

A Message to Parents and Teachers

In this manual I have attempted to provide the material you will need to successfully teach this course. The book and manual are meant for use by home school parents as well as Christian schools.

At the beginning of the chapters are suggestions sheets. These provide thought questions and illustrations to arouse students' interest and get them involved in thinking critically about what they are going to learn. Please take advantage of them. In addition, there are worksheets, review sheets and tests for each chapter and keys for all. There are also concept maps. Their best use is as a group review with the use of a computer or overhead projector.

I have also provided two vocabulary review sheets for a final exam. They cover everything that will be mentioned in the test. In addition, there is a final exam that is entirely objective. I set it up this way because I have found it very difficult to grade essay questions at the end of the semester.

The manual material can be copied, and you can then make the adjustments you need without changing the original. Some of the worksheets, especially those in Chapter 8, are geared to making students think, to helping them become more critical observers and interpreters of the information they receive from evolutionists. This is absolutely essential. If we are to help members of the next generation to remain faithful to God, it is crucial that we foster a Christian world view in them—one that is grounded in His Word and in a solid scientific understanding of His world. God's hand is on everything He made. Help them to see it.

Please believe me when I say that what you are doing is extremely important. One of the main reasons college students give for no longer believing in God's Word is that their immersion in evolution has convinced them the Bible is not trustworthy. The great irony is that the theory of evolution is not only theologically unsound but also scientifically unsound.

Above all else, bathe this course in prayer. You will find, as I did, that it can be the most important class you will ever teach, in terms of the lasting effect on your students.

Critical Thinking

Situation One

Walt was an eighth grader and an avid science fan. One night he was awakened by heavy rain coming down outside his window. The next day he awoke to find that it was still raining. “How long has it been raining?” he wondered. He looked through the dining room window and saw a bucket on the patio that was partially filled with water. He knew it had been empty yesterday evening when he went to bed. “I can know how hard and how long it has been raining!” he exclaimed. He ran to the kitchen, grabbed a bucket just like the first one, and set it by the first bucket where it could also catch rainwater. An hour later, at eight o’clock, he stepped out into the rain long enough to pick up both the buckets. The second bucket had a half inch of water in it. The first bucket had three inches of water. “It’s been raining at the rate of one half inch per hour,” he stated. A few minutes later Walt’s mom and sixteen year old brother Fred came into the kitchen.

“Mom, can you wash my good jacket? It was raining when I came in, and somehow I got mud on it.”

Before Mom could suggest to Fred that he wash his jacket himself, Walt yelled excitedly. “Mom, you’ve got to ground Fred. He came in after curfew!!!”

“What makes you think that?” Mom asked.

“Well, it’s been raining at the rate of one half inch per hour and there are three inches of rain in the bucket that was left outside, so it’s been raining for only six hours. That means he got in after two A.M., an hour past curfew.”

Mom smiled. “Why don’t we call the weather bureau just to verify your findings?”

“Not necessary,” Walt answered. “The facts don’t lie.”

When Mom contacted the weather bureau, she found it had been raining for about eight hours.

1. *How did Walt come up with one half inch per hour as the rate at which it had been raining?*
2. *What assumption did Walt make based on the half inch of water in the pan?*
3. *As a scientist, would you have accepted Walt’s findings without verification? If not, why not?*
4. *When Walt said “the facts don’t lie,” was he wrong? What does Walt know for sure? What doesn’t he know?*
5. *When Walt explains why he thinks Fred was out past his curfew, what error in reasoning does he make?*
6. *When he insists that it is not necessary to check with the weather bureau, what error in scientific procedure is he making?*

Critical Thinking

Situation Two

Mr. Jones, a teacher at Damon High School, was convinced that Tommy Brown, a student in his English class, was a complete loser who would soon end up in jail. Mr. Jones felt this way because Tommy tended to be somewhat “rowdy” in his class and was not very respectful. Tommy, along with two other students, James Wallace and George Kendrum, had been absent from school for several days due to the flu. When they returned, Mr. Jones called them out of study hall to help them catch up in their work. During the time that they were in the room, money that Mr. Jones had been collecting from his students for a field trip disappeared. Mr. Jones immediately suspected Tommy. His suspicion was based on two things: his opinion of Tommy’s past behavior and the fact that he had seen Tommy near his desk while he was in the hall for a short time.

