

# ASSESSMENT RUBRICS



## TEACHER'S GUIDE UNIT 1—WHAT IS THE NATURE OF SCIENCE? *In-depth Investigation Assessment Rubric*

	Excellent	Satisfactory	Needs Improvement
<b>Team Process</b>	Work well together to arrange available evidence (puzzle pieces) • Listen to all team members' ideas before deciding on hypotheses • Collaborate well with other teams, listening to others' hypotheses and reasons before revising their own	Work together to arrange puzzle pieces, but have problems discussing the hypotheses reflected by the evidence • Listen to other teams' hypotheses, but not sure how to use information to refine own hypotheses	Don't work together to arrange puzzle pieces • Don't listen to each other's suggested hypotheses and cannot agree on hypotheses • Don't look at other teams' evidence or listen to other teams' hypotheses and reasons
<b>Team Product</b>	Build their puzzle from all available pieces of evidence • Create several hypotheses and refine final hypothesis based on their evidence and collaboration with other teams • Give reasons for their hypothesis.	Build their puzzle from all available pieces • Create hypotheses, but can't explain how their final hypothesis reflects their evidence and evidence of other teams	Don't use all pieces of evidence in their puzzle • Don't create hypotheses that reflect their evidence • Can't give reasons for their hypotheses
<b>Discussion</b>	Answer all guiding questions • Thoroughly understand how the simulation demonstrates the nature of science and what the limitations of the simulation are	Able to answer some of the guiding questions • Partially understand how the simulation demonstrates the nature of science and what the limitations of the simulation are	Don't answer guiding questions • Don't understand how the simulation demonstrates the nature of science and what the limitations of the simulation are

## TEACHER'S GUIDE UNIT 2—WHO WAS CHARLES DARWIN? *In-depth Investigation Assessment Rubric*

	Excellent	Satisfactory	Needs Improvement
<b>Team Process</b>	Work well together to design and conduct their experiment • Listen to all team members' ideas • Work well to analyze their data and create a presentation of their results	Work together to design and conduct their experiment • Listen to each other fairly well • Have some problems analyzing their data and creating a presentation of results	Don't work together to design and conduct their experiment • Don't listen to each other's suggestions and cannot agree on a design • Don't understand how to analyze their data and don't work well together to create a presentation of results
<b>Team Product</b>	Team Product Data is well organized • Their conclusions accurately reflect their data • Their visual display and presentation are well done	Data is fairly well organized • Their conclusions don't quite reflect all of their data • Their visual display and presentation are adequate, but not exceptional.	Data is not well organized • They do not know how to use the data to reach a conclusion • Their visual display and presentation are poor
<b>Discussion</b>	Answer all guiding questions • Thoroughly understand how their experiment relates to the colonization of islands by plants • Thoughtfully compare their results with Darwin's	Able to answer some of the guiding questions • Partially understand how their experiment relates to the colonization of islands by plants • They partially understand how their results compare with Darwin's	Don't answer guiding questions • Don't understand how their experiment relates to the colonization of islands by plants • Don't understand how their results compare to Darwin's



## TEACHER'S GUIDE UNIT 3—WHAT IS THE EVIDENCE FOR EVOLUTION? *In-depth Investigation Assessment Rubric*

	Excellent	Satisfactory	Needs Improvement
<b>Team Process</b>	Work well together, dividing the job of counting amino acid differences in the different animals • Do backup counts and check with each other to confirm counting accuracy, re-counting if there is not a match • Help each other with any questions of understanding or procedure	Work together to divide the job of counting amino acid differences • Do not double check each other • Do not often take the initiative of asking questions or checking each other's understanding	Do not divide the counting task • One or two do the counting, while the others are not engaged • Little or no effort by anyone to get everyone involved or to offer or seek help in understanding
<b>Team Product</b>	Record their counts in the proper spaces on the cladogram • Find that their results are consistent with the counts by other teams	Find and record the differences for all requested animals, but they may not all be confident of the accuracy of all counts, or there may be errors • Do not check this with other teams	Do not get total counts for every animal requested • Cladogram spaces are not all completed
<b>Discussion</b>	Discuss each question before arriving at a consensus response for each question • Any student at random can explain any given answer, and can accurately explain the main points of the objective • All analysis questions are accurately answered	Do not always initiate discussion or seek help when needed • Some students may not be involved in the process • May not be able to explain all answers or the main points of the objective • Able to answer most of the analysis questions	Do not understand the questions • Cannot explain any of the objective items • Do not answer most of the analysis questions

## TEACHER'S GUIDE UNIT 4—HOW DOES EVOLUTION WORK? *In-depth Investigation Assessment Rubric*

	Excellent	Satisfactory	Needs Improvement
<b>Team Process</b>	Work well together to create beaks and conduct their simulation • Work well to analyze their data	Work together to create beaks and conduct their simulation • Have some problems analyzing their data	Don't work together to create their beaks and conduct their simulation • Don't understand how to analyze their data
<b>Team Product</b>	Data is well organized • Their conclusions accurately reflect their data	Data is fairly well organized • Their conclusions don't quite reflect all of their data	Data is not well organized • They do not know how to use the data to reach a conclusion
<b>Discussion</b>	Thoroughly understand how their simulation relates to natural selection and how it is similar and different than the real world	Partially understand how their simulation relates to natural selection and how it is similar and different than the real world	Don't understand how their simulation relates to natural selection and how it is similar and different than the real world

