Creationism vs. Evolution: A Unit of Instruction

An Honors Thesis (HONRS 499)

by

Tamara Smith

Melissa Warden Ph.D

Ball State University
Muncie, Indiana

Graduation Date: December 1995
Purpose of Thesis

The controversy over the origin of life has been raging for several years. Although commonly a political argument involving separation of church and state, it is also a common debate among biology educators. The quandary is about whether to teach both creation and evolution as possible explanations for the origins of life or to teach evolution as the only possibility. The former allows students to decide for themselves which theory they believe while the latter presupposes this decision and gives fewer opportunities for critical thought.

As a future educator faced with this dilemma, I believe that both theories regarding the origins of life should be taught in the classroom. In exploring this belief, I have examined both evolution and creationism and have discovered that they can, in fact, be taught side-by-side in schools as possible explanations for how life began. Although evolution does not address the specific issue of how life began, it does give a mechanism for the development of the diversity we know today. It is this mechanism which will be addressed. I have developed a unit plan which encompasses both explanations and allows students to form their own opinions about this subject.
## Unit Timeline

<table>
<thead>
<tr>
<th>Theme</th>
<th>Homework</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1</strong>: Introduction to Unit</td>
<td>Find information on the conflict between creation and evolution, and bring to class.</td>
</tr>
<tr>
<td><strong>Day 2</strong>: Begin Conflict Resolution Exercise</td>
<td>Make data cards.</td>
</tr>
<tr>
<td><strong>Day 3</strong>: Continue Conflict Resolution Exercise</td>
<td>Gather information for debate.</td>
</tr>
<tr>
<td><strong>Day 4</strong>: Process Evidence to Make a Value Judgement</td>
<td>Continue debate preparation.</td>
</tr>
<tr>
<td><strong>Day 5</strong>: Debate</td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Theme</th>
<th>Homework</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1</strong>: Coacervates Lab</td>
<td>Thought Questions Final Project</td>
</tr>
<tr>
<td><strong>Day 2</strong>: Designer Lab</td>
<td>Lab Sheet Thought Questions Final Project</td>
</tr>
<tr>
<td><strong>Day 3</strong>: Natural Selection Lab</td>
<td>Thought Questions Final Project</td>
</tr>
<tr>
<td><strong>Day 4</strong>: Mixture Lab</td>
<td>Lab Sheet Thought Questions</td>
</tr>
<tr>
<td><strong>Day 5</strong>: Natural History Field Trip</td>
<td>Thought Questions</td>
</tr>
</tbody>
</table>
Beginnings

The question of the origin of human life has been an important issue in the lives of people since the beginning of time. We have always questioned where we came from. Originally this question was left up to scholars and theologians to discuss and ponder until they came to some conclusions. Many religious thinkers came to the conclusion that the universe and, more specifically humans, had to be the creation of some type of higher being or god. Many different faiths held to this view, but the most accepted outgrowth came in the biblical account of creation. In the Bible, Moses writes about God creating the world in seven days from nothing. This was the predominate view which helped to shape early scientific efforts. The scientific historian Stanley Jaki said that "from Copernicus to Newton it was not deism, but Christian theism that served as a principal factor in helping the scientific enterprise reach self-sustaining maturity " (Noebel, 1991, p. 318). Thus, it is clear that creationism forms the basis of early scientific work. This view is held by many evangelical Christians today. Those who hold to this view believe that the biblical account of creation is a real, true story written under the divine inspiration of God himself. In this account, God creates the world in six days from nothing. All the diversity we now experience was present at that time. God made it all, including man.
These ideas were challenged over the years by a number of naturalists including Jean-Baptiste Lamarck who believed that life had been created long ago and that it gradually developed into the levels of complex organization we now know. In spite of this new idea, creationism remained firmly intact until the late 1800s when a man named Charles Darwin brought a whole new group of ideas on the scene. Although this theory was very similar to the one Wallace devised, Darwin was the first to present it and so he received most of the credit. His theory has four major parts which are: natural selection, struggle for existence, beneficial mutations, and adaptations. These were collectively given the title of evolution. The following is a brief explanation of each of the four parts of Darwin’s theory.

Natural selection, which is the most famous of Darwin’s ideas, is the idea that only the organisms best suited to their environment will survive. Genetic mutations, predators, geography and time will eventually select out those individuals which are not sufficiently adapted to live. Darwin believed that, given enough time, nature would select the traits most needed by the organism in its environment. He stated:

Slow though the process of selection may be, if feeble man can do so much by his powers of artificial selection, I can see no limit to the amount of change, to the beauty and infinite
complexity of the coadaptations between all organic beings, one with another and with their physical conditions of life, which may be effected in the long course of time by nature's power of selection (Noebel, 1991, p. 273).

The tenets of natural selection are:
1. More offspring are produced than survive to reproduce.
2. Population members show heritable variation.
3. Some of these traits improve the organisms chances of survival and reproduction.
4. Since these organisms are more able to reproduce, their offspring tend to be more prevalent in the population.
5. Some traits are selected for more often because there are more of them represented in the population. (Starr and Taggart, 1989, p. 31)

The idea of species struggling for existence goes along with natural selection very well. It simply allows for the species to improve its chances of survival with each passing generation. This is where mutations enter the picture. These changes occur in the genetic makeup of an organism. In order to allow a species to adapt better to its environment, it undergoes certain beneficial mutations in its genetic composition. These permanent changes increase the organism's chances of reproducing viable offspring. Changes which make an organism better able to survive in a particular environment are called adaptations. These are simply changes in an
organism's behavior or physical structure which make it better able to live in its environment.

Since Darwin presented his ideas in the book entitled, *On the Origin of Species*, many advances have been made in science. Experiments have been done which have given us more evidence from which to interpret conclusions about how we really came to be. A major body of evidence is the fossil record which has revealed many specimens since Darwin postulated his ideas. It remains incomplete, with no physical evidence to directly connect one species to another through time. In this regard, evolution has been not been able to address the origin of life or man's direct descent. We have also learned much more about the genes which determine our characteristics and how they are changed from one generation to another.

This is the history of the two popular explanations of the origins of life. Because Darwin's ideas dispute everything stated in the Bible, the creationists simply cannot accept them. If a person truly believes that God created the earth in six days, then there is no room for evolution. The whole idea of evolution involves time for species to gradually change and adapt to become other species. The six day approach simply does not mesh with this idea. Thus, the conflict began. Ever since that day, supporters of both sides have been going head to head in the courtroom, the schools, and especially in the minds of many students of science.
The battle in court really flared up in 1925 when an anti-evolution law was passed by the Tennessee state legislature. John T. Scopes, a science teacher, did not believe that he could teach from the official biology text without including a section on organic evolution. He decided to blatantly disobey the law. He was arrested and taken to court, charged with disobeying the anti-evolution act, called the Butler Act. His lawyer was a man named Charles Darrow. The state was represented by William Jennings Bryan. Darrow used the defense that Scopes had not necessarily violated the Bible when he taught evolution. The idea was to bring credibility to the theory of evolution. However, the state held out and Scopes was found guilty and fined $100.

