonobo females evolved this strategy and chimp females haven't?

SEX AND HUMAN BEHAVIOR

19. What kinds of questions, issues, or problems are evolutionary psychologists interested in?

20. Can humans "smell" a genetically compatible mate? Describe the experiment done to test this idea. What did researchers discover?

21. In the study about facial preferences, what kind of facial types did women prefer? Did this vary at all, and if so, how?

22. Why does Geoffrey Miller think humans evolved bigger brains?

Origins of Life

Unit 2 – At a Glance

In this unit, we'll look at the Order Primates to give us some context for studying human evolution. The Order Primates contains over 200 species, including humans. In this unit, you will learn what characteristics define primates, and how the radiation of this group of mammals over the last 50 million years or so has resulted in the fantastic degree of diversity we see today in lemurs, lorises, monkeys, and apes.

Note: each documentary or chapter has a study guide. Use the study guide as you view or read the material. Use your study guide to study for the exam.

UNIT 2	✓
<i>DVD: The Living Primates</i> (see this before you go to the Zoo!)	
Chapter 6 in BioAnth: The Primates (read this before you go to the Zoo!)	
<i>DVD: Wilds of Madagascar</i>	
<i>DVD: Monkey in the Mirror</i>	
EXAM 2 MONDAY OCT. 26 from 5:30 to 6:15 P.M. in Sweeney Hall 120: Unit 2	

Note: go to the San Francisco Zoo no later than about October 10 so that you have time to research your paper which is due on Monday October 26 at the beginning of the exam (you will also upload it to www.turnitin.com).

The Living Primates
Viewing Guide

1. How many living species are there?
2. What characteristics do primates share?
3. These characters evolved in response to what kind of pressure?
4. Primate evolution took place in _____ habitats, which refers to life in the trees. How does this kind of environment shape the behavior and evolution of primates?
5. Hands and feet with nails instead of claws allow primate to do what?
6. What kind of vision is possible when the eyes face forward with overlap in the visual field?
7. What happened to sense of smell as primates evolved?
8. Do primates have a greater reliance on learned behavior or instinct? What might account for this?

9. What is morphology?

10. The five fingers and toes on a gorilla indicate ancestry with _____. Their hair tells us they are _____. They retain a grasping hand, a trait that evolved early in the _____, along with an _____ which certain primates share. Their lack of a _____ is characteristic of all apes and humans. It must have emerged some time after their line separated from the other primates. The behavior and morphology of each living primate species today also reflects the _____ they occupy – where they spend their time, what they eat and what they need from their environment.

Prosimians

11. When did the prosimian radiation occur?

12. What features of modern prosimians suggest that they rely more on smell than do modern apes and monkeys?

13. What are the three groups of prosimians?

14. Where (geographically) are lemurs found?

15. What does diurnal mean? What does nocturnal mean?

16. Where (geographically) are lorises found?

17. Why are lorises nocturnal?

18. How does this contrast with the lemurs in Madagascar?

19. Where (geographically) are tarsiers found?

Anthropoids

20. Anthropoids include monkeys, apes, and humans. As a whole, how are they different from prosimians?

21. These two groups share basic “monkey” characteristics but have actually been evolving separately for at least _____ million years.

22. What does quadrupedal mean?

New World Monkeys

23. Are New World Monkeys exclusively terrestrial or arboreal?

24. Are most New World Monkeys diurnal or nocturnal?

Old World Monkeys

25. Old World Monkeys are the most widely dispersed of all living primates except for _____.

26. What are some of the habitats that Old World Monkeys live in?

27. Are Old World Monkeys nocturnal or diurnal?

28. Are Old World Monkeys terrestrial or arboreal?

The video mentions two main divisions of Old World Monkeys – just view this for general interest.

Apes

29. What are the characteristics of the Hominoidea (humans and apes)?

30. The form of locomotion that involves swinging arm to arm is called _____.
31. What anatomical features are required for this kind of locomotion?
32. What was the climate like during the time period when hominoids were first evolving (23 to 5 million years ago)?
33. Where (geographically) are orangutans found?
34. Where (geographically) are gorillas found?
35. Are gorillas terrestrial or arboreal? What is their diet like?
36. Are chimpanzees terrestrial or arboreal (or both?). What is their diet like?
37. Anatomically, which primates are humans closest to? What features do we have in common with this group? How are we different?