## TEACHER'S GUIDE UNIT 5—HOW DID HUMANS EVOLVE? *In-depth Investigation Assessment Rubric*

	Excellent	Satisfactory	Needs Improvement
<b>Team Process</b>	Work well together to map the data • Work well to analyze the data and answer discussion questions • Listen to all team members' ideas	Work together fairly well to map the data • Have some problems analyzing the data and answering discussion questions • Listen to each other fairly well	Don't work together to map the data • Don't understand how to analyze the data and answer the discussion questions • Don't listen to each other's suggestions
<b>Team Product</b>	Data is mapped accurately • Their conclusions accurately reflect the data	Data is mapped fairly accurately • Their conclusions don't quite reflect the data	Data is not mapped accurately • They do not understand how to interpret the data
<b>Discussion</b>	Answer all discussion questions • Thoroughly understand how to interpret hominid migration from the fossil data	Able to answer some of the discussion questions • Partially understand how to interpret hominid migration from the fossil data	Don't answer discussion questions • Don't understand how to interpret hominid migration from the fossil data

## TEACHER'S GUIDE UNIT 6—WHY DOES EVOLUTION MATTER NOW? *In-depth Investigation Assessment Rubric*

	Excellent	Satisfactory	Needs Improvement
<b>Team Process</b>	Excellent research using many reliable resources	Research includes a few good resources	Poor research, relying on few sources whose reliability is questionable
<b>Team Product</b>	Provide excellent information from assigned point of view • Do excellent job staging and running Town Meeting • Article is well written and offers conclusions based on the variety of information presented	Provide adequate information from assigned point of view • Do fairly good job staging and running Town Meeting • Article is fairly well done and is mostly based on information presented	Doesn't provide information from assigned point of view • Do poor job staging and running Town Meeting • Article is poorly written and does not reflect information in class presentations
<b>Discussion</b>	Thoroughly understand different points of view about the topic and can discuss the pros and cons of each position	Partially understand different points of view and can discuss the pros and cons of some positions	Don't understand the different points of views and cannot intelligently discuss the pros and cons of different positions

# GLOSSARY



## **adaptation**

any heritable characteristic of an organism that improves its ability to survive and reproduce in its environment; also used to describe the process of genetic change within a population, as influenced by natural selection

## **amino acid sequence**

a series of amino acids, the building blocks of proteins, usually coded for by DNA (exceptions are those coded for by the RNA of certain viruses, such as HIV)

## **antibiotic resistance**

a heritable trait in microorganisms that enables them to survive in the presence of an antibiotic

## **artifact**

an object made by humans that has been preserved and can be studied to learn about a particular time period

## **artificial selection**

the process by which humans breed animals and cultivate crops to ensure that future generations have specific desirable characteristics; in artificial selection, breeders select the most desirable variants in a plant or animal population, and selectively breed them with other desirable individuals

## **australopithecine**

a group of bipedal hominid species belonging to the genus *Australopithecus* that lived between 4.2 and 1.4 mya

## ***Australopithecus afarensis***

an early australopithecine species that was bipedal; known fossils date between 3.6 and 2.9 mya (for example, Lucy)

## **big bang theory**

theory that states that the universe began in a state of compression to infinite density and that in one instant all matter and energy began expanding and they have continued expanding ever since

## **bioengineered food**

food that has been produced through genetic modification using techniques of genetic engineering

## **biogeography**

the study of patterns of geographical distribution of plants and animals across the Earth, and of the changes in those distributions over time

## **biosphere**

the part of the Earth and its atmosphere capable of sustaining life

## **Cenozoic**

the era of geologic time from 65 mya to the present, a time when the modern continents formed and modern animals and plants evolved

## **centromere**

a point on a chromosome that is involved in separating the copies of the chromosome produced during cell division; during this division, paired chromosomes look somewhat like an X, and the centromere is the constriction in the center

## **cladogram**

a branching diagram that illustrates hypotheses about the evolutionary relationships among groups of organisms; cladograms can be considered as a special type of phylogenetic tree that concentrates on the order in which different groups branched off from their common ancestors

## **coevolution**

evolution in two or more species, such as a predator and its prey, or a parasite and its host, in which evolutionary changes in one species influence the evolution of the other species

## **contrivance**

an object or characteristics used or modified to do something clearly different from its usual use

## **creationism**

the religious doctrine that all living things on Earth were each created separately, in more or less their present form, by a supernatural creator, as stated in the Bible; the precise beliefs of different creationist groups vary widely

## **“creation science”**

an assortment of many different, non-scientific attempts to disprove evolutionary theory, and efforts to prove that the complexity of living things can be explained only by the action of an “intelligent designer”

## **DNA base sequence**

a chain of repeating units of deoxyribonucleotides (adenine, guanine, cytosine, thymine) arranged in a particular pattern

## **enzyme**

a protein that acts as a catalyst for chemical reactions

## **Eocene**

from 54 to 38 mya, the second oldest of the five major epochs of the Tertiary Period; it is often known for the rise of mammals

