



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1979 Volume VI: Natural History and Biology

METHODS OF TEACHING EVOLUTION TO MIDDLE SCHOOL CHILDREN

Curriculum Unit 79.06.01
by JEROME H. BERNSTEIN

Many children will ask their teachers or parents “where did I come from?” or how did I get here?” Children will usually be given some answer that the origins of all living things goes back to the days of Adam and Eve. They will be told of the Garden of Eden and how God created the Earth and all living things. The ideas and teachings of evolution are still in its embryonic stage. Certainly Charles Darwin was not the first person to observe this phenomena, but it was his conceptualizations of how organisms developed that gave impetus to this theory. Most children that I have taught have no idea what evolutionary theory is. They only understand what they were told about the Creation. In this paper I will show some methods to teach evolutionary thought

.

I believe it is important to teach evolution as theory rather than fact. It is important that students understand that you are not trying to change their beliefs. These beliefs are usually very strong as they have been taught by their parents and other areas of their culture. Teaching evolution as fact will probably antagonize many students and turn them off. Other students will accept it as a fact without ever drawing their own conclusions. By showing students how evolutionary theory and the Creation theory are in conflict, you will allow them to draw their own conclusions.

As I have already said most students will not have any idea what evolution is. Some students do know and usually refer to evolution as slow change but they will not be able to explain the process by which evolution takes place. Therefore in teaching on evolution it is important that students understand the processes by which evolution takes place rather than teaching it as a record of the changes that have taken place. While some record is important, especially geological record, as it supplies evidence to the beginning of mankind, it should not be the main focus of attention. The teaching of the science of heredity should be understood if students are to appreciate and comprehend evolutionary thought. They must understand how characteristics are inherited and that they are a source of variation. Together genetics and evolutionary thought are the capstone of the course. Together they will illustrate the perpetuation, elimination, and variation made among members of a species. It is not an easy task to teach genetics. Most students have no idea why the offspring of cats are cats, or why the offspring of humans are other humans. Many times their answer will be something like “it’s supposed to be that way.” A clear cut objective is to teach that something unique is transmitted from parent to offspring.

In doing this they will be able to understand why this allows for variation within a species. During the teaching

of genetics students should be exposed to selective breeding to show how we constantly upgrade desirable features of plants and animals and eliminate undesirable traits. Social selection should also be taught as it will illustrate another method by which traits are eliminated or perpetuated.

One of the first steps I would take is to make sure students understand the definition of evolution. Students should have the understanding that evolution is the process by which life progresses from one form into another. This is a slow change which many times takes thousands and many times hundreds of thousands of years. Ask students to describe what prehistoric man looked like. Record their answers on the board. While their answers will vary, I believe it is an important discussion. Almost all students will want to give their interpretation of what these people looked like. After this is done ask the students what Adam and Eve looked like. Record these answers also. Now, if Adam and Eve were the first humans, and all humans are the descendants of these people, how is it that prehistoric man is so much different looking than Adam and Eve? The purpose of this discussion is to show students the conflicts between spiritual beliefs and evolutionary beliefs. Let the students understand that to most people the two ideas are not compatible. This will encourage many students to become more active in studying evolution.

The next area to be covered will be the evolutionary ideas of Darwin, Wallace, and others. Stress that in Darwin's day people believed that the Bible contained all the detailed truths about natural history. Darwin's observations contradicted all revealed ideas as to the Creation and the Creator. At the time of Darwin's writing, people were looking to the church for answers as to why communistic ideas were spreading in Europe and for ways to stop this. For Darwin to disagree with the church in this manner was looked upon by many as a sin.

Have the class understand some background information about Darwin. Use a map and trace the journey that Darwin took from 1831 to 1836. Signed on as a naturalist for a charting survey on the *H.M.S. Beagle*, Darwin collected plants, fossils, rocks, and any other specimens relating to life. He constantly shipped stacks of his new finds back to England. Even though he continuously endured the agonies of seasickness, he religiously kept notes on marine life. While in the Galapagos Islands off the coast of Ecuador they saw that many related animals, such as birds, were different from those on the mainland and those separated on the islands. Darwin asked, why are these animals just slightly separated from each other? He observed that of the thirteen varieties of finches some ate seeds and others ate insects. Could they have been one type of finch and the other twelve varieties developed on each separate island to adapt to that particular place?