This began the courtroom story and also created a consciousness among teachers of the possible implications of teaching either position. Some even stopped teaching about the origins of life entirely. Schools are no longer run predominately by the views of the church. Because of this, it is no longer legal to teach creationism in the schools. The state, and in most cases, the people, want church and state kept separate. Students need only hear the scientific explanations in school and the rest is a personal matter. But the children who hold these beliefs still feel that their belief system is attacked every time the subject is addressed. Many times these students are forced to choose between being vocal and facing the ridicule of the class or simply keeping
quiet. Is this really necessary? Is there a way to allow students to form their own opinions and still make sure they know the facts? I believe there is.

**Purpose**

The purpose of this project is to present a teaching unit which addresses this conflict in a way which allows students to get involved in the debate and develop their own opinion on the issue without the teacher's view or the accepted view swaying their decision. The necessity for this comes out of the idea that students are thinkers and should be given the necessary tools to make up their own minds and not be forced into any particular opinion. As science teachers, we often try to convince students that the "best" way is the most scientific way. This unit allows the teacher to guide students in their quest to find the answer for themselves. While it provides structure, it also gives students room to make up their own minds. Because of the nature of the exercise, the teacher is also able to address this difficult subject without indoctrination or fear of saying the wrong thing. Because of the ongoing courtroom conflict about what can be taught in the classroom, this is an important thing for a teacher to think about.
Summary

Before beginning the unit, there are a few things the teacher needs to know. The unit consists of a series of lessons on conflict resolution in which the students are randomly assigned to defend either creationism or evolution. The conflict resolution approach is a useful system for dealing with any kind of conflict. The method used here is from *Values and Biology*, a science resource book, written by Garrett Hardin. It is only one example of this technique. There are many others including one by Johnson and Johnson which is a conflict resolution model designed to be used with any controversial issue. Another one, written for the 1991 Woodrow Wilson Biology Institute, deals more with the court cases and the legal aspects of this conflict. In the unit plan that follows, the students spend a week researching the arguments and support for the position they have been assigned. This work culminates in a debate at the end of the week using their assumed position. The purpose of this is to force students to realize the different explanations for the diversity of life and to see the issue from a different perspective than their own. The next week will be spent doing activities which allow the students to use the information gained in the first week to classify new data. This gives them a practical use for their learning and helps develop higher level thinking skills as they synthesize the new information.
Objectives

Overall, this unit should give students a clear picture of the two sides of the origin of life debate without condemning anyone for their judgement. This represents a way to deal with the difficulties involved in teaching about the diversity of life. The overall unit objectives are:

1) Students will distinguish between valid and invalid information.
2) Students will assume a position which may or may not represent their own values.
3) Students will defend this stance using valid information.
4) Students will determine why it is important to present opposing views of an issue.
5) Students will determine how well the evidence presented supports the conclusions drawn.
6) Students will recognize examples of data that can be interpreted to support different conclusions.

Teaching modes that will be used include laboratory, discussion, question and answer, individual projects, and homework.
Day 1:

Objectives:
- Students will define: conflict, resolution, and value judgement.
- Students will locate information on creationism and evolution.
- Students will distinguish between reliable and unreliable data.

Procedures:
1. Discuss with students what this unit will include. Be sure to emphasize that this is a conflict resolution unit which will encourage them to debate using a position different from their own. The purpose is to learn as much as possible about both sides of the issue. Perhaps, in the course of discussion, students will form their own opinion. This is a personal choice and is not an objective to be graded or taught.

2. Give students the worksheet "What Do You Win by Yelling Loudest?" They are to put SA, A, U, D, SD in the blanks.

3. Collect the worksheets. Give out the Involvement Survey. While students are completing this, tally the responses to "What Do You Win by Yelling Loudest?" Put results on the board.
4. After students have completed the Involvement Survey, begin discussing the most popular responses you put on the board. Help students to realize what factors influence the value judgement they make. List these factors on board.

5. Use the Involvement Survey to help students see how much prior knowledge they have about the issue of creation versus evolution.

Materials Needed:

"What Do You Win by Yelling Loudest?" worksheet
Involvement Survey

Assignment:

Find information on creation and/or evolution which might be useful in defending either position. Copy and bring to class. Possible sources could be teacher's personal library, a university library, the school library, or a public library.
5.4 What Do You Win by Yelling Loudest?

(To the student)

Here is a statement by an evolutionist:

Finally, I would again urge biologists to take their case to the public. Experience in Iowa and other states has shown that ad hoc groups led by local scientists and other public figures can be effective in countering creationists' efforts to "convert" legislators. Such efforts must be persistent to be successful. However, furthermore, evolutionists should not neglect to speak out — in talk shows, letters to the local newspaper, school board meetings, curriculum or textbook adoption committee meetings, and public forums of any kind. For it is at the grassroots level that public opinion often matters most.16

This statement is by a creationist:

The majority in the scientific community and educational circles are using the cloak of "science" to force the teaching of their view of life upon all. The authoritarianism of the medieval church has been replaced by the authoritarianism of rationalistic materialism. Constitutional guarantees are violated and free scientific inquiry is stifled under this blanket of dogmatism. It is time for a change.17

Use the following key to record your reaction to statements related to the two quotations.

SA = strongly agree
A = agree more than disagree
U = undecided
D = disagree more than agree
SD = strongly disagree

(__) 1. Scientists have a responsibility to let the public know what they are doing and thinking.

(__) 2. It would be a good idea to have scientists on TV talk shows regularly.

(__) 3. If a scientist says something (about science) it is true and the scientist can prove it.
4. Scientists pick out the one best theory available to them to explain how things work.

5. There is a difference between one scientist trying to convince a school board to allow only evolution in the biology classroom and another scientist trying to convince a board that the school should provide equal time for evolution and creationism.

6. The general public should decide whether evolution only or evolution and creationism will be taught in schools.

7. Each school district should make its own rules about what is included in the school curriculum.

8. The courts should decide what will be included in the school curriculum.

9. The state legislature should decide what will be included in the school curriculum.

10. The federal government should decide what will be included in the school curriculum.

11. The Constitution gives Americans freedom of religion. Teaching evolution to students whose religion instructs them that life came about through the creation violates their freedom.

12. The Constitution gives Americans freedom of speech. If a school does not allow creationism to be taught, then creationists' freedom of speech is violated.