BIO ANTH CHAPTER 6 READING GUIDE

THE PRIMATE RADIATION

What are the eutheria?

How many species of nonhuman primates are currently recognized?

What anatomical traits tend to distinguish primates from other mammals? (There are 8; hint: be sure you know what prehensile means!)

What life history traits tend to distinguish primates from other mammals? (There are 3; hint: be sure you know what encephalization means!)

What behavioral trait characterizes most primates?

A GUIDE TO THE NONHUMAN PRIMATES

This section in Chapter 6 is pretty dense. Use the information from page 170 (starting with “A Guide to the Nonhuman Primates”) to page 192 (up to “Primate Ecology”) as a reference just to find the answers to the following.

Primates can be divided into two general groups: The strepsirhines and haplorhines. Some authors prefer to divide them into prosimians (more or less the same as strepsirhines) and the anthropoids (more or less the same as haplorhines). Your book uses the strep-hap groups, so we’ll stick with that one.

The Strepsirhines include the _____ of Madagascar and the _____ of mainland Africa and tropical Asia.

What are some characteristics of Strepsirhines? (p. 174)

The haplorhines include which primates? (p. 177)

Where do the New World monkeys live? (specifically; see p. 180).

What three features do all New World monkeys share? (p. 180)

Name a few types of New World monkeys.

Where do the Old World monkeys live? (specifically; see p. 181-182).

What are two characteristics of Old World monkeys? (p. 182)

Name a few types of Old World monkeys.

The Hominoids contain three “families” which are _____,
_____ and _____. (p. 184)

Apes and humans share several postcranial (below the head) traits that are all related to a form of locomotion called _____.

What are the four different kinds of “great” apes?

Where are orangutans found?

Where are gorillas found?

Where are chimpanzees found?

Where are bonobos found?

PRIMATE ECOLOGY

What is ecology?

How can primates influence the ecology of tropical forests? (p. 192)

Regarding diet, most primates are _____, although many “lower” primates (such as lemurs) eat insects.

What primate is entirely carnivorous?

Why do ecologists predict that natural selection will “endow trees with the means to protect their leaves”?

What is a folivore?

Why do ecologists predict that natural selection will “build traits into fruit that encourage frugivores to seek out the fruit crop and eat it”?

What is a frugivore?

Wilds of Madagascar
Viewing Guide

Describe Ankarana

1. Where is it?

2. What surrounds it?

3. In previous times, what surrounded Ankarana?

4. What types of animals are found there? (About 14 are mentioned, including three species of lemurs).

5. When did the island of Madagascar split from Africa?

Reflect on Ankarana

6. What makes Ankarana so unique? (And why)

7. What makes Ankarana so vulnerable? (And why)

8. This documentary was made in the 1980s. What became of Ankarana? (Do a detailed look-up on Google).

Monkey in the Mirror
Viewing Guide

SIMILARITIES & BEHAVIORS

1. How are baby chimps and baby humans similar?
2. What are some characteristics that primates share?
3. How do chimps use tools?
4. What evidence do we have that different populations of chimps develop different cultures?

5. Name some chimp traditions.

SOCIAL CREATURES

6. There are some striking parallels between stress in humans and stress in monkeys. How do the Japanese macaques handle the stress of living in overcrowded conditions?

INTELLIGENCE

7. What happens when a monkey looks at itself in a mirror? What happens when a chimp looks in a mirror?

8. Self-recognition measures a special kind of intelligence – a sense of _____. What animals is this found in?

THE PYGMY CHIMPANZEES & LANGUAGE

9. Of all the apes, the bonobos (pygmy chimps) may be the most closely related to us. In what way are they similar to humans?

Unit 3 – At a Glance

In this unit, we conclude our study by focusing on human evolution – from early hominids in the late Miocene or early Pliocene up to the appearance of “anatomically” modern humans during the Paleolithic. What defines “humanness”? What were key events in hominid evolution? How have biological and cultural adaptations of humans figured into our evolutionary history? These questions provide an intriguing backdrop for this final unit.