## **evolution**

in general terms, biological evolution is the process of change by which new species develop from preexisting species over time; in genetic terms, evolution can be defined as any change in the frequency of alleles in populations of organisms from generation to generation

## **fact**

a natural phenomenon repeatedly confirmed by observation

## **fossil**

most commonly, an organism, a physical part of an organism, or an imprint of an organism that has been preserved from ancient times in rock, amber, or by some other means; new techniques have also revealed the existence of cellular and molecular fossils

## **founder effect**

the loss of genetic variation when a new colony is formed by a very small number of individuals from a larger population

## **genetic drift**

changes in the frequencies of alleles in a population that occur by chance, rather than because of natural selection

## **genetic engineering**

removing genes from the DNA of one species and splicing them into the DNA of another species, using the techniques of molecular biology

## **half-life**

the amount of time it takes for one half of the atoms in a radioactive isotope to decay to a stable form

## **hominids**

members of the family Hominidae, which includes only modern humans and their ancestors

## ***Homo erectus***

a species of hominid that lived between 1.8 mya and 300,000 years ago; the first *Homo* species to migrate beyond Africa

## ***Homo habilis***

a species of hominid that lived between 1.9 and 1.8 mya, the first species in genus *Homo*, and the first hominid associated with clear evidence of tool manufacture and use

## ***Homo neanderthalensis***

a species of hominid that lived between 150,000 and 30,000 years ago in Europe and Western Asia, originally thought to be a geographic variant of *Homo sapiens*, now generally accepted to be a distinct species

**Homo sapiens**

modern humans, evolved to present form about 100,000 years ago

**homologous structures**

structures shared by a set of related species because they have been inherited, with or without modification, from their common ancestor (for example, the bones that support a bat's wing are similar to that of a human arm)

**hypothesis**

an explanation of one or more phenomena in nature that can be tested by observations, experiments, or both; in order to be considered scientific, a hypothesis must be falsifiable—which means that it can be proven to be incorrect

**intelligent design**

the non-scientific argument that complex biological structures have been designed by an unidentified supernatural or extra-terrestrial intelligence

**inversion**

a segment of a chromosome that has been turned around so that the order of the nucleotides in the DNA is reversed (specifically, where a small portion of a chromosome is upside down compared to the same region of an otherwise identical chromosome)

**isotope**

an atom that shares the same atomic number and position as other atoms in an element but has a different number of neutrons and thus a different atomic mass

**law**

a description of how a natural phenomenon will occur under certain circumstances

**meiosis**

a type of cell division that occurs only in the reproductive cells of organisms, during which paired chromosomes are separated into different daughter cells, reducing the number of chromosomes in those daughter cells by half

**mitochondrial DNA**

DNA found in the mitochondrion, a small round body found in most cells, that produces enzymes to convert food to energy; because mitochondria are generally carried in egg cells but not in sperm, mitochondrial DNA is passed to offspring from mothers, but not fathers

**mutation**

a change in genetic material that results from an error in replication of DNA; mutations can be beneficial, harmful, or neutral

**natural selection**

a process by which the forms of organisms in a population that are better adapted to their local environment increase in frequency relative to less well-adapted forms over one or more generations

**Neanderthal**

a hominid, similar to but distinct from, modern humans, that lived in Europe and Western Asia about 150,000 to 30,000 years ago

**paleoanthropologist**

someone who uses fossil evidence to study early human ancestors

**paleontologist**

a scientist who studies fossils to better understand life in prehistoric times

**pathogen**

a microorganism that causes disease

**pesticide-resistant insects**

insects with the ability to survive and reproduce in the presence of pesticides; these resistant variants increase in frequency over time

**phylogeny**

the study of ancestral relations among species, often illustrated with a “tree of life” branching diagram, which is also known as a phylogenetic tree

**postulate**

a basic principle

**radiometric dating**

a dating technique that uses the decay rate of radioactive isotopes to estimate the age of an object

**recombination**

the appearance in offspring of different gene combinations than are present in either parent; in most organisms whose cells have a nucleus, recombination occurs because of two processes that occur during the production of eggs and sperm; one process involves the random sorting of chromosomes into eggs and sperm; the other process, called crossing-over, involves exchange of DNA between chromosomes

**relative dating**

the process of ordering fossils, rocks, and geologic events from oldest to youngest; because of the way sedimentary rocks form, lower layers in most series are older than higher layers, making it possible to determine which fossils found in those layers are oldest, and which are youngest; by itself, relative dating cannot assign any absolute age to rocks or fossils

**science**

a way of knowing about the natural world based on observations and experiments that can be confirmed or disproved by other scientists using accepted scientific techniques

**species**

usually defined as a group of organisms capable of mating and producing fertile offspring with one another

**supernatural**

relating to phenomena that cannot be described by natural laws, cannot be tested by scientific methodology, and are therefore outside the realm of science

**symbiosis**

a relationship of mutual benefit between two organisms that live together

**taxon**

a group in biological classification such as species, genus, family, order, class, and phylum

**theory**

a well-substantiated explanation of some aspect of the natural world that typically incorporates many confirmed observations, laws, and successfully verified hypotheses

**transitional fossil**

a fossil, or group of fossils, representing a series of similar species, genera, or families, that link an older group of organisms to a younger group; often, transitional fossils combine some traits of older, ancestral species with traits of more recent species (for instance, a series of transitional fossils documents the evolution of fully aquatic whales from terrestrial ancestors)

**vestigial**

structures that have been greatly reduced in size and function over evolutionary time to the extent that they now appear to have little or no current function

# EVOLUTION SERIES INDEX



The entire *Evolution* TV series is available on home video on seven videocassettes, with a total viewing time of eight hours. For your convenience, we have described the series by program segments. You may want to use specific segments to focus classroom discussions and activities. To find a segment, queue up to the approximate starting time and look for the starting image.