Later that day, however, Melissa, a shy but conscientious and hard working student in one of his classes, stopped to see him. At first she was hesitant to talk, but finally she blurted out,

“Mr. Jones, I heard the field trip money was stolen today. I just wanted you to know that when I passed your class while you were speaking to Mr. Taft, I saw George Kendrum at your desk. I didn’t think anything of it at the time, but later I heard him tell his girlfriend Josie that they could go out to dinner and a show because he had “come into some money.” That’s the way he put it—“come into some money.” So when I heard the money had been taken from your desk, I thought it was important to let you know what I had seen and heard.”

Mr. Jones thanked Melissa for the information. After she left, he considered the facts. “I can’t believe George would steal from me,” he thought. “After all, he is always courteous, and I have never had any trouble with him. I’m not going to mention this to the principal. I’ll simply tell him I saw Tommy near my desk, and the money was gone when I checked immediately after he left.”

The next day Tommy was suspended from school for stealing.

1. *What affects Mr. Jones’ ability to examine all the facts?*
2. *What error in reasoning is he guilty of?*
3. *How does his error in reasoning affect the judgment of his principal?*

Critical Thinking

Situation Three

John was an intelligent but somewhat lazy eleventh grader. Shortly after the beginning of the semester, he was in speech class when he suddenly realized he had forgotten that today was the day he was to give a summary of his speech on the contributions of the Republican Party to the United States. John, a Republican, was also a good speaker. In spite of his lack of preparation, he decided to proceed. He walked to the lectern and began.

“It is always advantageous for the Republican Party to be in power because it is highly beneficial to the country for Republicans to lead us. Although the other students clapped as John sat down, his teacher, also a Republican, pointed out to him that he had a low mark for his summary and could expect a low grade on his speech unless he did his research and came up with valid reasons for his position. He also told him that he had committed a serious error in reasoning.

1. *What error in reasoning did John commit?*
2. *What does this mean?*

Critical Thinking

Situation Four

Tommy's dad was very upset with him. Mr. Martin had been called to the principal's office because his twelve-year-old son had been caught copying another student's answers on a test.

"What did you think you were doing?" Mr. Martin thundered. "You know it's wrong to copy. That's cheating! How can you hope to do well if you are stealing other people's work? You know better than that."

"I—I'm sorry, Dad," Tommy whispered. "I guess—I wasn't thinking."

"Well, you're going to be sorrier," his father replied. "You're grounded for two weeks." Tommy and his dad were told that he was suspended from school for a day because of his actions, and father and son went home.

The house was strangely silent through dinner. Both parents were disappointed with Tommy and had no desire to talk to him. Later, Tommy's dad went to his study to work on his income tax returns. Tommy felt increasingly guilty about his actions and decided to join his father in his study and, at the first opportunity, apologize again. He sat behind his father and watched him working at the computer. Suddenly, Mr. Martin picked up the phone and called the treasurer of the church the family attended.

"Hi, Al. It's me, Arthur Martin. Say, I think you made a mistake on the summary of our

church offerings," he stated. "I made a \$100 contribution on July 23rd of last year that you don't have recorded. I have the check to prove it."

Tommy's face filled with concern. "Dad, that's not..."

Tommy's father frowned and shook his head at Tommy. He remained quiet.

"Do I need to show you the check on Sunday?" Mr. Martin continued. "Okay then, thanks a lot. See you Sunday."

When Mr. Martin hung up, Tommy burst out, "Dad, you made a mistake. That \$100 was money you paid for me to go to camp. That wasn't an offering!"

"Sure it was. I gave it to the church, didn't I?" his dad answered.

"Yeah, but it wasn't an offering," Tommy repeated. "That's cheating!"

Mr. Martin's face grew red. An angry scowl appeared. "It is not cheating! Uncle Sam gets too much of my money as it is. What I'm doing is just good business!"

Tommy stared at his father. He knew he was wasting his time and taking a chance on being grounded for an additional two weeks, so he just shook his head, turned around and went to his room, all thoughts of apologizing gone from his mind.

1. *What did Mr. Martin have to say about Tommy's behavior when he was in the principal's office?*
2. *How does Mr. Martin define cheating when he is at home?*
3. *What is this error in logic called?*

Critical Thinking

Situation Five

Mr. Burns owned a public skating rink that many of the teens in his town patronized. One particular Saturday Mr. Burns overheard some of the teens talking about their activities. One of them, a boy named Morris, mentioned that he was going on a skiing weekend with the First Christian Church, a congregation that worshipped nearby. Later, Mr. Burns had to break up two fights in which Morris was involved. After the second one he expelled Morris and returned to his office, exhausted and angry. Soon after, the phone rang.