Note: each documentary or chapter has a study guide. Use the study guide as you view or read the material. Use your study guide to study for the exam and quiz.

UNIT 3 – Part 1	✓
<i>The First Human</i> (book by Ann Gibbons; begin reading, finish before November 16).	
Chapter 8 in BioAnth: Fossils in Geological Context	
Chapter 10 in BioAnth: Ape-Hominid Transformation	
DVD: Great Transformations	
DVD: The First Biped	
Chapter 11 in BioAnth: Early Hominids	
Chapter 12 in BioAnth: Rise of Genus <i>Homo</i>	
DVD: The Mind’s Big Bang	
DVD: Premodern Humans	
Chapter 13 in BioAnth: Archaic <i>Homo sapiens</i> and Neandertals	
DVD: Neandertals on Trial	
Chapter 14 in BioAnth: Emergence of <i>Homo sapiens</i>	
QUIZ: THE FIRST HUMAN MONDAY NOV. 16 from 5:30 to 6:15 PM in SWEENEY HALL 120.	
EXAM 3 MONDAY DEC. 7 from 5:30 to 7:00 P.M. in SWEENEY HALL 120: Unit 3.	

The First Human Reading Guide

Introduction

What was significant about Michel Bruner's find? (Note the age of the find and its location)

What fossil finds are the following scientists associated with (as per the introduction)?

Eugene Dubois:

Raymond Dart:

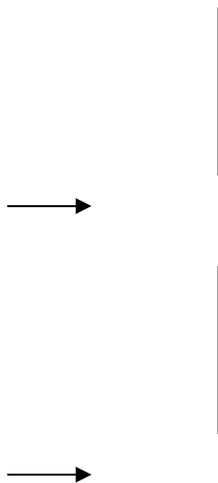
Louis and Mary Leakey:

Don Johanson:

Where is the Middle Awash? What did Tim White publish in 1994 from the Middle Awash? What was the key shortcoming of this publication?

In January 1995, Meave Leakey and Tim White compared fossils and decided they had different species which they thought belonged to one lineage that eventually evolved into *Australopithecus afarensis*. Plot their two species, their ages, and their locations below (at the arrows).

Australopithecus afarensis (Hadar, Ethiopia; 3.18 million years; also Laetoli, but more on that later)



Chapter 1

What hominid did Mary Leakey discover in 1959 from Olduvai Gorge in Tanzania? (A little later in the chapter, Gibbons discusses the significance of this specimen – when you get to that point, come back to this question and indicate what the significance is of this fossil).

Who was Eugene Dubois and what did he discover? Where did the fossil come from? By what name is this species now known?

What is Piltdown Man? What anatomical features “suggested” that it was human?

Why did Raymond Dart’s 1924 discovery run counter to Piltdown Man?

What fossil upstaged Raymond Dart in 1931? Where did the fossil come from? By what name is this species now known?

What is the Acheulean tradition and what time does it date to?

What is *Proconsul*? Where is it known and how old is it? What is *Proconsul* believed to be ancestral to?

What key technology was advanced in the 1950s that allowed paleoanthropologists to accurately date their fossils?

Chapter 2

The sites of Kanapoi and Lothagam figure prominently later on in the book. Jot some notes down about early exploration of these sites here (i.e., who worked these sites, where the sites are located, how old the sites were either thought to be or are known to be now, etc.).

Kanapoi

Lothagam

In 1967, F. Clark Howell led an expedition to the Omo River Valley. What is the approximate date of this site and why was Howell's contribution so significant to paleoanthropology?

Chapter 3

Let's talk about *Ramapithecus*...first, what is this fossil, where was it found, and what is the approximate age of it?

What was it about *Ramapithecus* that led Elwyn Simons to decide it was a hominid? What was the implication of this?

What is a type specimen?

How does the typological approach differ from the biological species concept? What are the pros and cons of each?

Chapter 4

What is a phylogenetic tree?

What is a molecular clock?