## Show One: Darwin's Dangerous Idea (two hours)

Summary: Introduction to Charles Darwin and his theory of evolution by natural selection.

### Segment 1

Length: 4 min.

Starting image: Darwin and Fitzroy lead horses

Ending image: portrait of Darwin

Commentary from Daniel Dennet, Stephen Jay Gould, and James Moore.

### Segment 2

Approximate starting time: 4 min.

Length: 6 min.

Starting image: London, ships at dock

Ending image: Darwin talking to Fitzroy  
Darwin returns from voyage; tries to piece together data; discovers he has 13 species of finches.

### Segment 3

Approximate starting time: 10 min.

Length: 7 min., 30 sec.

Starting image: Darwin and Erasmus at Geological Society

Ending image: Darwin drawing tree of life  
Darwin encounters controversy at the Geological Society; Owen speaks of divine will.

### Segment 4

Approximate starting time: 17 min., 30 sec.

Length: 3 min.

Starting image: river in Ecuador

Ending image: hummingbird

Biologist Chris Schneider studies rainforest biodiversity; ornithologist Tom Smith studies the beaks of hummingbirds.

### Segment 5

Approximate starting time: 20 min., 30 sec.

Length: 1 min., 30 sec.

Starting image: tree of finches

Ending image: James Moore

Stephen Jay Gould and James Moore emphasize the importance of Darwin's idea that all finches are related to a common ancestor finch.

### Segment 6

Approximate starting time: 22 min.

Length: 7 min., 30 sec.

Starting image: rainforest

Ending image: fog over mountains

Chris Schneider and Tom Smith compare animals in the mountains to those found in lowland rainforest; hummingbirds hibernate at night and have different beak lengths.

### Segment 7

Approximate starting time: 29 min., 30 sec.

Length: 9 min.

Starting image: arrow hitting target

Ending image: Darwin in chair

Darwin courts Emma; talks about artificial and natural selection; reads Malthus' essay about population.

### Segment 8

Approximate starting time: 38 min., 30 sec.

Length: 1 min., 30 sec.

Starting image: James Moore

Ending image: beetles

Discusses beetles' protective coloring as example of natural selection.

### Segment 9

Approximate starting time: 40 min.

Length: 11 min., 30 sec.

Starting image: HIV cells

Ending image: man swimming

Jeff Gustavson and Clarence Johnson have been battling HIV for years; virus evolves drug-resistance; Dr. Veronica Miller found that if patient went off drugs, virus returned to wild-type, then she could attack the virus with drugs.

### Segment 10

Approximate starting time: 51 min., 30 sec.

Length: 6 min., 30 sec.

Starting image: man pushing wheelbarrow

Ending image: Emma looking down

Erasmus tries to convince Darwin to publish; Owen has assembled sloth and thinks divine creator made blueprint.

### Segment 11

Approximate starting time: 58 min.

Length: 11 min.

Starting image: James Moore

Ending image: trees outside cottage

Kenneth Miller discusses how the intricacy of the eye was considered proof of God; Dan-Eric Nilsson studies eye evolution, models different types of eyes.

### Segment 12

Approximate starting time: 69 min.

Length: 12 min.

Starting image: Darwin looking through microscope

Ending image: Annie's gravestone

Darwin studying barnacles, assembling evidence for theory; Annie becomes ill and dies; Darwin refuses to enter church, cannot believe a God could exist that would kill an innocent child.

### Segment 13

Approximate starting time: 81 min.

Length: 5 min.

Starting image: children singing

Ending image: James Moore

Kenneth Miller, author of *Finding Darwin's God*, believes religion compatible with evolution.

### Segment 14

Approximate starting time: 86 min.

Length: 13 min.

Starting image: Darwin at party

Ending image: Darwin with Erasmus

Owen presents views on human superiority; Huxley champions Darwin's ideas; Darwin publishes a joint paper with Wallace; Darwin publishes *On the Origin of Species*.

### Segment 15

Approximate starting time: 99 min.

Length: 4 min., 30 sec.

Starting image: man with beard

Ending image: DNA from different animals

Creationists against evolution because believe human soul at stake; DNA now used to show comparisons between animals.

### Segment 16

Approximate starting time: 103 min., 30 sec.

Length: 4 min.

Starting image: Chimp Dr. license plate

Ending image: river

Psychologist Sally Boysen compares developmental milestones in chimps and humans.

### Segment 17

Approximate starting time: 107 min. 30 sec.

Length: 2 min.