13. Creationism is not accepted as a part of science by the majority of scientists; therefore creationism does not belong in a science classroom, though it may be taught in a history or religion class.

14. No one outside the school tells algebra teachers what their courses can and cannot contain; therefore no group outside the school should try to influence what biology teachers teach.
(To the teacher)

Tally the number of SA, A, U, D, and SD responses recorded by students. (No one needs to reveal how he or she reacted to any specific question.) Concerning the category with the most responses, ask for reasons why students find this the most satisfactory response.

The question is intended to lead into a discussion of the factors that influence the strength of our value judgments (such as slanted or inadequate information, personal prejudices, parents' opinions). Recalling that a value is something that we prize and therefore feel strongly about, this activity may help some students recognize what they value most in the making of public policy.
5.5 How Far Would You Go?

(To the student)

The creation model and the evolution model both attempt to explain the history of life forms on this earth. The creation model states that at one time in the past, all living things were created according to natural laws that do not operate in the world today. Living things have not changed significantly since they came into being.

The evolution model states that life forms have changed as the environmental conditions changed in the past and that different forms of life have come into existence and others have become extinct. Evolutionists believe that the forces that bring things into existence and cause them to become extinct have always been the same as they are today.

Creationists want their model taught in biology classes because they believe it to be a valid interpretation of the scientific evidence and because they feel the evolution model is taught as if it were beyond criticism. Evolutionists oppose the inclusion of creationism in science classes (not in history or religion classes) because they feel that creationism will stifle research and bring a religious bias into the classroom which is prohibited in public schools. Evolutionists believe that the evolution model is the only scientific interpretation of available evidence.

I. Mark the list below to show how much you have been involved in this issue. You may check more than one item.

— A. Not been involved in any way

— B. Heard it discussed somewhere

— C. Read one or more brief articles about it

— D. Talked about it informally with friends or relatives

— E. Had a real argument with someone about it

— F. Read a major article or book about it

— G. Did a research paper related to the issue

— H. Made a speech about it in class

Copyright 1983  J. Weston Walch, Publisher   Portland, Maine 04104-0658
I. Wrote a letter to the editor about it

J. Wrote a letter to a state or national political figure about it

K. Spoke to an organization outside of school about it (at church, club meeting, school board meeting, etc.)

L. Joined a group trying to do something about it

M. Other: ________________________________________________________________

II. Mark the list below to show how much you think you should be involved in the issue. You may mark more than one item.

A. Pay no attention to the issue

B. Listen to TV programs or to class discussions about it

C. Read one or more brief articles about it

D. Talk about it with friends or relatives

E. Read a major article or book about it

F. Defend my position strongly when the issue comes up

G. Write a research paper concerning some aspect of it

H. Make a speech about it in class

I. Write a letter to the editor about it

J. Write to a state or national political figure about it

K. Speak to a group outside of school about it

L. Join a group trying to do something about it

M. Other: ________________________________________________________________
III. Mark the list below to show how much you think your biology teacher should be involved in the issue. You may mark more than one item.

___ A. Pay no attention to the issue

___ B. Listen to TV programs or to discussions about it

___ C. Read one or more brief articles about it

___ D. Talk about it with friends or relatives

___ E. Read a major article or book about it

___ F. Defend his or her position strongly when the issue becomes a topic of debate

___ G. Write a research paper concerning some aspect of it

___ H. Make a speech about it in class

___ I. Write a letter to the editor about it

___ J. Write to a state or national political figure about it

___ K. Speak to a group outside of school about it

___ L. Join a group trying to do something about it

___ M. Other: ___________________________________________________________
Day 2:

Objectives:
- Students will identify sources of conflict between teams.
- Students will discuss data supporting the conflicting judgments.
- Students will eliminate unreliable data.

Procedures:
1. Pass out
   - Issue statement
   - 1/2 of class receives creation model/info.
   - 1/2 of class receives evolution model/info.
   - graphs
   - Statement form

2. Have groups list data statements that support their theory. Rank statements from 1 to 5 and list criteria used. (These may need to be listed on the board.) Repeat this for data statements which don't support their theory.

3. Pair 1 member of the creation group with one member of the evolution group. Students will compare factual statements to reduce differences. Revisions will be made using a different pen or pencil. This exercise allows students to be working from the same data. Students may then re-rank data statements to include
any revisions made.

4. As a team, students will identify important sources of conflict by comparing the two sets of information. Students can accomplish this by:

- Comparing the highest ranking positive statement from each set.
- Comparing the highest ranking negative statement from each set.
- Looking at differences in ranking of data from team to team.

These sources of conflict should be listed by each team on a separate piece of paper.

Materials Needed:

Issue statement
Creation model and additional information
Evolution model and additional information
Graphs
Statement form

Assignment:

Students will use the statement form (and any additional information they have) to make out data cards for facts supporting the statements that make up the sources of conflict.
Cards will include:

Data statement

Criterion used for initial ranking of statement

Criterion used for re-ranking
5.1 Two Models or One?

(To the student)

Statement of the Issue

Consider two conflicting ideas used to explain the diversity of order among living things. These two ideas are called models. They are in conflict because one, the creation model, presumes that an event occurred in the past in which all plants, animals, and protists were formed suddenly and without precedent and essentially just as they appear to us today. The other model, the evolution model, presumes that each kind of organism is the result of natural selection; that is, out of a wide variety of related organisms the one type best suited to the environment survives and the others die or move to other environments. The evolution model presumes that environments change and thus the population of organisms shifts so that only the best-suited organisms make up the greatest part of the population. The creation model presumes that from time to time, worldwide catastrophes have wiped out all life.

According to the creation model, a supernatural force made the original types of organisms with the ability to adjust to conditions, but only within a specified range — the adjustments do not alter the appearance of the organisms significantly or permanently.

According to the evolution model, living matter can take diverse shapes, and therefore there is no foreseeable limit to the forms of life that may develop as environmental changes occur. There have been organisms in the past that no longer exist. Any type of organism alive today may become extinct at any time if the environment changes so that the organism cannot tolerate it any longer.

The creation model is closely linked with the Christian religion. Most major religions accept some form of creationism. Religious people do not necessarily accept the creation model, however. The evolution model is materialistic: that is, it does not require a spiritual force to guide it. Therefore the model is not religious in any sense, though many religious people accept the model.

THE ISSUE: Is it better to keep both of these models to explain forms of living things, or should one model be selected over the other?

The issue has political and economic importance as well as being of interest from the religious and scientific points of view. Some states have passed laws requiring that both models be taught in schools. Some courts have ruled that it is not illegal to teach only evolution; in fact, some courts have said it is illegal to teach only creation. As state laws are revised, teaching materials used in biology classes may have to be replaced. This will place an economic burden on taxpayers and students.