The caller was the youth pastor from First Christian Church. He wanted to book the rink one Monday night for his youth group.

"I'm sorry, but we have no openings," Mr. Burns stated.

"Well, that's okay," replied the pastor. "We can wait a few weeks until something opens up."

Mr. Burns looked at his schedule for Monday nights and noted it was half empty. "I'm sorry, but we are booked for the rest of the year, he stated emphatically. "We have NO openings!"

Since he knew how slow business was on Monday nights, the puzzled youth pastor thanked Mr. Burns anyway and then wondered what he had done to offend him.

1. *What led Mr. Burns to lie about having openings in his schedule? Why didn't he want to allow the youth group of First Christian Church to rent his rink?*
2. *What error in reasoning is Mr. Burns guilty of?*

Critical Thinking

Situation Six

Max, an eleventh grade student at Washington High, was anxious to get out of the house one Friday night. He was going on a weekend trip with his youth group, skiing and snowboarding. Although he still had an hour before he was scheduled to go to the church, he was anxious to get there early to talk with his friends before leaving. As he was preparing to leave, his mom stopped him.

“Are you sure you have all your homework done?” she asked. “You know you won’t have any time this weekend, once you leave here.”

“Mom, I got all my math and chemistry done. That’s what I’ve been working on,” Max answered.

“What about your English?”

“I don’t remember anything, but Mrs. Droulliard never assigns any homework on Fridays.”

Max’s mom shook her head. “Things change. If you’re not sure, why not call Pete or Manny. They’re good students; they will know.”

Max considered this. He was doing well in English, and he wanted to keep his grades up. Yet Mrs. Droulliard did not often give homework assignments on Fridays. “I’m sure she didn’t give any work today, Mom. Gotta go!” With that, he picked up his equipment and headed for the door.

Monday, Max lost some English credit because he forgot to finish as homework the class work Mrs. Droulliard had given that day.

1. *What was the mistake Max made?*
2. *What error of reasoning is this? Explain.*
3. *How could he have tested his assumption?*

Critical Thinking

Situation Seven

Jeff was talking with two of his co-workers, Andrew and Paul, during their lunch break at McDonald's.

"So, you go to a Christian school, don't you?" Paul asked.

"Yeah," Jeff replied, his mouth full of double cheeseburger.

"They teach any creationism there?"

Jeff sighed. He didn't know if he wanted to get into this discussion with Andrew present because Andrew was known as a hothead, who didn't listen to anything others had to say. "Yeah, they teach creationism. I am in a semester course in origins right now."

"What are you learning?" Paul asked.

"Well, so far our teacher has explained to us that change does occur but not evolution as it is

defined in public school. She has given us several scientific examples to support her claims."

"Are you kidding?" Andrew practically yelled. "The only thing creationism's got going for it is the Bible. How could they have a semester course on Adam and Eve?"

"We don't study the Bible in this class. We study just science," Jeff answered. "What I'm learning could be taught in the public schools because it's all science."

"Yeah, right!" Adam sneered, his face turning red with exasperation. "They talk about God having to create the world. Creation is religion and evolution is science! You can't teach religion in the public schools!"

1. *What has Andrew failed to do before making his statements?*
2. *If one can prove through science that the specified complexity of this world could not have happened by chance, would it be good science to say so? When would religion come into the picture?*
3. *What error of reasoning has Andrew committed that leads him to the conclusion that creationism cannot be taught in the public schools?*

Chapter 1

Suggestions for Beginning

One profitable way to begin your semester is by a discussion of the theories of origins. Guide your student(s) to an understanding that there are basically only two possibilities—everything came about as a result of a cosmic “accident” (random mechanistic processes), or some intelligent being had to create it. (He may suggest that God used evolution to create the world. This still fits in one category or the other. He either allowed chance to determine the outcome or He guided the process.)

Then discuss how each of these world views will affect how people interpret the scientific facts. Point out that the first three chapters of the book reflect the evolutionary viewpoint—everything that exists today is here as a result of millions of random changes.

If you have a secular university nearby, it would be profitable to set up a field trip to their museum of natural history. About midway through to the end of the book is a good time. Take a trip on your own prior to the date of the field trip and “scout out” how many of the so-called proofs of evolution are displayed there.

If you and your student(s) are prepared to get a real “dose” of evolution, arrange for a docent to take you around. If not, then look over the displays, determine how many relate to what you are studying, and act as your own docent. Give your students a list of questions about the displays and what they have learned in class. Have them answer the questions as they go through the museum. Collect these at the end of the trip and check them for completeness. You can use them as your basis for a discussion of the trip the following day.