Darwin observed another grotesque creature at the Galapagos, the land iguana and the marine iguana. While these two creatures "agree in their general habitat and their structures" they each eat different foods. The land iguana eats leaves while the marine iguana with slightly webbed toes and a flattened tail for effective swimming which he needs to obtain seaweed.

One of Darwin's first stops was at Tierra Del Fuego in the southern tip of Argentina. Darwin called this "one of the most inhospitable areas within the limits of the globe." He witnessed almost naked Indians sleeping on near frozen ground. They would swim in rough seas at temperatures of 35 degrees. How could the Fuegian swim in this miserable climate? Darwin concluded they were "fitted" to this land. Students should be aware that Darwin's theories were formulated by careful research and observation. He did not publish his findings until 1859.

Students should be required to know and understand the factors (according to Darwin) that cause evolution.

1. Organisms produce more than can actually survive. This will usually happen because there is either a great deal of food or a lack of enemies. An oyster may spawn over one hundred thousand eggs each year. The ocean would be filled with oysters if all these survived. Why haven't all of them survived?
2. Because of overpopulation there is constant struggle for existence among individuals. The balance of nature is upset. Some lions run faster than others. If speed is a criteria for getting food then those that can run the fastest will get more food than the slower ones. However, if getting food depends upon stalking an animal, then a lion that could remain quiet and camouflaged would have a better chance of catching prey.
3. Among the species individuals vary. Certain members of a species will develop variations that allow them to survive. Some lions run faster than others.
4. The best adapted or fittest of a species survive. Lions that run the fastest would survive and reproduce. Their offspring would be like them. The lions that could not run fast would not survive and leave surviving offspring.

Organisms that survive make possible their evolution in other forms. The animals that do not survive will not become part of this evolutionary scheme. At this time have the students learn that the process by which living things adapt to survive in their environments is called natural selection.

At this time give students examples of how natural selection works.

1. Suppose a raccoon is looking for tadpoles to eat. There are fifty tadpoles in a small stream. Ten of them are albino . Which tadpoles are likely to be eaten? Which are likely to leave surviving offspring? Why?
2. Why is it that young deer have spots on their body. What would probably happen if they were born without these spots? Would they reproduce? Why?
3. The venus flytrap "captures" and digests many insects by secreting a sweet smelling fluid. What would happen if some flytraps did not contain this fluid?
4. Why is it helpful that a person living in tropical Africa has dark skin and dark eyes? If you were living in this area, looking to choose a mate, would you choose a light skinned mate or a dark skinned mate? Which type of person would tend to leave surviving offspring?

There are a great many examples of how natural selection works. Without coloration many species would not be able to survive; be they prey or predator. Some organisms mimic others. An example of this is the treehopper which mimics thorns to escape the sight of birds. The blossoms of some orchids are insectlike which help them attract pollinating wasps. The walking stick escapes birds by mimicing stick and will lie in wait to capture passing insects.

Coloration is very important in natural selection and students should learn some of the various types of coloration.

1. Mimicry—This has been discussed.
2. Camouflage—When it is difficult to see an organism. Examples—The polar bear which will lie in wait for prey or the moth which rests on trees, its body obscured to birds. The story of the peppered moth would be a good example of camouflage to give to the class. Camouflage is one of the most common means an organism uses to survive.
3. Warning Coloration—Color will warn other organisms that they are harmful when eaten. Many bees are marked with black and yellow to give their warning.
4. Countershading—The process by which animals are shaded pale on their abdomen and darker on their backs to counteract shadows caused by the sun. A frog is an example. What would happen to this frog is by some unusual occurrence (mutation) it was not countershaded? What would happen if one particular frog was shaded better than others? It would probably escape predators for a longer span and consequently leave more surviving offspring. What would these offspring look like? Would they fit in their environment?