Sarich and Wilson were the first to use the molecular clock to date branches of human phylogeny. At what time do they believe humans and African apes diverged?

What was the controversy over Sarich and Wilson's work?

In the late 1970s, David Pilbeam went back to the Siwalik Hills where *Ramapithecus* was initially found in 1932. He found more jaws of *Ramapithecus* along with another taxon, *Sivapithecus*. What do we now know *Sivapithecus* and *Ramapithecus* to be? What living ape is this taxon ancestral to/

To what did Pilbeam attribute paleoanthropology's errors in so badly misinterpreting *Ramapithecus*?

Give the dates of divergence for the following taxa, using Pilbeam's molecular clock (I've started the first one for you):

Gibbons 20 my (my = millions of years)

Orangutans

Gorillas

Chimps

Australopithecines

Chapter 5

Why is the Afar depression so interesting/

What is faunal data or biochronology? What fossil initially suggested to Taieb that Hadar was three million years old?

What was so significant about Johanson's discovery in 1973?

What was so significant about Johanson's discovery in 1974?

Chapter 6

What is the most recent radiometric dates for Lucy?

What are the most recent radiometric dates for Laetoli?

Where did White and Johanson put *A. afarensis* in the “family tree” with respect to other hominids known at the time? (Draw a picture/tree, if that helps).

Chapter 7

Why is 4 – 7 million years ago considered to be a blackhole in paleoanthropology?

According to Don Johanson, what is the biggest remaining challenge in paleoanthropology?

Who is Martin Pickford? Where was he working in the 1970s and what did he find? What is the age of these deposits?

Who is Andrew Hill? What was his research program on and what did he find?

Chapter 8

What was interesting about Meave Leakey's finds in 1994? (Also very helpful: look up 1994 in the table at the very beginning of the book called "First Human" Fossil Finds by Year)

What is the scientific name of this discovery? (Again, see the table at the beginning of the book).

Chapter 9

What about the Afar depression makes it especially conducive to fossilization?

What is tephrostratigraphy and what is it good for?

Chapter 10

What are the features of the "Root Ape" (*Ardipithecus ramidus*)

When Tim White and colleagues set out to examine specimens of *A. ramidus*, what were they looking for? What did they find?

What was the issue over *A. ramidus* that led Henry Gee to refer to “voodoo paleontology”? What preconceptions or biases are at work here?

What was the hypothesized environment of the Aramis fossils? What was the implication for models of the origin of human bipedalism? (p. 147 or thereabouts)

Chapter 11

Describe the “East Side Story” hypothesis. How would you test this hypothesis?

Chapter 12

No questions – just marvel at the antics of paleoanthropologists as you read this chapter.

Chapter 13

Should there be a code of ethics for best practices in the field? How should research permits be given out? How would you resolve the Galili debate/issue between Haile-Selassie and Seidler?

Chapter 14

What was significant about the discovery of “Millennium Man” (*Orrorin tugenensis*)? How did this discovery affect the hominid “family tree”?

What are the best anatomical features for diagnosing upright walking?

Do you think *Orrorin tugenensis* is valid?

Chapter 15

What are the features of the Toumai skull?

How did the discovery of the Toumai hominid refute Coppens' "East Side Story" hypothesis?

How was Toumai dated? What is the name of this technique (think back to the lecture we had on dating)

Chapter 16

Should researchers be obligated to share their fossils? If not, why not? If so, what do you think the guidelines should be?

According to Clark Howell and Tim White, what is the central focus of human origin studies?

Regarding Howell and White's question, what answers do we now have? What remains to be answered?

Suggestion: pages 231 – 233 contain some good summary information.

Chapter 17

What is the evidence that Toumai may have been bipedal? What is your impression of this type of indirect evidence?

Based on all you've read in this book, if you had a million dollars to fund paleoanthropology research, who would you give it to? (You have to give the money away – you can't keep it – and your pool of prospective recipients is limited to those mentioned in the book!)

BIO ANTH CHAPTER 8 READING GUIDE

1. What is paleontology? (p. 229)

2. What is geology? (p. 229)

HOW TO BECOME A FOSSIL

3. What is taphonomy? (p. 230-231)

4. What are the steps or stages of fossilization? Which stage is probably the most important in terms of preserving the animal for later fossilization?