It is also important to point out as your student reads and discuss the first three chapters that even though what is said may seem logical and reasonable, there is much more to the “story” than that. This is especially true with the so-called “evidence” of evolution given in the second and third chapters. Emphasize as your student(s) covers these sections that all the facts have not yet been given.

Sections Question Key

Section One: Types of Rocks

1. What are igneous, sedimentary, and metamorphic rocks?

Igneous rocks are formed from molten rock either above or beneath the Earth's surface. Sedimentary rocks are formed from the broken particles of other rocks and materials compacted and cemented together. Metamorphic rocks are formed when other rocks undergo physical and chemical changes due to heat and pressure.

Section Two: The Geologic Column

1. Who started the first geologic column? How did he put it together?

William Smith put together the first geologic column. He began to make diagrams of rock sequences and of the fossils he found in them. Using this data he made a chart of the rocks in his region, designating the bottom layers as the oldest and the top layers as the youngest.

2. How did Lyell contribute to this work?

Lyell traveled widely, observing rock formations in many locations. He also spent much of his time gathering and organizing information from other scientists. Then he used local geologic columns from around the world to help in his formation of one large column.

3. Define "correlating the rocks".

Correlating the rocks is examining rocks in different locations and determining through the character of the rocks and the fossils that they hold that they are of the same age.

Section Three: Developers of Evolutionary Theory

1. What was Lyell's major contribution to the theory of evolution?

Lyell postulated the principle of uniformity, which states that the processes that shape the world today are the same processes that shaped the world in the past and at the same rate of speed. Because of this, scientists began to think of the earth as much older than they had in the past. This made it feasible for evolution to have occurred.

2. Explain Lamarck's Theory of Acquired Traits and Use and Disuse of Organs.

The theory of acquired traits states that characteristics acquired in one generation can be passed on to the next generation. The theory of use and disuse of organs states that heavily used organs will

gradually become bigger in succeeding generations while unused ones will gradually get smaller and eventually disappear (vestigial organs).

3. Explain natural selection as Darwin pictured it.

Darwin realized that most species produce more offspring than can survive. Nature then selects for the best adapted and against the less adapted, so the “fit” organisms survive and reproduce more often than the “unfit”.

Section Four: Mendel’s Work

1. Describe Mendel’s work with pea plants. What did he discover?

Mendel took different varieties of pea plants and cross pollinated them to see if there was a blending of traits in succeeding generations. Mendel found when he cross pollinated two pea plants, certain traits would disappear in the second generation, only to reappear in the third in a three to one ratio.

2. Define the principle of dominance and the principle of segregation.

The principle of dominance states that if the factors for a trait in an organism are different, one factor may prevent the other factor from being expressed. The principle of segregation states that when hybrids are crossed, the recessive factor separates or segregates in some of the offspring.

3. Does the recessive factor ever show up in later generations? When and in what ratio?

It reappears in the F₂ generation in approximately a 3 to 1 ratio.

Section Five: Later Contributions

1. Describe the process of meiosis. What does it do?

Meiosis duplicates all the genetic information that an organism possesses, followed by two cell divisions. This results in four sex cells which each possess one half the genetic information of the parent. Crossover helps with the “reshuffling” of existing information.

2. What contribution did Weisman make?

Weisman showed that changes caused by the environment could not be passed on to an organism’s offspring.

3. Describe the process, which de Vries postulated as another cause of changes within organisms.

De Vries believed that the random changes within the genes and chromosomes of organisms provided the genetic variety on which natural selection could work to cause large scale evolution.

Sections 1 & 2

Types of Rocks & the Geologic Column

Use the following words to correctly fill in the blanks below. Four words will be used twice.

ages
Charles Lyell
chart(s)
dating
exposed
fossils
geologic column
heat
igneous

information
lava
layers
magma
metamorphic
nineteenth century
organizing
primary
sedimentary

sediments
similar
three
water
William Smith
years
correlating principle of uniformity dates

The Earth is made up of three basic types of rock. One type, igneous, is formed from molten material either beneath or on the Earth's surface. Molten material beneath the Earth's surface is magma. However, molten material reaching the Earth's surface is referred to as lava. As each of these harden, they form igneous rock. Igneous rock that is exposed to wind, water and weathering will erode into small rock particles. If these sediments gradually build up, especially under water, they can harden, forming sedimentary rock. Finally, both igneous and sedimentary rocks can be subjected to heat and pressure, forming yet another rock which is called metamorphic.