Starting image: church in England

Ending image: Darwin's face

Darwin died in 1882 and was interred at Westminster Abbey.

## Show Two: Great Transformations (one hour)

Summary: Examines the history of life on Earth, including the role of transitional fossils in deciphering the fossil record.

### Segment 1

Length: 2 min., 30 sec.

Starting image: pole vaulter

Ending image: dolphin

How did each creature alive today evolve so differently?

### Segment 2

Approximate starting time: 2 min. 30 sec.

Length: 11 min., 30 sec.

Starting image: sunrise on mountains

Ending image: whale bones

Paleontologist Phil Gingerich found a fossil in Pakistan that looked like part of a wolf-like creature but had the inner ear of a whale; some skeletons have been found of whales with legs.

### Segment 3

Approximate starting time: 14 min.

Length: 3 min.

Starting image: dolphins

Ending image: river bank

Frank Fish studies how mammals swim—fish flex their spine from side to side and mammals move it up and down.

### Segment 4

Approximate starting time: 17 min.

Length: 6 min.

Starting image: Volvo on road

Ending image: fish fossil

Limbs developed first on aquatic creatures; Jenny Clack found a fish with fingers.

### Segment 5

Approximate starting time: 23 min.

Length: 3 min.

Starting image: Neil Shubin

Ending image: fossil

Evolution is not a goal-directed process; it's a tinkering.

### Segment 6

Approximate starting time: 26 min.

Length: 5 min.

Starting image: fossil

Ending image: fossil

During the Cambrian explosion, many diverse

animals suddenly appear on Earth; in 1913, Charles Walcott found 540 million-year-old sea creatures in the Burgess Shale.

### Segment 7

Approximate starting time: 31 min.

Length: 13 min., 30 sec.

Starting image: Shubin

Ending image: Levine

Bill McGinnis and Mike Levine found the "master switch," a gene turned on in a band in an early embryo.

### Segment 8

Approximate starting time: 44 min., 30 sec.

Length: 10 min.

Starting image: people at café

Ending image: Shubin

Liza Shapiro studies the movement of living primates; chimpanzees share 99% of their DNA with humans; a series of chance coincidences led to human bipedalism.

## Show Three: Extinction! (one hour)

Summary: Traditionally, extinction and evolution have been in balance. Today, extinction far outpaces the evolution of new species.

### Segment 1

Length: 2 min.

Starting image: forest

Ending image: debris

Extinction is the termination of a species; an average lifetime for a species is 4 million years.

### Segment 2

Approximate starting time: 2 min.

Length: 4 min., 30 sec.

Starting image: bird flying

Ending image: animation sequence

There have been five mass extinctions; geologist Peter Wards studies mass extinctions.

### Segment 3

Approximate starting time: 6 min., 30 sec.

Length: 11 min.

Starting image: open plain

Ending image: wheat in sunset

End of Permian, all but a few species became extinct; Mike Novacek studies small mammals that lived alongside dinosaurs and survived the mass extinction.

### Segment 4

Approximate starting time: 17 min., 30 sec.

Length: 3 min., 30 sec.

Starting image: asteroid

Ending image: footprints in ash

In the K-T event, an asteroid crashed on earth and dinosaurs became extinct but mammals survived.

### Segment 5

Approximate starting time: 21 min.

Length: 1 minute

Starting image: people boarding boat

Ending image: barges on river

6 billion people inhabit the earth; current rate of extinction now 100 times greater than normal.

### Segment 6

Approximate starting time: 22 min.

Length: 2 min., 30 sec.

Starting image: fog over trees

Ending image: raft down river

Alan Rabinowitz of the Wildlife Conservation Society studies total number of species in Kaeng Krachan National Park in Thailand.

### Segment 7

Approximate starting time: 24 min., 30 sec.  
Length: 10 min.

Starting image: animated sun  
Ending image: men walking through woods  
The presence of healthy carnivores, at the top of the food chain, indicates a healthy forest; number one cause of extinction is habitat destruction by humans.

### Segment 8

Approximate starting time: 34 min., 30 sec.  
Length: 5 min.

Starting image: shoreline of Hawaii  
Ending image: tree close-up  
Number two cause of extinction is invasive species; paleontologist David Burney studies the biological invaders brought to Hawaii by the Polynesians.

### Segment 9

Approximate starting time: 39 min., 30 sec.  
Length: 3 min., 30 sec.

Starting image: plane  
Ending image: sky over water  
Modern transportation has increased rate of species invasion.

### Segment 10

Approximate starting time: 43 min.  
Length: 2 min., 15 sec.

Starting image: sky  
Ending image: face of scientist  
Weed species are mobile, adaptive, flexible; humans are the most successful weeds of all time.

### Segment 11

Approximate starting time: 45 min., 15 sec.  
Length: 5 min., 15 sec.

Starting image: North Dakota farm  
Ending image: truck driving away  
Sy Kittleston has introduced the flea beetle, a non-native species, to his farm to keep an invading weed in check.

### Segment 12

Approximate starting time: 50 min., 30 sec.  
Length: 4 min.

Starting image: fog over trees  
Ending image: room of animal skulls  
Rabinowitz's team found photos of carnivores; maybe it's still possible to avoid a mass extinction.