Copyright 1983  J. Weston Walch, Publisher  Portland, Maine 04104-0658

22
The Creation Model

The model begins with the statement that at some point in the past (some creationists accept a date of about six thousand years ago), an event took place called the creation in which all basic animal and plant types were brought into existence by the act of a nonmaterial force. The creation occurred through forces that are no longer in operation.

Among the reasons given for accepting this model are (1) the book of Genesis in the Holy Bible, which states that such an event occurred; (2) the fossil record, in which creationists find only evidence of sudden emergence of life forms; and (3) the lack of any evidence that new forms of life have been produced, despite efforts by geneticists to do so.

Some predictions that can be made on the basis of the creation model include these: (1) The fossil record will show the sudden appearance of life forms. (2) The fossil remains will appear in the form essentially like the life forms known today. (3) The fossil record will show that sharp boundaries have separated major groups of organisms since the creation; the fossil record will not show evidence of links between one major group and another, such as between the ancient seed ferns and flowering plants. (4) Genetic evidence will show that the individuals resulting from crosses between different types of animals or plants will fail to reproduce or will revert to original type, thus keeping all organisms "after their own kind" as stated in Genesis.

Paleontologists (the scientists who study the fossil record) can produce some evidence in support of this model. For one thing, life forms do appear quite suddenly (in the geological time scale) as fossils in the rock strata. Furthermore, the fossil record of organisms older than the Cambrian period (500 to 600 million years ago) is so incomplete that it is open to different interpretations.

Fossil evidence has failed to show linking types of plants or animals in every instance where they might be expected. There are no fossil remains of organisms linking invertebrates with vertebrates, for example.

Here is a creationist's interpretation of fossil data:

The bat is presumed to have evolved from nonflying insectivores — although, as stated earlier, the oldest-known bat to appear in the fossil record is one hundred percent bat, and no trace of a transitional form can be found. In the bat four of the five fingers support the membrane of the wing and are extremely long, compared with the normal hand. These and other unique structures are solid bone and are anything but delicate structures. Transitional forms, if they existed, should certainly have been preserved. The absence of such forms leaves unanswered, on the basis of the evolution model, such questions as when, from what, where, and how bats originated.
The biologists who study classification of organisms (taxonomists) define a species as a type of living organism that does not interbreed with any other type. Thus, by this definition, crosses between different species do not occur in the normal environment, and new species are not created by crossing old ones.

Here is an example of the different ways evolutionists and creationists interpret genetic data: Karpechenko crossed radishes with cabbages. An evolutionist commenting on Karpechenko’s results said, “Recombination did in fact bring about a new ‘type’ of ‘form’ . . . .” A creationist replied, using the same experimental data, “Of the grains of pollen only a few are developed and pollen mostly degenerates.” The creationist in this case went on to refer to other experiments showing that radish-cabbage crosses do not produce offspring that can be called a new form of plant life.

Hybrids and breeds produced by selective breeding are not new life forms, according to this model. Hybrids quickly revert to the types they came from if free of human influence. Breeds, as in the case of dogs, are considered to be of the same basic life form and all are said to have been created at the same time.

The model includes the concept of a worldwide (Noachian) flood to account for fossils all having the same age. The model challenges the radioactive data which indicates the age of fossil-bearing rock.

Those who accept the creation model feel they are justified in reaching their conclusion that life forms have not changed significantly through time. Creationists believe that the lack of any change indicates that a purpose and design exists for the earth and the life it holds. That plan is contained in the Holy Bible, according to creationists.

The creation model has been put forth as an alternative to evolution as an explanation of the history of life forms, and creationists believe the creation model should be taught in schools.
The Evolution Model

The evolution model begins with the idea that living material is capable of changes in its chemistry and in its physical form. Slight changes due to genetic mutation are occurring all the time, according to this model.

Environments also change, says the evolution model — land sinks down and is flooded, sea floors rise up to produce islands, volcanoes change the shape of the land, and whole continents and seas move about on tectonic plates. Even the composition of the air has changed through time.

As environments change, the conditions are slightly better for one form of plant or animal life than another. The form that fits into the changed environment best produces the most offspring and becomes the dominant organism until another environmental change "selects" another type of plant or animal.

The evolution model also includes the concept of "isolation" to explain changes in life forms. Small populations can move away from their larger group or be separated from it by accident. These isolated groups may carry minor or major differences in their genetic makeup. The differences may become characteristic traits of future generations of these isolated organisms. Eventually, the traits may be so distinct that crossbreeding with the original types is impossible. New species, organisms that only breed with their own kind, are formed in this way, say the evolutionists.

The predictions that can be made from this model include the following: (1) Newer, different forms of life will gradually replace older forms. (2) There have been billions of years in which these changes have taken place. (3) The fossil record, as well as biochemical evidence, will show that living forms in existence today are related to forms that are either extinct now or to forms that developed from a common ancestor now extinct. (4) The environmental changes taking place today and in the future will permit some life forms to live and reproduce at the expense of others. (5) Life forms that we know today may gradually be replaced by new types.

The predictions based on this model are supported by the fossil record to some extent. Fossils arranged in order of their apparent age seem to show that mammals replaced dinosaurs as the dominant life form beginning about 136 million years ago, for example. The fossil record is being pushed back through steady research, and new evidence shows that some simple life forms, such as blue-green algae, existed 2.8 billion years ago.

There are some series of fossils that show the gradual development of species. One of the most complete is that of the horse, in which both toe bones and teeth reveal a record of changes in horse ancestors. The changes begin in the Eocene epoch (38 to 53 million years ago) and extend through the Oligocene, Miocene, and Pliocene, until the horse took its present form in the Pleistocene epoch about a million years ago.
It is taken by evolutionists as convincing evidence that they can predict the discovery of certain fossils which will reveal specific information. Thus Thomas Huxley predicted in 1876 that some day the fossil of a four-toed horse would be uncovered. It was four months later.¹³

More recently, Louis and Mary Leakey predicted the discovery of fossils that would reveal the link between human beings and apelike forerunners. In the 1970s the Leakeys found evidence of such a creature, called *Homo habilis*, which lived 3.5 million years ago. Their findings are still being analyzed by paleontologists, the scientists who study fossils.

As evidence of geographic isolation in the development of new species, a scientist has found that leopard frogs cannot produce offspring if the parents come from places as far apart as Vermont and Texas, but if leopard frogs from neighboring states are crossed, fertile offspring are produced.¹⁴ Evolutionists see this as support for their model, which predicts that isolated groups may become separate species.

Those who accept the evolution model feel that despite important gaps in the fossil record, gaps that remain open despite more than a hundred years of intensive study, they are justified in their conclusion that some life forms have changed drastically through millions of years. Evolutionists expect continued change as time goes on. Some evolutionists see a purpose in these changes. Others do not believe evolution has any purpose, but is merely a product of chemical and physical reactions.