5. What are trace fossils? (p. 231)

THE IMPORTANCE OF CONTEXT

6. What are strata? What is stratigraphy? (p. 231)

7. What is uniformitarianism? What does this have to do with stratigraphy? (p. 232)

8. Describe the four principles of stratigraphy (p. 232-233)

THE GEOLOGIC TIME SCALE: You can skip this section, as this information appears in one of the documentaries (Elements of Biology: Biological Evolution)

HOW OLD IS IT:

Read this short introductory chapter – it is very useful for understanding what follows.

9. What can relative dating techniques tell us about the possible age of a fossil? (p. 235)

10. Lithostratigraphy, tephrostratigraphy and biostratigraphy are all types of relative dating techniques. Define each of these. (p. 235-239)

lithostratigraphy _____

tephrostratigraphy _____

biostratigraphy _____

CALIBRATED RELATIVE DATING TECHNIQUES

Read the section on geomagnetic polarity carefully!

11. How has the earth's magnetic field changed through geologic time? (p. 239)

12. What is the geomagnetic polarity time scale (GPTS)? (p. 239)

13. What is paleomagnetism (p. 239)

14. What are the last four chrons? Give the name, the orientation and the approximate date. (We'll do the first one for you.) (p. 239-241)

Gauss: reversed, 4.2 – 3.5 million years ago

15. How was the geomagnetic technique used to interpret age at the site of Dmanisi? (p. 241).

CHRONOMETRIC DATING TECHNIQUES

16. What are chronometric dating techniques in general? How do they differ from relative dating techniques? (p. 242)

17. What is the most famous radioactive decay clock? What are some other ones mentioned in the same paragraph? (p. 242)

Read p. 244 – 247 (up to Fission Track Dating) very carefully. We will not cover all the techniques in this section – just the ones on 244 – 247 (excluding fission track dating).

18. What is radiometric dating?

19. What is the difference between ^{12}C and ^{14}C ? What makes ^{14}C unstable?

20. What will happen to ^{14}C over time?

21. What is a half-life?

22. What is a parent isotope? What is a daughter isotope?

23. What is the half life of ^{14}C ? _____

24. Regarding Potassium-Argon dating, what does the system measure?

25. What kind of material does Potassium-Argon require?

26. What is the half-life of ^{40}K (potassium 40)? _____

27. How can we use Potassium-Argon to date fossils when it can only give us dates about the time of formation of volcanic rocks?

28. Why is Argon-Argon considered a better method than Potassium-Argon?

BIO ANTH CHAPTER 10 READING GUIDE

This is a very readable chapter. Read pages 289 – 300 (up to “The Transition to Human Behavior”).

1. What was the earliest trait to separate the hominid line from hominoids?

ANATOMICAL CHANGES

2. What is the most critical issue that must be overcome when shifting from quadrupedal locomotion to bipedal locomotion? (p. 290)

3. In what ways is the hominid vertebral column modified for bipedalism? (p. 291-292)

4. In what ways is the hominid pelvis modified for bipedalism? (p. 292-293)

5. In what ways is the hominid leg modified for bipedalism? (p. 294)

6. In what ways is the hominid foot modified for bipedalism? (p. 294-295)

WHY BIPEDS?

7. The chapter presents four different scenarios to account for why bipedalism arose. Describe each scenario, including the pros and cons of each.

Great Transformations
Viewing Guide

THE EVOLUTION OF WHALES

1. When did mammals first appear on Earth?
2. What was so unusual about the fossil that Gingerich found in Pakistan in 1978?
3. What was so unusual about the fossil of *Basilosaurus* that Gingerich found in the Sahara Desert?
4. Forty million years ago, what did the Sahara Desert look like?
5. Bones aren't the only evidence of whale evolution. What else holds a clue to their ancestry?

FROM WATER TO LAND

6. What did Ted Daeschler find in Pennsylvania and why was it so interesting? How old is this fossil?

7. Regarding how animals from the sea first colonized land, the old idea was that the fish came on shore first and then developed legs. What do we now think happened?