## Show Four: Evolutionary Arms Race (one hour)

Summary: Predators and their prey evolve alongside one another in an escalating arms race.

### Segment 1

Length: 1 min., 50 sec.

Starting image: Moscow traffic  
Ending image: crowd  
Idea of evolutionary arms race; disease in Russian prisons released to population at large.

### Segment 2

Approximate starting time: 1 min., 50 sec.  
Length: 6 min., 30 sec.

Starting image: Oregon landscape  
Ending image: newt in tank  
Edmund Brodie, Jr. and his son study a poisonous newt in an arms race against a garter snake.

### Segment 3

Approximate starting time: 8 min., 20 sec.  
Length: 3 min.

Starting image: E.O. Wilson  
Ending image: pills on conveyor belt  
Predator and prey relationship drives evolution; humans' only predator since civilization is infectious disease.

### Segment 4

Approximate starting time: 11 min., 20 sec.  
Length: 14 min., 30 sec.

Starting image: cell door  
Ending image: multiplying microbes

Antibiotic-resistant strains of tuberculosis reign in crowded Russian prisons; microbiologist Alex Goldfarb trying to change the way TB treated.

### Segment 5

Approximate starting time: 25 min., 50 sec.  
Length: 5 min., 30 sec.

Starting image: man walking dog  
Ending image: man walking away from camera  
Evolution can domesticate a disease.

### Segment 6

Approximate starting time: 31 min., 20 sec.  
Length: 7 min.

Starting image: cheetah fur  
Ending image: lion's face  
Geneticist Stephen O'Brien studies feline resistance to immunodeficiency virus; O'Brien found mutation in humans that protects against HIV infection.

### Segment 7

Approximate starting time: 38 min., 20 sec.  
Length: 3 min.

Starting image: E.O. Wilson  
Ending image: girl wearing glasses  
Introduces mutualistic symbiosis.

### Segment 8

Approximate starting time: 41 min., 20 sec.  
Length: 9 min.

Starting image: tropical forest  
Ending image: "antibacterial" label  
Ted Schultz and Ulrich Mueller studying leafcutter ants in the Amazon rainforest; grad student Cameron Currie found alliance of four organisms.

### Segment 9

Approximate starting time: 50 min., 20 sec.  
Length: 4 min.

Starting image: doctor in hospital  
Ending image: boy leading cows  
Pediatrician Erika Von Mutius treats allergies and asthma; compares children of farmers and non-farmers.

### Segment 10

Approximate starting time: 54 min., 20 sec.  
Length: 1 minute, 30 sec.

Starting image: crowd  
Ending image: crowd  
E.O. Wilson: mistake for us to separate ourselves from all other organisms.

## Show Five: Why Sex? (one hour)

Summary: Examines how sex evolved as the means of reproduction.

### Segment 1

Length: 2 min.

Starting image: molting peacock  
Ending image: walrus couple in sunset  
Prologue outlines topic of sexual selection.

### Segment 2

Approximate starting time: 2 min.  
Length: 5 min.

Starting image: Texas landscape  
Ending image: Meredith Small  
Jerry Johnson studies a type of lizard that clones itself.

### Segment 3

Approximate starting time: 7 min.  
Length: 7 min., 15 sec.

Starting image: Mexican village  
Ending image: men playing basketball  
Robert Vrijenhoek studies a minnow that uses both sexual and asexual reproduction; sex generates variability among offspring and is the best defense against evolving enemies.

### Segment 4

Approximate starting time: 14 min., 15 sec.  
Length: 3 min.

Starting image: single-celled organisms  
Ending image: flying peacock  
Sex evolved from a random encounter of two single-celled creatures; males and females evolved with sperm and eggs.

### Segment 5

Approximate starting time: 17 min., 15 sec.  
Length: 8 min.

Starting image: Marion Petrie  
Ending image: Katharine Hepburn  
Males compete for the right to mate with females and females choose the mate with the best genes; Petrie has found that peahens choose peacocks with the largest tails.

### Segment 6

Approximate starting time: 25 min., 15 sec.  
Length: 5 min., 30 sec.

Starting image: man walking in woods  
Ending image: jacana chick  
Stephen Emlen studies songbirds; 40% of chicks do not belong to the father raising them; female Wattled Jacanas have taken on a male role.

### Segment 7

Approximate starting time: 30 min., 45 sec.  
Length: 8 min., 30 sec.

Starting image: Tree of Life animation  
Ending image: animation of early humans  
Chimpanzees and bonobos have evolved very different social systems due to an ancient drought; chimps make war and bonobos make love.

### Segment 8

Approximate starting time: 39 min., 15 sec.  
Length: 7 min.

Starting image: Meredith Small  
Ending image: masculine computer image  
Evolutionary psychologists study how human evolutionary history affects the way we think today; Victor Johnston studies the correlation between beauty and fertility.

### Segment 9

Approximate starting time: 46 min., 15 sec.  
Length: 5 min., 30 sec.

Starting image: men walking on campus  
Ending image: Picasso painting  
Geoffrey Miller believes that artistic expression comes from a drive to impress the opposite sex.

### Segment 10

Approximate starting time: 51 min., 45 sec.  
Length: 2 min., 30 sec.