Students must understand how an organism passes its traits on to its offspring. However at this time students will probably want to believe in evolution, but they will be giving arguments such as “I didn’t come from an ape.” Of course Darwin never said this. This type of ridicule came from newspapers wishing to sell papers and others that wished to discredit Darwin. I will deal with this latter in the paper while explaining other evidence for evolution.

Hopefully students will now understand that characteristics are inherited from their parents and those that inherit favorable characteristics will survive. How are these favorable characteristics inherited? While Darwin was unlocking the laws of evolution an Austrian monk was addicted to the research on inheritance.

The following information treats genetics in a superficial manner. Much of the material on genetics is abstract and is frequently difficult for students and teachers to deal with. I have intentionally left out a great deal of material as I feel it would create much more harm than any beneficial aspects it could have.

By careful observation, recording, breeding, and experimenting on pea plants Mendel found the answers as to how traits are passed. Before these answers are discussed it is important students understand that a new life is begun with a joining of the sperm from the father and the egg of the mother. The egg and the sperm contain parts called the chromosomes. These chromosomes are contained in just about all cells in the human body. Each chromosome contains a smaller substance called a gene. These genes contain all the information as to what the new organism will look like. Now the new individual will have traits from both the mother and the father. If the mother is tall and the father is short the child cannot be tall and short at the same time. The child will be one or the other. If the mother has blue eyes and the father has brown eyes the child will have brown eyes or blue eyes, but not both. How does this happen? A process takes place in which the sex cells (gametes) divide. In humans the forty-six chromosomes divide so they now contain only twenty three. When

the sperm unites with the egg (ovum) the embryo now has its full fortysix chromosomes. The new offspring will have two traits for each feature, however only one feature will show.

At this time it is important that students learn some definitions.

1. Pure—An organism contains the same two genes for a particular characteristic. Only one type of trait ever shows up.
Examples—only blue eyes for eye color, only brown hair color.
2. Hybrid—an organism that contains two different genes for the same characteristic. Sometimes one trait appears, sometimes the other trait appears. Blue eyes would show, brown eyes would be hidden in the genes.
3. Law of Dominance—when two parents of opposite traits are mated the first generation shows only one trait (dominant). The other trait (recessive) is hidden.
4. Law of Segregation—When hybrids are crossed, the opposite traits are separated into different offspring. The ratio will be three fourths dominant and one fourth recessive.

The following section will explain how some of these Mendelian laws take place. As it is abstract many students will need a great deal of work to understand the process by which traits are passed on. I will give some elementary examples to use.

If the father is pure brown eyes (BB) and the mother pure blue eyes (bb) what color eyes could the child have? Brown eyes are a dominant trait. Ask the students where the trait for blue eyes is. Explain that it is hidden in the genes of the new offspring. If this new offspring mated with someone with hybrid brown eyes, recessive trait blue; what color eyes could their offspring have? Which of Mendel's Laws does this apply to? If this same person with hybrid brown eyes mated with someone with pure blue eyes what color eyes could their new offspring have? Why?

It must be emphasized to students that passing on favorable traits makes it easier for the new offspring to live and reproduce. The unfavorable trait will become extinct after a long period of time as it will not be passed on. As an example let's use bodyweight.. What would the four offspring of two people who mated in tropical Africa look like if the parents were hybrid thin, recessive trait heavy. Which of Mendel's Laws would this apply to? In a very hot climate. it favors for a person to be thin. In this way they will endure as they will not keep in as much body heat. They will be better hunters as they can run faster and not make noise while stalking an animal. They will make better farmers as they can stand the hot sun for a longer period of time. Of the four children one is heavy. While he may survive he probably would not survive to reproduce. Many people would not pick a mate that would not be able to provide. In this way a trait will disappear. Of the other two children two are hybrid thin. If they choose hybrid thin mates what would the children be like as to bodyweight? Which trait would the children be like? Which trait would probably survive? Emphasize again that those traits which make survival difficult will die out and traits and mutations which make survival easier are passed on.

While these are only the very basic .Mendelian laws they do allow students to understand how the fittest

survive. At this time you could also explain to students that man uses Mendel's Laws for plant and animal breeding and improvement. The most common reasons for using these techniques are:

1. To improve yield.
2. To improve quality.
3. To make plants and animals more resistant to disease.
4. To make plants capable of withstanding otherwise adverse climate conditions.
5. To produce new varieties of plants and animals.