The geologic column is made up of layers of sedimentary rock. William Smith, a surveyor, began studying rock layers that had been exposed when his workers dug a canal in England. He made charts of the rock sequence and the fossils in them. He combined this data with information he got in other locations. Using this data, he made a chart of the layers of rocks throughout the area. When he showed other geologists what he had done, they began to make similar charts for their areas also.

Charles Lyell, a lawyer and amateur geologist, began gathering and organizing this information. He also began examining rocks from different locations and determining that they were the same age because of their similar character and fossils. This is known as correlating

the rocks. Using the principle of uniformity, he assigned ages to each layer of rock in the column. By the end of the nineteenth century, Lyell had developed a geologic column for the whole Earth. His geologic column is very similar to the one used in textbooks today. This method of dating the ages of rocks and fossils was the only one used for many years and is still the primary method used today.

Section 3

Developers of Evolutionary Theory

Fill in the blanks by unscrambling the words below them.

1. Charles Lyell first proposed the principle of uniformity.
crippnlei fo froinutimy
2. The principle of uniformity states that “the present is the key to the past”.
treepsn
3. This principle (see #2) means that the processes that shape the world today are no
cropsesse
different from those of the past.
4. This principle (see #2) means that the world is very old.
dol
5. Jean Baptiste de Lamarck first proposed the inheritance of acquired traits.
therecinain fo queadicr rattis
6. Lamarck believed that organisms changed their organs to adapt to a new environment.
gornas
7. He also believed that acquired traits could be passed on to an organism’s offspring.
adicrque sittar
8. Scientists still call organs vestigial if they appear to have no function.
gestialvi
9. Charles Darwin was influenced by both Lyell and LaMarck.
yellL carakLM
10. During his job as a naturalist he traveled to the Galapagos Islands.
apagGaslo dIsslán
11. He saw animals on the islands that were similar to those in South America.
minalas

Section 4

Mendel's Work

Determine whether the following statements are true or false. On the line provided, rewrite the false statements correctly.

 F 1. Gregor Mendel was a mayor and politician who was born in 1822.

 Gregor Mendel was a monk who was born in 1822.

 T 2. He entered the University of Vienna and became interested in plant breeding.

 T 3. He joined a monastery and continued his research.

 F 4. Over a period of several years he discovered natural selection.

 Over a period of several years he discovered genetics.

 F 5. Mendel used bean plants for his experiments.

 Mendel used pea plants for his experiments.

 T 6. Mendel chose seven characteristics to study, one to three traits at a time.

 F 7. When Mendel crossed two different varieties, he got a blending of traits.

 When Mendel crossed two different varieties, he got only one trait of each pair in the F1 generation.

 T 8. Traits disappeared in the second generation and reappeared in the third.

 F 9. Mendel developed the principle of homology, which states that if the factors for a trait in an organism are different, one factor may prevent the other from being expressed.

 Mendel developed the principle of dominance.

 F 10. The factors expressed in an organism Mendel called recessive.

 The factors expressed in an organism Mendel called dominant.

F 11. The factors which were masked he called dominant.

The factors which were masked he called recessive.

Section 5

Later Contributions

Matching

Use the letters below to fill in the space provided.

A. August Weismann

C. homologous

E. mutation

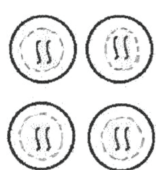
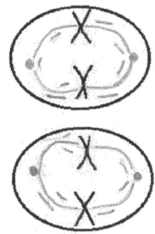