Evolutionists claim that their model is the only scientific theory because it is based on free and open inquiry, which continually produces new evidence and as such should be included in biology classes.
<table>
<thead>
<tr>
<th>ORGANISMIC GROUP</th>
<th>PRECAMBRIAN 3 Bil*</th>
<th>PALEOZOIC ERA</th>
<th>MESOZOIC ERA</th>
<th>CENOZOIC ERA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cambrian 500 Mil</td>
<td>Ordovician 425 Mil</td>
<td>Silurian 360 Mil</td>
</tr>
<tr>
<td>Bacteria. Blue-green algae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>True algae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bryophytes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psilopsids</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnosperms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angiosperms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sponges</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cnidarians</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bryozoans</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brachiopods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mollusks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthropods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echinodermes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chordates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Approximate beginning date.

Graph I: Major Features of the Fossil Record
Graph II: Plant Phylogeny
<table>
<thead>
<tr>
<th>Time Period</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent 20,000 Yrs Ago</td>
<td>Contemporary Man</td>
</tr>
<tr>
<td>20,000 Yrs Ago</td>
<td>H. sapiens</td>
</tr>
<tr>
<td>25,000 Yrs Ago</td>
<td>H. sapiens</td>
</tr>
<tr>
<td>30,000 Yrs Ago</td>
<td>H. sapiens</td>
</tr>
<tr>
<td>50,000 Yrs Ago</td>
<td>H. sapiens</td>
</tr>
<tr>
<td>100,000 Yrs Ago</td>
<td>H. sapiens (Europe)</td>
</tr>
<tr>
<td>200,000 Yrs Ago</td>
<td>H. sapiens (Europe)</td>
</tr>
<tr>
<td>400,000 Yrs Ago</td>
<td>H. erectus (Europe)</td>
</tr>
<tr>
<td>500,000 Yrs Ago</td>
<td>H. erectus (Europe)</td>
</tr>
<tr>
<td>700,000 Yrs Ago</td>
<td>H. erectus heidelbergensis</td>
</tr>
<tr>
<td>800,000 Yrs Ago</td>
<td>H. erectus heidelbergensis</td>
</tr>
<tr>
<td>1 Mil Yrs Ago</td>
<td>H. erectus (Europe)</td>
</tr>
<tr>
<td>2 Mil Yrs Ago</td>
<td>Australopithecus (Africa)</td>
</tr>
<tr>
<td>3 Mil Yrs Ago</td>
<td>Homo Sp. Indeterminate (Africa, 1973)</td>
</tr>
<tr>
<td>12 Mil Yrs Ago</td>
<td>Ramapithecus</td>
</tr>
<tr>
<td>30 Mil Yrs Ago</td>
<td>Ramapithecus</td>
</tr>
<tr>
<td>Miocene</td>
<td>Ramapithecus</td>
</tr>
<tr>
<td>30 Mil Yrs Ago</td>
<td>Ramapithecus</td>
</tr>
<tr>
<td>30 Mil Yrs Ago</td>
<td>Dryopithecus</td>
</tr>
<tr>
<td>30 Mil Yrs Ago</td>
<td>Dryopithecus</td>
</tr>
<tr>
<td>30 Mil Yrs Ago</td>
<td>Dryopithecus</td>
</tr>
</tbody>
</table>

Graph III: Suggested Human Phylogeny
STATEMENT FORM FOR USE IN CONFLICT RESOLUTION

Value Topic: Is it better to keep two models to explain the history of life forms, or should one model be selected over the other?

Your Initial value judgment: ________________________________

<table>
<thead>
<tr>
<th>Data statements that support Initial value judgment (1)</th>
<th>Initial rank order of statements and criteria used (Write criterion next to rank number.) (2)</th>
<th>Revised rank order (3)</th>
<th>Data statements that do not support initial value judgment (4)</th>
<th>Initial rank order and criteria (5)</th>
<th>Revised rank order (6)</th>
</tr>
</thead>
</table>

Copyright 1983  J. Weston Walch, Publisher  Portland, Maine 04104-0658
Day 3:

Objectives:

- Students will list the criteria used to write their data statements.
- Students will derive a value principle from those criteria.
- Students will compare their value principles to those of fellow team members.
- Students will work together to eliminate flaws in value principles.

Procedures:

2. Instruct students to put the data statements in the left hand column of the sheet.
3. Then they are to list value judgements for each data statement. These are basically a list of criteria used to judge the data statements.
4. From these criteria, a value principle is derived. The value principle is a general statement which you hold to be true that contributes to your value judgement.
5. The members of each team are to compare value principles to see where differences lie.
6. Now that each student has a set of value principles the two teams will switch roles. The evolution group
will take the role of creationists and defend against that value principle and vice versa. By doing this, students will attempt to find flaws in their own value principles.

7. Finally, assign the students to write out their position on whether or not there should be two models to explain the history of life forms. This will be due on Friday.

Materials Needed:

Value Principle Sheet

Assignment:

Since this is the last day of the actual conflict resolution activity there are several things that could be done.

1. If the students took longer than the allotted time to go through this material, extra time may be designated for finishing. If necessary, the next class period could be used.

2. If students are on schedule, assign them to answer the question below using the information they have gathered:

Is it better to keep both of the models to explain the diversity of living things, or should one be selected over the other.

This assignment will be due on Friday.
<table>
<thead>
<tr>
<th>Data Statements</th>
<th>Value Judgments</th>
<th>Value Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>(What statements are you using in support of your value judgment?)</td>
<td>(Why is this statement important to you?)</td>
<td>(What general statement(s) that you hold to be true contribute to your value judgment?)</td>
</tr>
</tbody>
</table>
Day 4:

Objectives:
- Students will synthesize the information given in graphic form and use it to distinguish between statements supporting different models.
- Students will list ways of processing evidence used in making a judgement.

Procedures:
1. Pass out the 3 graphs and statement forms.
2. Have students use the graphs to answer the statements.
   If the graph strongly supports a statement from the evolution model, mark a 1. If the graph supports a statement from the creation model mark a 5. Most things will fall somewhere in between. Number 6 is used when there is no evidence to support the statement.
3. Ask students if any more information is needed to decide whether the fossil record supports either theory, neither or both. Begin to discuss how students process pieces of evidence before making a judgement.
4. If this activity is completed on Thursday, students will be given the rest of class period to put together their debates.
Materials Needed:
3 graphs
Statement Form

Assignment:
Prepare for Friday’s debate.