Many genetic diseases such as TaySach's, sicklecell anemia, hemophilia and color blindness may be eliminated from offspring if Mendelian law is followed. The final section of the unit will clarify what Darwin did say and include some other evidence of evolution. Darwin, in his first paper published jointly with Alfred Wallace, did insist all species had a common ancestry. Our common ancestor appeared on the earth a very long time ago. While the earth may be close to five billion years it was not for another three billion years that life appeared. Then, perhaps through a continuous series of catastrophes a single molecule appeared with a miraculous ability to reproduce itself. The first forms of life are some of the simplest living today; bacteria, algae, and flagelates. Flagelates, which are half plant, half animal evolved into another life form, the protozoa. Some protozoa colonized themselves to form volvox. It is estimated these volvox had a new feature, the ability to die. Evolution continued with new organisms developing mouths and stomachs (jellyfish). At This time it would be useful if the students made their own chart or geological time scale. One of the keys to understanding evolution is a realization of the vastness of earth's time. It is too easy for students to hear numbers such as one or two billion years. It usually does not bother or annoy students or get them to thinking in any way. Distant time is an abstract idea and it is very difficult to deal with. Somehow students must understand that the history of the earth is extremely long: One method I use to try and accomplish this is to have each student make their own time scale(see following pages). Give each student a booklet of five stapled page.. On each page have twenty equally spaced lines, for a total of one hundred lines. Each student will fill the appropriate line when important events in the earth's history took place. Students will see that the story of life would not begin till line twenty five. On line seventyfive they will see we are now in the age of fishes (approximately fivehundred million years ago). On line ninety amphibians appear. On line ninety four we see that reptiles appear. Try to have the student's ask "where does man appear?". On the very last line of the booklet, really the last oneforth line, does man appear. At this stage of history we find the first humansor hominids arrive. Explain to the students that there is no room in this booklet to chart when Christ was born (less then twothousand years ago). The entire history of man with all the evolutionary changes that has made him into what he is today, hardly makes a dent in the history of the earth.

SOME TRAITS IN MAN KNOWN TO BE INHERITED

ALLOW STUDENTS TO FILL IN A WORKSHEET SIMILAR TO THIS

TRAITS

DOMINANT	RECESSIVE	YOUR TRAIT WHERE DID YOU INHERIT YOUR TRAIT
<i>free ear lobes</i>	attached ear lobes	
broad lips	thin lips	
large eyes	small eyes	
long eyelashes	short eyelashes	
normal blood cells	sicklecell anemia	
tongue roller	not a tongue roller	
widow's peak	straight hairline	
second toe longer then big toe.	second toe not longer	
dimples	no dimples	
hitchhiker's thumb	no hitchhiker's thumb	
blood groups A, B and AB	blood group O	

Allow students to use this worksheet to answer questions 4,. 5, and 6 on the following page...

Allow students to work out a great many easy genetic problems. In general students will have difficulty with them.

1. pure tall pea plant(TT)

pure short pea plant(tt)

All the offspring will be _____. Are they hybrid or pure? Explain why.

2. hybrid tall pea plants(Tt)

hybrid tall pea plants(Tt)

How many pea plants will be tall? How many plants will be short?

How many will be pure? This is Mendel's Law of _____?

3. Father has free ear lobes(FF)

Mother has Attached ear lobes(ff)

All the children will have _____ lobes. This is Mendel's Law of _____
_____. As to earlobes, are the children pure or hybrid?

4.

Dimples is a ____ trait. Can two parents with dimples have an offspring that does not have dimples.

This would' show Mendel's Law of _____.

5.

Can an offspring have type O blood if both parents have AB blood. Explain.

6.

Can the offspring have sicklecell anemia if neither parent has it. Explain. This is Mendel's Law of _____.

BIBLIOGRAPHY

Bastian, Hartmut., *And Then Came Man* . New York, Viking Press, 1964. A highly readable account of' the beginning of' the earth as a ball of fire and subsequent elaborations of life. Many good charts end' fine drawings.