B. crossover

D. Hugo de Vries

F. mutation theory

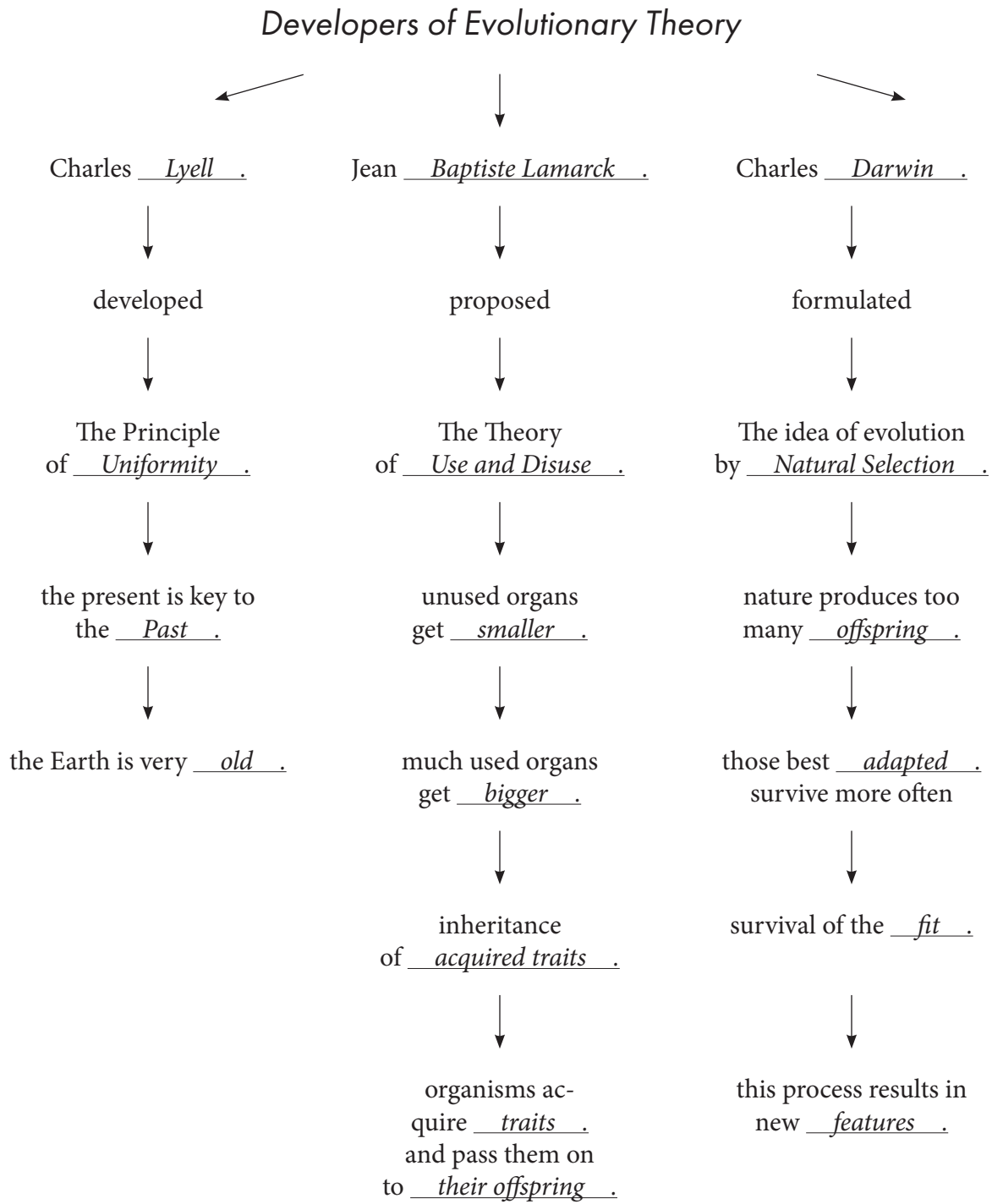
- C 1. Chromosomes which carry genes for the same traits.
- F 2. The belief that random changes in genes provided the new genes for the evolutionary process.
- B 3. A process in which homologous chromosomes come together and trade genes.
- D 4. Proposed the mutation theory.
- A 5. Showed that changes brought about by the environment cannot be passed on to an organism's offspring.
- E 6. A spontaneous change in a gene or chromosome.

II. Below are pictured the stages of Meiosis. Label each one correctly.

					1. <u> Telophase II </u>
					2. <u> Metaphase II </u>
					3. <u> Telophase I </u>
					4. <u> Metaphase I </u>
					5. <u> Prophase I </u>
					6. <u> Anaphase II </u>
					7. <u> Prophase II </u>
					8. <u> Anaphase I </u>
					9. <u> Prophase I Crossing Over </u>
					10. <u> Cell before Meiosis </u>

Concept Map

History of Evolution



Group Activity

Geologic Column

This activity is designed to show how geologic column dating works. On the attached sheet is a sample cross section of rock strata. Using the information given you there, demonstrate how some scientists determine the approximate age of the rocks. This cross section does not represent any particular location and the rate of deposition of the sediments is also arbitrary.

Materials:

- ▶ Sample cross section of rock strata
- ▶ Question sheet
- ▶ Calculator—if necessary

Procedure:

1. Looking at the sedimentary rock layers on the rock strata cross section. Which layer was laid down first? How do you know?