Note to Teacher:
The Friday debate will help students defend the position they have researched. It will also allow them to fully realize the complexity of this conflict. Each group will begin with an opening statement which will describe their position. Then, one group will be asked to present an aspect of the controversy to the other group. After responding, that group will present to the first group. This will continue until either the groups have no more questions to raise or the class period is over.
Day 5:

Objectives:
- Students will demonstrate the information they have learned all week in a debate format.
- Students will defend the stance to which they have been assigned.
- Students will demonstrate their ability to deal with ideas and not people.

Procedures:
1. The two teams will participate in a formal debate about creation/evolution. The students' personal opinions are not used, but the assumed stances only.
   
   Each team will:
   1. Develop an opening statement which summarizes their position.
   2. Develop 5-10 areas which, based on value principles of the groups, will be areas of controversy. These will be used in the debate.

Materials Needed:
None

Assignment:
None
For the second week, the students will perform a series of laboratory exercises which deal with creation and evolution. They will then be asked to react to them. They must try to use the skills learned in the first week to synthesize the information and make a judgement as to its validity. This gives them a practical use for the skills learned in the first week. Two of the activities deal directly with evolution and two deal specifically with creation. The last day will be spent at a local museum of natural history. This is a place where the students can see the evidence for the diversity of life for themselves and decide what they believe to be the truth. After each of these experiences, the students will be asked to answer the same set of thought questions. Using these, the students can see how their opinions have progressed from the beginning of the week to the end. They will be assessed based on this progression, not on the ultimate opinion they hold. Grades will be based on completion of the labs and on the conclusions drawn from them. The students will also be given a final project to be turned in at the end of the unit. This is addressed on the assignment sheet.

Criteria for Grading Unit Work:

Neatness
Progression of thought from last assignment
Clarity
Logic of arguments
Assignment Sheet

Each of you will complete one of the following projects to be turned in after the completion of the unit. This is an out-of-class assignment. You will not be given class time to do it. All materials to be handed in must be typed and double-spaced.

1. Write a letter to one of the following and convince them that either creationism or evolution should be taught in your school. Give valid reasons and arguments. You must use at least five outside sources to support your claims. You may write to either a school official, a textbook publisher, or a legislator.

2. Design a laboratory which could be used to teach whichever view you support. You may not use any existing lab for this!! Be creative!! Come up with a new way to get across the information.

3. Design a display board which gives visual evidence for whichever view you support. You may use pictures and drawings to enhance your presentation.

4. Make a video which persuades the audience to believe whichever view you hold. Use valid information and support any claims you make. Be creative and present the information in a fun way. The video must be at least five minutes long.
Thought Questions

1. Which view of the origin of life does this activity support? Why do you think so?

2. Does this activity affect your views in any way? Describe how they have been changed.

3. What is your opinion on the subject of the origin of life as of this moment?

4. List some reasons which support this view.
Day 6-Coacervates Lab

Objectives:
- Students will learn the recipe for making coacervates.
- Students will decide whether or not coacervate behavior allows them to be classified as living.
- Students will organize their data according to the characteristics of life.
- Students will infer whether coacervates are alive.

Procedure:
1. Discuss the purpose of models and what makes something alive.
2. Go over procedure listed on the lab sheet.
3. Distribute labs and have students perform. Walk around and make sure they stay on task.

Materials:
Listed on lab sheet.

Assignment:
Answer the thought questions and work on final project.

This lab is from Holt's Modern Biology, Eighth edition.

Note to Teacher:
This lab addresses the question "Can living organisms come from nonliving materials?" Students need to understand that evolution itself does not explain the beginning of life. If evolution is the way that life began, then somewhere life
had to come from nonliving materials. Challenge students to think about this. Remind them that even scientists don’t always agree about this.
Learning Objectives
- To learn the recipe for making coacervates.
- To decide whether coacervate behavior allows coacervates to be classified as living.

Process Objectives
- To develop an awareness of the dynamic model technique.
- To organize your data according to the characteristics of life.
- To infer whether coacervates are alive.

Materials
For Group of 2
- 4 Medium-sized test tubes
- 4 Rubber stoppers to fit the test tubes
- Test tube rack
- 2 10-mL Graduated cylinders
- 5 mL 1% Gelatin solution
- 4 mL 1% Gum arabic solution
- Glass stirring rod
- pH Paper (with pH scale)
- 2 Medicine droppers
- Microscope slide
- Coverslip
- Compound light microscope
- Drawing paper
- Lab aprons
- Safety goggles
- 5 mL 1% Hydrochloric acid
- Dilute solutions of water-soluble dyes (e.g., Congo red, neutral red, methylene blue, food coloring)

Introduction
How did life on earth begin? What were the first organisms like? Scientists such as Alexander Oparin believe that all life developed gradually in the ancient seas. According to Oparin, prehistoric oceans probably contained a rich mixture of organic chemicals, including proteins and carbohydrates. When protein and carbohydrate molecules are mixed together in liquid water, coacervate (ko-e-AS-ur-VATE) droplets, showing lifelike characteristics, may form. In this lab, you will make coacervates and observe their behavior.

Prelab Preparation
A model is a visual or verbal construction that helps make difficult concepts more easily understood. It often simulates something that is impossible to study firsthand due to size or unavailability. This lab permits observation of coacervates, which scientists believe to be similar to the ancestors of the first living organisms. Proteins and carbohydrates are used to model the probable contents of prehistoric oceans.

Since this lab is an actual "working" model, it is referred to as dynamic. A dynamic model differs from a static model, such as a replica of the human ear, in that it changes as you observe it. This dynamic model uses a process that occurs in nature—the formation of coacervates—to simulate the possible beginnings of life on earth.

1. List the basic characteristics of life. You may refer back to Investigation 1, "What Is Life?"

Because the pH of your solution will have to be carefully adjusted in order for coacervates to form, review Investigation 3.1 on the concept of pH.

Procedure
A. Get 4 test tubes, 4 rubber stoppers, and a test tube rack. Pour 5 mL of gelatin solution (a protein) into one test tube. Then add 4 mL of gum arabic solution (a carbohydrate). Stopper the tube tightly, and mix the contents gently by turning the tube upside down several times. NOTE: Do not shake; it will affect the solution.

B. Uncork the test tube, and dip a glass stirring rod into the mixture. Touch a drop of the mixture onto a piece of pH paper.

2. Is there a color change? Record the pH under Trial 1 in your data chart.

3. Hold the tube up to a light source. Is the mixture clear or cloudy? (If it is cloudy, the mixture may contain coacervates.) Record your results as Trial 1 in your data chart.
Strategy for Inferring
Imagine yourself as the first scientist to ever see coacervates. Finish one of these statements: “It makes sense that coacervates are not alive because...” or “It makes sense that they are alive because...”

Strategy for Modeling
A model should emulate the environment of the process it is depicting.