8. What is *Acanthostega* and why was it such an important find for Jenny Clack?

9. Why might tetrapods have ventured on to land?

THE FIRST ANIMALS

10. When did animals first appear on Earth? What is this event called?

11. The Burgess Shale fossils found in the Canadian Rocky Mountains have been called the “greatest fossil find in history”. The “crown” of the Burgess Shale is an animal called *Pikaia*. What is remarkable about this fossil?

THE MECHANISM OF CHANGE

12. Ed Lewis had a controversial idea regarding how genes shaped the body of fruit flies. He thought that each segment was directed to grow by

_____.

13. How did the research of Mike Levine and Bill McGinnis confirm this idea?

THE TRANSFORMATION OF HUMANS

14. What was the great transformation in human ancestors that opened up an “extraordinary breadth of possibilities and opportunities”?

15. The human skeleton has several adaptations for upright walking. What are these and how do they contrast with the chimpanzee skeleton?

The First Biped
Viewing Guide

1. What crucial divergence took place about 6 – 7 mya?
2. Hominid & hominins are terms what what?
3. The following are the main groups of “protohominids” (the earliest representatives of the hominid lineage”) known so far. For each, give the geographic areas where it’s known from.

Orrorin:

Ardipithecus

Sahalanthropus;

4. What kind of environment were these protohominids adapted to?

Biomechanics

5. Why might have bipedality been selected for? (name three possibilities)

6. What features that distinguish a biped (human) from a quadruped (ape)? Five are discussed in the video.

Would the First Biped Please Stand Up?

7. Where are humans (hominids) thought to have originated from?

8. We can look at a simple time sequence to get an idea of what changes are occurring. Around 4 mya in Kenya and Ethiopia, we have evidence of _____ (with jaws, teeth, and some post crania that tell us it was adapted for bipedal walking). Several hundred thousand years later, we see the appearance of _____ (best known member is Lucy which was found in Ethiopia); it's known from partial skulls, jaws, and parts of the skeleton over a period of nearly a million years 3.8 – 2.8 my; males stood nearly _____ tall and weighed over _____, females stood _____ and weighed _____.

9. In 1924, Raymond Dart discovered the "Taung Child". Why was it an anomaly? Because of this, did it look more like a chimp or a human?

10. What key feature in "Mrs Ples" was a clear indication that she was a habitual biped?

11. What species do the Taung Child and Mrs. Ples belong to? When did this species live? Where did this species live?

12. At about 2.5 million years old the evolutionary tree branches into two significantly different evolutionary lineages. On one hand we have _____ and on the other, our own genus, _____. Within the australopiths, there is an interesting distinction between _____ forms and _____ forms. *A. africanus* is a _____ form (with smaller dentition and jaw structure); *Paranthropus*, an East African australopith, is a _____ (with megadont dentition and a very thick mandible). Robust forms have also been found in _____.

13. When did the first species of the genus *Homo*, *Homo habilis*, first appear? What happened to the climate during this time?

14. What was *Paranthropus* adapted to?

15. When did *Paranthropus* go extinct (die out)?

16. Olduvai Gorge in Tanzania is an interesting site because it shows evidence of two hominid species living at the same time in East Africa. What were these two species?

17. Is *H. habilis* thought to be a hunter or a scavenger?

18. With *H. habilis*, we begin to see “glimmerings” of the origins of humanity. What are some of these “glimmerings” (characteristics) that distinguish *H. habilis*?

BIO ANTH CHAPTER 11 READING GUIDE

Start with reading pages 309 - 312 (up to “The First Hominids?”) very carefully. Skim the rest of the chapter to fill in the table below, or to understand the fossils better.

WILL YOU KNOW A HOMINID WHEN YOU SEE ONE?

1. Hominids are the family of primates that includes (p. 309) _____

2. A fundamental adaptation in the hominid lineage is (p. 309) _____

THE FIRST HOMINIDS?