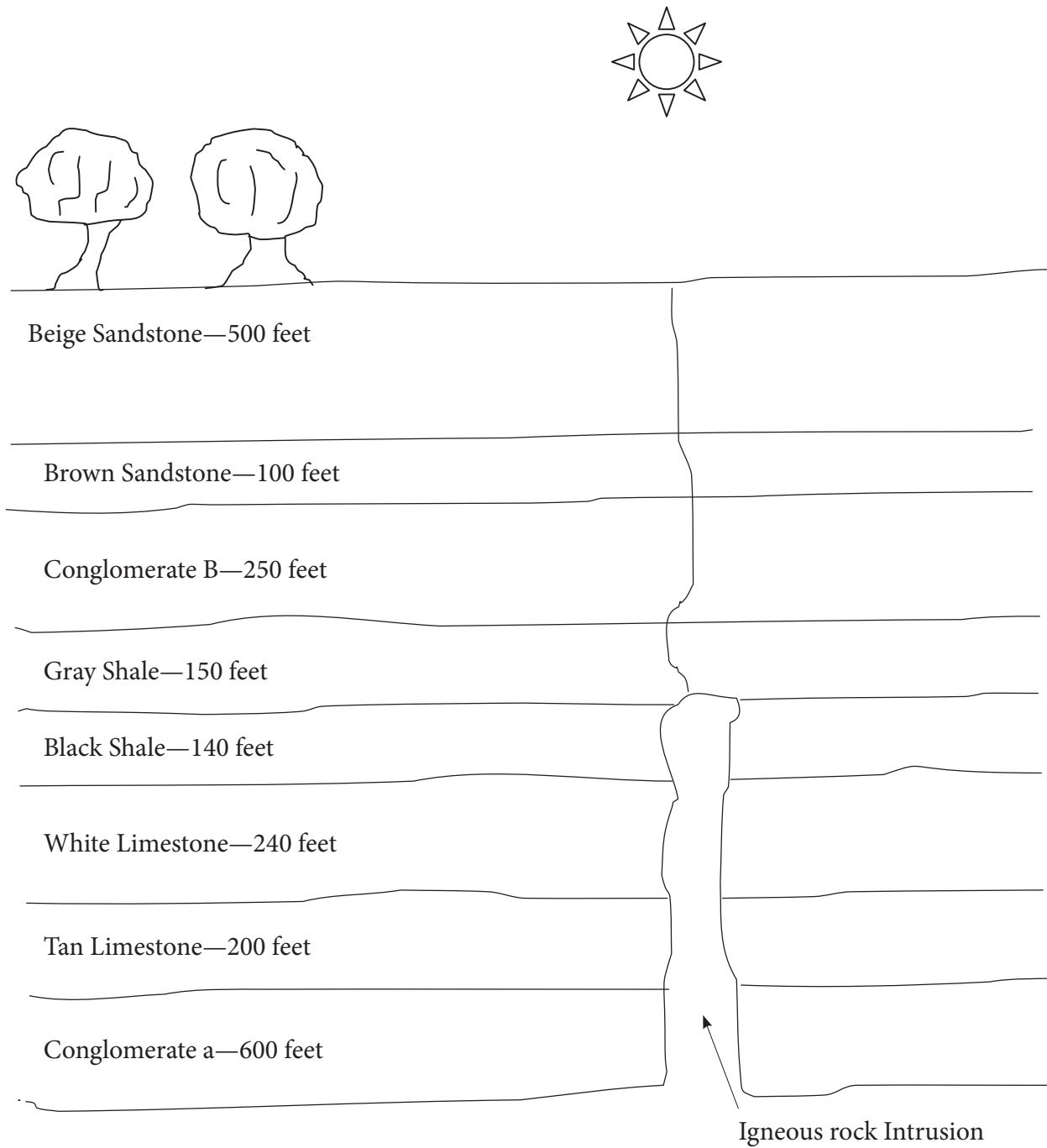
Conglomerate A. It is on the bottom.

2. You will notice there are several layers of sedimentary rock with an igneous rock intrusion extending through some of the layers. Which occurred first—the deposition of the sedimentary layers or the igneous rock intrusion?

The deposition of the sedimentary layers. They must have been there for the magma to intrude.

3. If we had an independent means of dating the igneous rock intrusion, what would we know about the age of the layers through which it extends?

We would know that the sedimentary rock layers are older.



Vocabulary

Use the letters below to fill in the space provided.