Cohen, Robert, *Color of Man* . New York, Random House, 1968.

Excellent black and white illustrations with an easy to follow text. It explains the genetic reasons for color. Cylmer, Elizabeth., *The Case of The Missing Link* . New York' Basic Books, 1962. An easy to read text which explains methods used in tracking preman. The illustrations by Robert Macquire are first rate.

Dobzhansky, T., *Genetics and the Origin of the Species* . New York, Columbia Univ. Press' 1951. Well worth feeding it deals with the process of evolution in animals.

Edel, May., *The Story of Our Ancestors* . Boston, Little, Brown, and Co. 1955. An easy to read text which as the title suggests deals with our early ancestors through modern man.

Hotton, Nicholas., *The Evidence of Evolution* . New York,

American Heritage, 1968. This book, through it excellent color illustrations and well written text, explains the modifications of the species through adaptation. It also explains in great detail how scientists have strung together the whole story of evolution, through fossil finds.

Howell, F. Clark., *Early Man* . New York, Time Inc., 1969. Book contains excellent illustrations and pictures.

Leakey, Louis., *Adams Ancestors* . New York, Harper and Bros., 1960. This book explains the findings of this famous paleontologist.

Moore, Ruth., *Evolution* . New York, TimeLife Books, 1964. Through excellent illustrations and text this book explains evolution.

Stebbins, G. L., *Variation and Evolution in Plants* . New York,

Columbia University Press, 1950. A useful book as it contains many examples of differentiation in plants.

Villiers, Alan., *In the Wake of Darwin's Beagle* . "National Geographic". October, 1969. This story recreates the voyage of the Beagle.

STUDENTS BIBLIOGRAPHY

Adler, Irving and Ruth., *How Life Began* . New York, Dobson Publishing Co. 1959. An excellent book. The chapters on inheritance are especially good.

Bova, Ben., *The Weather Changes Man*. Reading, Mass., Addison Wesley, 1974. Traces weather patterns and climatic conditions on man's physical development.

Bradford, Camaliel., *Charles Darwin*. New York, Houghton-Mifflin, 1936. A well written account, however it will be too difficult for most students.

Burton, Virginia., *Life Story*. New York' Houghton-Mifflin, 1962. A history of life from the beginning to the present. The book would be more valuable if it explained the process of evolution.

Colburt, Edwin, and Burns, William., *Digging for Dinosaurs*. Chicago, Children's Press, 1960. Recommended for it excellent color pictures, most photographed at the American Museum of Natural History.

Darling, Lois and Louis., *The Science of Life*. Students will be interested in this book for its descriptive prose.

Dickenson, Alice., *Charles Darwin and Natural Selection.*, New York, H. W. Wilson co. 1964. A wellwritten biography, the book also deals with natural selection as a process' which many books seem to avoid.

Lerner, Marguerite., *Where do you Come From*. An easy to read book. The chapters on Darwin and Mendel are particularly good.

May, Julian., *They Turned to Stone*, New York, Holiday House' 1965. A short, well written account of the way fossils are formed. Young readers will appreciate the illustrations.

Moore, Ruth., *Evolution*. New York, Time Life Books, 1965. Excellent illustrations with an easy to read text.

Pomerantz, Charlotte., *Why You Look Like You Whereas I Tend to Look like Me*. Reading, Mass., AddisonWesley, 1969. In poetic form this book explains genetic reasons for what the title suggests.

Selsam, Millicent., *Around the World with Darwin*. New York, Harper Bros. 1960. The excellent illustrations by Anthony Ravielli make this a useful book.

Sootin, Harry., *Gregor Mendel: Father of Genetics*. New York, H. Wolff, and Co. 1959. Mendel's experiment" are explained in simple

down to earth terms. The general text will be too difficult for many seventh graders.

Webb, Robert., Gregor Mendel and Heredity. New York, Franklin Watts Co. 1963. Mendel's law are painlessly unlocked.

<https://teachersinstitute.yale.edu>

©2019 by the Yale-New Haven Teachers Institute, Yale University

For terms of use visit <https://teachersinstitute.yale.edu/terms>