Starting image: cranes courting  
Ending image: family  
The ancestors who had the most surviving offspring were those who found sex to be fun and parenting rewarding.

## Show Six: The Mind's Big Bang (one hour)

Summary: Examines the evolution of the human mind.

### Segment 1

Length: 2 min., 30 sec.

Starting image: flashlight beam in cave  
Ending image: people running past sunset  
Archaeologist Randy White studies cave paintings; modern humans developed communication and culture.

### Segment 2

Approximate starting time: 2 min., 30 sec.  
Length: 1 minute

Starting image: skull  
Ending image: Rick Potts  
Rick Potts studies stone tools from the Great Rift Valley in East Africa; hominids made the same stone axes for about 1 million years.

### Segment 3

Approximate starting time: 4 min., 15 sec.  
Length: 2 min.

Starting image: large rocks and trees  
Ending image: group of modern humans  
The humans of about 40,000 years ago would be recognizable to us, in terms of both behavior and physical appearance.

### Segment 4

Approximate starting time: 6 min., 15 sec.  
Length: 30 sec.

Starting image: Steven Pinker  
Ending image: world map showing migration routes  
Mary Stiner and Steve Kuhn have found shell beads from 43,000 years ago; the beads show the path of migration.

### Segment 5

Approximate starting time: 6 min., 45 sec.  
Length: 3 min.

Starting image: person sitting at table with laptop  
Ending image: beads  
Randy White demonstrates the bead-making techniques used 35,000 years ago.

### Segment 6

Approximate starting time: 9 min., 45 sec.  
Length: 2 min., 15 sec.

Starting image: fire  
Ending image: modern human skeleton decorated with beads  
Modern humans in ancient Europe encountered Neanderthals, a species that shared many characteristics but were more massive and less sophisticated.

### Segment 7

Approximate starting time: 12 min.  
Length: 4 min., 30 sec.

Starting image: modern human skull  
Ending image: John Shea pulling spear out of ground  
John Shea is trying to understand the differences between Neanderthals and modern humans by recreating some of their activities.

### Segment 8

Approximate starting time: 16 min., 30 sec.  
Length: 1 minute, 30 sec.

Starting image: ancient arrowheads  
Ending image: shell necklace  
Neanderthals lived in isolated pockets, while modern humans lived in larger groups and used portable art as a means of communication.

### Segment 9

Approximate starting time: 18 min.  
Length: 1 min.

Starting image: fire in cave  
Ending image: stalactites in cave  
Michel Lorblanchet studies the technique of cave painting; he can reproduce "spit painting."

### Segment 10

Approximate starting time: 19 min.  
Length: 1 minute, 30 sec.

Starting image: trees  
Ending image: Steven Pinker  
Richard Klein thinks modern humans became innovative because of a change in the brain; Stephen Pinker thinks there were many changes over a long period of time.

### Segment 11

Approximate starting time: 20 min., 30 sec.  
Length: 13 min.

Starting image: Richard Wrangham walking in forest  
Ending image: boy signing  
Chimpanzees use the threat of physical force for social climbing; with humans, language is the key to complex relationships; in 1980, deaf village children developed their own sign language in Managua.

### Segment 12

Approximate starting time: 33 min., 30 sec.  
Length: 4 min., 30 sec.

Starting image: Richard Dawkins watering flowers  
Ending image: two girls talking  
Dawkins thinks that those who could use language left the most offspring; Robin Dunbar has found that 2/3 of all conversations are gossip about social relationships.

**Segment 13**

Approximate starting time: 38 min.  
 Length: 5 min., 30 sec.  
 Starting image: Richard Dawkins  
 Ending image: Susan Blackmore  
 Susan Blackmore studies memes; today cultural evolution more likely than genetic evolution.

**Segment 14**

Approximate starting time: 43 min., 30 sec.  
 Length: 1 min.  
 Starting image: two people running on plain  
 Ending image: cave painting of hand  
 The mind's "Big Bang" led to a new era of the evolution of ideas.

**Show Seven: What About God?  
 (one hour)**

Summary: Examines the controversy surrounding evolution.

**Segment 1**

Length: 1 min., 30 sec.  
 Starting image: blue sky behind cliff  
 Ending image: skull outside classroom  
 Christian fundamentalists debate with scientists and teachers over the future of religion, science, and science education.

**Segment 2**

Approximate starting time: 1 min., 30 sec.  
 Length: 4 min.  
 Starting image: church exterior  
 Ending image: Ken Ham  
 Ken Ham, a fundamentalist, argues that if the Bible is wrong in regards to science, why trust it for morality?

**Segment 3**

Approximate starting time: 5 min., 30 sec.  
 Length: 2 min., 15 sec.  
 Starting image: speaker in front of crowd  
 Ending image: folk singer  
 Since the Scopes Monkey Trial in 1925, 37 anti-evolution bills have been passed in 20 states.

**Segment 4**

Approximate starting time: 7 min., 45 sec.  
 Length: 12 min.  
 Starting image: light coming through crevice  
 Ending image: Nathan Bard at counter  
 Rachel Benton, an anthropologist, discusses with students from Wheaton College how scientists determine the age of a watering hole; Nathan Bard tries to reconcile God with science.