Where has the majority of fossil evidence of the earliest hominids come from? (p. 312)

This chapter, and those that follow, contain a lot of information about different fossil hominids. For the different species and/or fossils, you want to ask yourself: how old is it and where did it come from. Try to get a general sense of what it looked like (although you do not need to record information on characteristics here).

The following hominids listed below are discussed on pages 313-334. Read through these pages to fill out the following table (we’ve done the first one for you).

Hominid Name (Scientific and “Nickname”)	Age	Geographic Location
<i>Sahelanthropus tchadensis</i> (Toumai)	6.0 - 7.0 million years ago	Northern Chad (western Africa)
<i>Orrorin tugenensis</i> (Millienium Man)		

Hominid Name (Scientific and “Nickname”)	Age	Geographic Location
<i>Ardipithecus ramidus</i> (Ardi)		
<i>Australopithecus anamensis</i>		
<i>Australopithecus afarensis</i> (Lucy)		
<i>Australopithecus africanus</i>		
<i>Australopithecus (Paranthropus) aethiopicus</i> (The Black Skull)		
<i>Australopithecus (Paranthropus) robustus</i>		
<i>Australopithecus (Paranthropus) boisei</i>		

BIO ANTH CHAPTER 12 READING GUIDE

DEFINING THE GENUS *HOMO*

1. Scientists think that *Homo* differs from australopithecines due to differences in adaptive strategies. What are some of the general differences between these two? (p. 341-342).

EARLIEST GENUS *HOMO*

2. Olduvai Hominid 7 (OH 7), which was discovered by Louis and Mary Leakey, was assigned to the species *Homo habilis*. It is the earliest known member of the genus *Homo*. What are some key anatomical features of this hominid? (Figure 12.1, p. 342).

EARLY TOOL USE

3. When do stone tools first appear? (p. 344). What was the name of this tool industry?

4. The use of tools enabled these early hominids to do what?

Read “Insights and Advances” box on p. 347.

5. Why do Robert Blumenshine and Curtis Marean think that early hominids were scavengers rather than hunters? (p. 347)

Skip figure 12.5 on pp. 348 and 349.

WHO WAS *HOMO ERECTUS*?

6. What happened 1.8 million years ago? How is this reflected in the fossil record? What hominid appeared in Africa at this time? (p. 348)

7. How long did *Homo erectus* persist and what part of the world is the last fossil evidence found? (p. 350)

8. What are anatomical features of *Homo erectus* (and *Homo ergaster*). (p. 350 – 356, especially Fig. 12.6).

A note about *Homo ergaster* vs. *Homo erectus*: these are essentially geographic variants of the same animal. *Homo ergaster* is African and European (from the Republic of Georgia, anyhow), and *Homo erectus* is Asian. At least for now – but this will no doubt change as scientists learn more.

Skim from “*Homo erectus* around the world” on p. 356 to “The First African Diaspora” on p. 358).

9. In the 1990s, scientists found *Homo erectus*-like fossils from the Republic of Georgia. These fossils really proved problematic and changed our thinking about when the genus *Homo* left Africa (where it is believed to have originated). What is the age of these fossils? What tool technology is associated with these fossils? How are they similar to *H. erectus*? How are they similar to *H. habilis*?

Skip “Dispersal into East Asia” on p. 359 to “The Lifeways of *Homo erectus*” on p. 364.

Two different tool technologies are found with *Homo erectus*. What are these? (p. 364)

What is the acheulean tool industry? What are the dates of this industry? (p. 364)

What is the movius line? (p. 366)