C. Using a medicine dropper, put 2 drops of the mixture on a clean slide. Put a coverslip over the drops, and look at them under low power (10×). You may not see coacervates until the pH (acidity) is adjusted, so do not be discouraged. If present, coacervates will look like droplets with tiny bubbles inside. (If the mixture is not cloudy, move on to Step D, and come back to Questions 5–8 later.)

4. Describe the appearance of the coacervates in your data chart.
5. Record the number of coacervates in the microscope field.
6. Draw a coacervate (under high power) on a separate piece of paper.

D. CAUTION: Wear lab apron and safety goggles; hydrochloric acid causes burns. Using a second medicine dropper, add 2 drops of dilute hydrochloric acid to the mixture in the test tube. Cork the tube and turn it upside down once or twice to mix the acid.

E. Repeat Step B. This is Trial 2 on your data chart.

7. What is the pH now? Is the mixture cloudy?

F. Repeat Step C.

8. Does a change in pH cause a change in coacervate structure?

G. Repeat Step D. Continue the procedure (Steps B through D) until coacervates are no longer observed and the mixture is no longer cloudy. When the mixture is no longer cloudy, proceed to Step H. Pay attention to changes in the appearance, number, size, and activity of the coacervates as more and more acid is added.

9. Draw and label coacervates from 3 different trials.

H. When the mixture is no longer cloudy, make a slide, as before, but put 1–2 drops of dilute dye on the mixture before adding the coverslip. Observe the coacervates.

10. What characteristic of coacervates does the dye allow you to observe?
11. Infer, based on coacervate behavior with the dye, whether coacervates are living or nonliving.

Postlab Analysis
Look at your list of characteristics of living organisms for Question 1.

12. In what ways do coacervates seem to be alive?
13. In what ways do they seem not to be living?
14. Describe how the coacervates changed as the pH was altered?
15. What does this tell you about coacervates?

Further Investigations
1. If a live ameba culture is available, make a wet mount from it. Compare amebas and coacervates in terms of appearance, shape, number, grouping, size, and activity. Add dye as you did with coacervates. Notice how the amebas are affected by the dye. How does this compare with the effect of dye on coacervates.
2. Do some further reading on the subject of the origin of life on earth. Prepare a report on this fascinating topic. Important areas to discuss include: Oparin’s and Haldane’s concurrent hypotheses; conditions necessary for the origin of life on earth; Miller’s experiment, simulating the early development of organic material; formation of organic polymers and aggregates; development of life (metabolic) processes.
Investigation 14 Coacervates

1.

2.-5. Enter your answers on the data chart.

| Coacervate Data |
|-----------------
| Trial 1 2 3 4 5 6 7 8 9 10 |
| pH | | | | | | | | | |
| Cloudy/clear | | | | | | | | | |
| Microscopic Observations | | | | | | | | |

6. Make a drawing on a separate sheet of paper.

7.-8. Enter your answers on the data chart.

9. [Diagram]

10.

11.

12.
Day 7 Circuit Lab

Objectives:
- Students will design a simple circuit.
- Students will use a circuit to show the need for a designer.
- Students will reconcile the meaning of this to creation/evolution.

Procedures:
See Lab Sheet. This lab is designed to show the need for a designer. Do not tell the students. They are to figure it out based on their previous knowledge. This will require some higher level thinking, however. Be certain to keep encouraging them so they don’t give up.

Materials:
flashlight bulbs
D-batteries
insulated wire

Assignment:
Finish lab sheet and thought questions.
Laboratory Sheet for Circuit Lab

1. Look at the items given to you in the box and answer the following questions.
   a) Why does the lightbulb not work?
   b) Will someone or something have to act on the lightbulb in order to make it work?

2. Now assemble the circuit by putting the two wires on opposite ends of both the battery and the lightbulb.
   a) Why does the lightbulb now work?
   b) What happened to it that made it work?

3. Draw connections between this lab and last week's lessons.

4. Finish the day by doing the thought questions.
Day 8-Natural Selection Lab

Objectives:

1. Students will explain how the color of individuals and the predation of members of a population can be factors in natural selection.

2. Students will predict the color changes that are likely to take place in a population, given the background color of a certain habitat.

3. Students will develop a definition of natural selection.

Procedure:

1. Introduce the idea of natural selection and how color can be a factor in natural selection. It may also be helpful to make sure the students understand what predation is.

2. Distribute labs and assist students in doing it.

Materials:

See lab sheet.

Assignment:

Answer the thought questions and work on the final project.

This lab is from Experiences in Biology 2nd edition, published by Laidlaw Bros.
Question Sheet for Natural Selection Lab

1. Table on procedure sheets

2. How would you describe the distribution of colors in the first generation?

3. How does the distribution of colors change from the first generation to the second generation?

4. As a "predator," does it take more time or less time to find five "prey" individuals as you move from one generation to the next? Explain.

5. How does the appearance of the individuals in the population in the fourth generation compare with the appearance of the environment?

Analysis:

1. How would you explain your observation in question 3 of the previous section?
2. If your hypothesis was correct, what do you think will happen to the total number of individuals of each color by the end of the fourth generation?

3. Which color of individuals, do you think, is best suited to this environment? Explain.

4. Is the population as a whole better suited to the environment after four generations of predation than it was to begin with? Explain.

5. In this activity, the only characteristic studied was color. In a real situation, do you think color is the only important characteristic? If not, what are some others you can think of?
As a result of doing this activity, you should be able to
- Explain how the color of individuals and the predation of members of a population can be factors in natural selection.
- Predict the color changes that are likely to take place in a population, given the background color of a certain habitat.
- Arrive at your own definition of natural selection.

**Background**

In any population, some individuals reproduce, and some do not. Some individuals will have more young that survive than others. Some, but not all, of the characteristics that enable an individual to be successful in reproducing are easy to see. For example, the most successful individuals are often the strongest, the best able to find food, or the best camouflaged. In the final analysis, however, conditions in the environment are what determine which individuals will be the most successful. Thus, the environment "selects" some individuals over others to produce the next generation. This process is often called natural selection.

The color of organisms in a certain environment is one characteristic that is determined by natural selection. For instance, studies of field mice indicated that the color of the mice was strongly influenced by the background color of their environment. Experiments supported this idea. Mice of varying colors were released into environments of controlled background colors. Owls were also released in these areas. Owls use two of their keen senses—hearing and sight—to capture prey. Color affects only one of these senses, but owls still captured more mice that had a color of fur that contrasted with their environment.

Thus, the reason that most mice in any one environment match their environment is that those that do not match their environment are more likely to be removed by predators. In this instance, predators are the selective force that influences the makeup of the population.