**Segment 5**

Approximate starting time: 19 min., 45 sec.  
 Length: 3 min., 30 sec.  
 Starting image: students exiting building  
 Ending image: professor talking to students  
 Emi Hayashi, a student at Wheaton, is comfortable with both science and religion.

**Segment 6**

Approximate starting time: 23 min., 15 sec.  
 Length: 7 min.  
 Starting image: Wheaton College sign  
 Ending image: professor's face  
 Faculty at Wheaton sign a statement of faith; Kansas State University geologist Keith Miller said in a lecture at Wheaton that he sees no conflict between evolution and religion.

**Segment 7**

Approximate starting time: 30 min., 15 sec.  
 Length: 4 min., 30 sec.  
 Starting image: group of boys on stage  
 Ending image: discussion group  
 Peter Slayton, an anthropology major and young Earth creationist, says you can't pick sides because then you're doing bad science or bad theology.

**Segment 8**

Approximate starting time: 34 min., 45 sec.  
 Length: 1 minute  
 Starting image: Ken Ham in hallway  
 Ending image: Students at lockers  
 Ham thinks people will develop a sense of purposelessness if they're just a mixture of chemicals.

**Segment 9**

Approximate starting time: 35 min., 45 sec.  
 Length: 3 min., 30 sec.  
 Starting image: classroom  
 Ending image: science teacher Stephen Randak  
 Claire McKinney is both a Christian and a science teacher; over half the students and 35 faculty members at Jefferson High petitioned for special creation to be taught alongside evolution.

**Segment 10**

Approximate starting time: 39 min., 15 sec.  
 Length: 4 min., 15 sec.  
 Starting image: Eugenie Scott  
 Ending image: school board meeting  
 Eugenie Scott, of the National Center for Science Education, said, "All evolution as a science can tell us is *what* happened. Can't tell us who done it."

**Segment 11**

Approximate starting time: 43 min., 30 sec.  
 Length: 2 min.  
 Starting image: open book  
 Ending image: Eugenie Scott  
 In 1961, Henry Morris and John Whitcomb published a book called *The Genesis Flood* in which they selected scientific evidence to demonstrate that the Earth was created as described in Genesis.

**Segment 12**

Approximate starting time: 45 min., 30 sec.  
 Length: 6 min.  
 Starting image: students at podium  
 Ending image: Claire McKinney  
 Students at Jefferson High asked for the teaching of special creation alongside evolution; the school board decided that they could address the students' concerns through a humanities class.

**Segment 13**

Approximate starting time: 51 min., 30 sec.  
 Length: 3 min.  
 Starting image: a Christian a capella group at Wheaton  
 Ending image: a sunset  
 Stan Jones agrees that Wheaton is placing students' faith at risk by helping them examine difficult questions, but in the real world their faith is always at risk.



## NATIONAL SCIENCE EDUCATION STANDARDS: GRADES 9–12

**UNIT 6****Science As Inquiry - Content Standard A**

Abilities Necessary to do Scientific Inquiry

Identify Questions and Concepts That Guide Scientific Investigations

✓ ✓

Design and Conduct Scientific Investigations

✓ ✓

Formulate and Revise Scientific Explanation and Models Using Logic and Evidence

✓

✓ ✓

Recognize and Analyze Alternative Explanations and Models

✓ ✓

✓ ✓

Communicate and Defend a Scientific Argument

✓

✓ ✓

Understandings about Scientific Inquiry

✓

✓ ✓

✓ ✓

**Life Science - Content Standard C**

The Molecular Basis of Heredity

✓ ✓

Biological Evolution

✓ ✓ ✓

The Interdependence of Organisms

✓

✓

The Behavior of Organisms

✓

**Earth and Space Science - Content Standard D**

The Origin and Evolution of the Earth System

✓ ✓

**Science in Personal and Social Perspective - Content Standard F**

Personal and Community Health

✓

Natural and Human-Induced Hazards

✓



# CREDITS

The *Evolution Teacher's Guide* was produced by the Educational Programming and Outreach Department of the WGBH Educational Foundation.

## Director of Educational Print and Outreach

Karen Barss

## Director of Evolution Initiatives

Julie Benyo

## Manager of Educational Print

Sonja Latimore

## Editorial Project Director

Susan Reed

## Assistant Editor

Erica Thrall

## Outreach Coordinator

Susan Buckey

## Outreach Intern

Kristal McKanders

## Writer

Carol Bershad

## Contributor

Larry Flammer

## Designers

Laura Varacchi

Kathleen Hogan

## Print Production

Mark Hoffman

## Photography

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## Illustrations

**Page 25 Fossil skulls:** Ryan Scott McCullar for Martin K. Nickels, Ph.D.

## Evolution Executive Producer

Richard Hutton

## Clear Blue Sky Productions

### Executive-in-Charge

Jody Patton

## Evolution Teacher's Guide

### Advisory Board

John Banister-Marx

Jean Beard

Richard Benz

Rodger Bybee

Deborah Haber

Judith Decherd Jones

Joseph S. Levine

Martin Nickels

Susan Plati

Eugenie Scott

Lynne Chase Shoemaker

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