The Mind's Big Bang
Viewing Guide

1. Identify the key events mentioned in the video that occurred at:

6 million years _____

4 million years _____

2.5 million years _____

2 million years _____

60,000 years _____

50,000 years _____

43,000 years _____

38,000 years _____

2. Trash pits at the cave in Turkey has yielded what type of information?

3. What were some of the physical characteristics of the Neandertals?

4. What were some of the cultural characteristics of Neandertals?

5. What is one hypothesis proposed to explain how cave art was created?

6. What neurological change is believed to have occurred to the brain 50,000 years ago?

7. Describe how chimps are similar in brain capacity to a 3 year old child?

8. What new cognitive ability do normally developing children acquire at around 4 or 5 years of age?

9. List two or three possible purposes of language from an evolutionary standpoint.

10. What is a meme? Suggest some memes other than those identified in the video.

Premodern Humans
Viewing Guide

1. When did premodern humans exist?
2. What was the climate like during this time? Why is “ice age” potentially a confusing term?
3. What does the term “glaciation” refer to? What is an interglacial?
4. The Pleistocene Epoch is divided into the following three segments. Give the time interval for each segment.
5. What are some Neandertal traits mentioned in the video?
6. What can we infer from these traits?
7. Are fossil bones of Neandertals and Modern Humans ever found at the same site?
8. Are similar Neandertal and Modern Human tools ever found at the same site?
9. What is the Paleolithic Era? (Note this is a different question than “what is the Pleistocene epoch”!)
10. When did the Paleolithic era start? When did it end?

CHAPTER 13 READING GUIDE

Read introductory comments on p. 373-374.

HOMINID EVOLUTION IN THE MID- TO LATE PLEISTOCENE

1. Archaic *H. sapiens* are intermediate between _____ and _____
2. What are the features of anatomically modern *Homo sapiens*? (Figure 13.1 on p. 375).
3. Read about the archaic *Homo sapiens* in Europe (p. 375-378). Where are specimens of archaic *Homo sapiens* found in particular and what are the dates of these fossils?
4. What is unusual about the fossils from Sima de los Huesos?
5. What kinds of tools did archaic *Homo sapiens* use? (p. 379-380)

You can skip to the bottom of page 382 after answering the question above.

THE NEANDERTALS

6. The term Neandertals refers to what? (p. 382-383) Include information about time and location!
7. The time during which neandertals lived was marked by extremes in temperature fluctuations. As result, _____ is an important variable for understanding the origin and evolution of this group. (p. 383)

8. Neandertals are known by two different formal taxonomic names (depending on who the scientist is). What are these two names? (p. 383)

The information under “History of Neandertal Discovery” (p. 383 – 389) is optional reading.

NEANDERTAL ANATOMY AND DNA

9. What are the features of Neandertal skulls and teeth? (Figure 13.14 on p. 390, also p. 390-393).

10. What are the features of Neandertal postcranial skeleton? (p. 393)

The information under “Growth and Development” and “Health and Disease” is optional reading.

NEANDERTAL BEHAVIOR

Neandertals were all over the map (meaning there was a lot of variation) with respect to stone tool use, so the section on “Material Culture” is a little confusing. We’ll keep things simple here.

11. Early Neandertals are associated with _____ tools. (p. 406).

12. What is the most unusual tool associated with the Neandertals? (p. 399)

What are two different lines of evidence that suggest Neandertals lived in cold environments? (p. 399-400)

How did Neandertals cope with cold environments?

After answering the above question, you can skip the rest of the chapter.

Neanderthals on Trial
Viewing Guide

NOTE: Click on the “FBI Warning” box to launch this DVD.

1. When did Neanderthals go extinct?
2. How has mitochondrial DNA been used to determine whether humans and Neandertals were the same species?
3. How do Ian Tattersall and Erik Trinkaus differ in their views on Neanderthals?
4. What is the date of the site in Portugal where Joao Zilhao made his discovery?
5. What are some of the characteristics of the Neanderthal found at this site and why is it so unusual?

5. What is the replacement model?

6. What is the multiregional model?

ANATOMY AND DISTRIBUTION OF EARLY HUMANS

Look at Figure 14.2 on page 413 showing geographic distribution of early humans and the dates of important paleontological and archeological sites.

7. What is the oldest early human? Where does it come from and how old is it? (Figure 14.2, also p. 412)

8. Modern humans first appear out of Africa about 110,000 years ago in what region? (Figure 14.2, also p. 414)

9. The oldest currently known modern human in Europe comes from a site in Romania and dates to _____ (p. 414)

10. The Dordogne region of France shows that two hominid species (or sub-species) overlapped in time and space. What are these two species (or sub-species)? (p. 414-415)

11. Regarding Asia, definitively anatomically modern humans do not appear until _____ in China and _____ in Indonesia. (p. 415-416)