This activity will give you a chance to see how color and predation affect natural selection. Many of the members of your class will act as "predators." These "predators" will remove individuals of a make-believe "prey" species from a make-believe environment. You should work in groups of four to do the activity. Three people in the group will be "predators." The other person in the group—call that person the caretaker—will be in charge of setting up the environment for each generation. All the people in the group will be responsible for collecting and analyzing the data.

**Materials**

- newspaper
- scissors
- white construction paper
- black construction paper

Any 2 colors of construction paper will also work here, but white and black are the best to use.
The want-ads section would probably work best for the 50 squares and for the "environment."

1. This step can be done by the 3 people who are to be "predators." From a piece of newspaper (use a regular page, not a special feature such as the comics or an advertisement) cut 50 squares of paper about 12 to 15 millimeters on a side. Also cut 50 squares of the same size from the sheet of white construction paper and 50 squares from the sheet of black construction paper. These squares represent individuals of different colors, but all are members of the "prey" species.

2. The caretaker should spread a large sheet of newspaper flat on the floor or on a large table. The sheet of newspaper represents the environment of the "prey," so a typical page of the newspaper should be used—not comics or a large advertisement. When the squares are cut, the caretaker should take 10 of each kind, mix them up, and scatter them about on the environment while the "predators" are not looking. "Predators" must not look at the environment except when it is their turn to capture "prey."

3. Each "predator" should, in turn, remove 5 "prey" squares from the environment. "Predators" should pick those squares that are easiest to find, just as a real predator would hunt the prey that is easiest to find. Remember, "predators" must look at the environment only when it is their turn to capture "prey."

4. When each "predator" has finished "hunting," the caretaker should remove all the individuals left on the environment and count the number of each kind left. Record the data in the table in Observations and Data. If your teacher suggests it, you should also put your data on the chalkboard, so that you have a class total.

5. Now let the survivors "reproduce." For each survivor, the caretaker should add one individual of the same type. This will bring the total number of individuals back up to 30. This is the second generation. The caretaker should then scatter these second-generation individuals about on the environment and the "predators" should repeat the process of "hunting" and of "reproduction." Repeat these procedures for at least 4 generations. Record your observations and data for each generation in the table.

### Observations and Data

1. In the table below, record the number of individuals of each kind that are left in the second generation, the third generation, and the fourth generation.

<table>
<thead>
<tr>
<th>Species Color</th>
<th>First Generation</th>
<th>Second Generation</th>
<th>Third Generation</th>
<th>Fourth Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newspaper</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Answers will vary.)
2. How would you describe the distribution of colors in the first generation?
In the first generation, colors were equally distributed because there were 10 of each color.

3. How does the distribution of colors change from the first generation to the second generation? (Answer questions 1 and 2 of Analysis after you answer this question.)
(Specific numbers will vary, but in general, "newspaper" will increase, and "black" and "white" will decrease.)

4. As a "predator," does it take more time or less time to find five "prey" individuals as you move from one generation to the next? Explain.
It takes more time to find five "prey" individuals in the later generations, because there are fewer of the "blacks" and "whites," which are much more noticeable.

5. How does the appearance of the individuals in the population in the fourth generation compare with the appearance of the environment?
(Specific numbers may vary, but most groups will report that the population in the fourth generation is almost all "newspaper.")

Analysis

1. How would you explain your observation in question 3 of Observations and Data?
The "whites" and "blacks" are easiest to see against the newspaper, so they are picked out more frequently, leaving the population mostly "newspaper."

2. If your hypothesis is correct, what do you think will happen to the total number of individuals of each color by the end of the fourth generation?
If my hypothesis is correct, by the fourth generation almost the entire population will be "newspaper."
3. Which color of individuals do you think is best suited to this environment? Explain.

The "newspaper" individuals are best suited to this environment—at least as far as not being preyed upon is concerned—because they blend in and are harder to see than the others.

4. Is the population as a whole better suited to the environment after four generations of predation than it was to begin with? Explain.

The population is better suited to the environment after four generations—at least as far as not being preyed upon is concerned—because they blend in with their environment, making it hard for predators to see individual members.

5. In this activity, the only characteristic studied was color. In a real situation, do you think color is the only important characteristic? If not, what are some others you can think of?

Color is not the only important characteristic. Size of litter, resistance to disease, strength, speed, and ability to find a mate are all important for the survival of a species.

Doing More

1. You could modify this activity to see if the general color of the population would change if the "white" and "black" individuals reproduced faster than the "newspaper" individuals. For every "white" survivor, you could add three individuals to the next generation. You could add two for every "black" survivor. Would you also have to take out more individuals by predation for each generation? Would this be good or bad for the predators?

2. Design and carry out an activity to see what might happen to the color of a population if there was a change in the natural background color of the environment. As you can imagine, such a change is not likely unless some other factor of the environment, such as rainfall or temperature, also changed. However, to try to design an activity to take several changes in factors into consideration would be very difficult.
Day 9 Mixtures Lab

Objectives:
- Students will use random mixtures to demonstrate how chaos rarely has any useful products.
- Students will combine what they have just seen with their previous knowledge to form an opinion on the issue.
- Students will synthesize the new information based on what they already know.

Procedures:
See Lab Sheet.

Materials:
Unknown liquids and solids. Household items that are unrecognizable, but not hazardous are probably the best idea. Some possibilities include powdered sugar, flour, water, salt water, sugar water, unflavored gelatin in water, etc.
beakers to mix in.

Assignment:
Finish Lab Sheet and thought questions.

Note to Teacher:
In this lab students will try to mix random chemicals to achieve some useful product. They are supposed to realize that without order, these things are worthless. It will be important for you to set the stage for this discovery. Keep encouraging!
Laboratory Sheet for Mixtures Lab

1. Make mixture of any of the given chemicals. You may mix them in any combination you wish.

2. What have you achieved?

3. Do you feel like you have made something useful?

4. Repeat this several times.

5. What are the odds that you can make something productive out of this stuff?

6. Draw connections between this lab and last week's lessons.

7. Do thought questions.
Day 10—Museum Trip

Objectives:

1. Students will gather information about creation/evolution firsthand from the museum.
2. Students will synthesize the information and use it to make a decision about this issue for themselves.

Procedures:

1. Take students to a local museum of natural history. Secure a tour guide who knows about both creation and evolution to lead the students through the museum. This will help to keep students on task as the museum could easily be a "blow off" assignment. Remind students that they will need this information to do the thought questions later. Some possible exhibits could be fossil displays and dinosaur museums. Also, live animals could be used to stimulate questions about how they became the way they are.

Materials:

Transportation to museum

Assignment:

Do final thought questions sheet.
Students may also use resources that the teacher collects and keeps in the classroom.
Suggested Student Reading List and Bibliography


59