- | | | |
|--------------------------|-----------------------------------|-----------------------------|
| A. acquired trait | H. inheritance of acquired traits | N. principle of segregation |
| B. adaptation | I. meiosis | O. principle of uniformity |
| C. crossover | J. metamorphic rock | P. recessive |
| D. dominant | K. mutation theory | Q. sedimentary rock |
| E. geologic time scale | L. natural selection | R. use and disuse of organs |
| F. homologous chromosome | M. principle of dominance | S. vestigial |
| G. igneous rock | | |

- M 1. States that if the factors for an organism's trait are different, one factor may prevent the other from being expressed.
- N 2. When hybrids are crossed, the recessive factor separates in some of the offspring.
- O 3. The present is the key to the past.
- K 4. Random changes in genes provide the genetic variety on which natural selection can work.
- S 5. Reduced in size and with no apparent function.
- B 6. Traits that organisms have which help them to survive in their environments.
- J 7. Rocks formed by heat and pressure.
- R 8. Organs that are heavily used become more prominent in an organism; those that are not gradually disappear, according to Lamarck.
- L 9. The organism best adapted to its environment will survive better and reproduce more often.
- H 10. Traits acquired in one generation can be passed on to the organism's offspring, according to LaMarck.
- I 11. The process by which a parent's genes are divided and passed on to the offspring.
- A 12. A new or changed organ developed through adaptation to the environment, according to Lamarck.
- F 13. One of two chromosomes which carry genes for same trait.
- G 14. Rock formed from molten material.
- D 15. The factors that are expressed in an organism.

- Q 16. Rocks formed by rock, plant and animal fragments being pressed or glued together.
- E 17. A calendar that scientists have developed to try to outline the history of the Earth.
- P 18. The factors that are not expressed in an organism.
- C 19. A process in which homologous chromosomes come together and trade genes.

Review

I. In the spaces provided, explain what the words have in common.

1. Igneous, metamorphic, sedimentary

They are the three major types of rock found on the Earth .

2. Use and disuse, acquired trait, inheritance of acquired traits

They are all parts of Lamarck's theory of evolution.

3. Emus, rheas, finches

They are all birds which Darwin studied before he formulated his theory of evolution.

4. Dominant, recessive, principle of segregation

These are all terms coined by Mendel in developing his genetics theory.

5. Homologous chromosomes, crossover, 23 pairs

All of these terms related to the process of meiosis in humans.

II. Following are several false statements. Rewrite each statement to make it true.

1. Fossils are usually found in metamorphic rock.

Fossils are usually found in sedimentary rock.

2. An adaptation is a chart of the sedimentary rock layers of the world with their relative ages.

A geologic column is a chart of the sedimentary rock layers of the world with their relative ages.

3. Charles Lyell discovered the principles of heredity.

Gregor Mendel discovered the principles of heredity.

4. Evolutionists propose that meiosis provides enough genetic variety for large scale evolution to occur.

Evolutionists propose that mutation provides enough variety for large scale evolution to occur.

Test

Place the letter in the space provided that best completes the sentence.

Worth 1 point each

- A 1. Most fossils are found in sedimentary rock.
- A. sedimentary
B. metamorphic
C. basalt
D. igneous
- C 2. According to Lamarck's theory,
- A. evolution was a quick, punctuated process
B. traits acquired in one generation would be passed on only if they were in the sex cells
C. traits acquired in one generation were passed on to the next generation
D. only the fittest survive
- B 3. Natural selection is a process by which
- A. acquired traits are passed on to the next generation
B. organisms well adapted to the environment will survive and reproduce more often than other organisms
C. mutations change organisms
D. all answers are correct
- C, D 4. Two scientists who influenced Darwin were
- A. de Vries
B. Redi
C. Lyell
D. Lamarck
- D 5. De Vries
- A. wrote a book on populations
B. proved the theory of use and disuse
C. discovered genes
D. proposed that species changed suddenly by mutations
- B 6. Lyell proposed
- A. the theory of use and disuse
B. the principle of uniformity
C. the theory of populations
D. the mutation theory

- D 7. Darwin developed much of his theory of evolution by studying
A. finches
B. emus
C. rheas
D. all of these
- A 8. Meiosis:
A. reshuffles existing information
B. provides enough variety to go from molecules to man
C. does not effect evolution
D. none of these
- C 9. Darwin did much of his research in
A. Peru
B. The United States
C. Galapagos Islands
D. Tahiti
- A 10. Organs which appear to be reduced in size and to have no function are said to be
A. vestigial
B. adaptations
C. acquired traits
D. recessive
- D 11. Rocks which are formed from fragments of plants, animals and other rocks are
A. metamorphic
B. granite
C. gneous
D. sedimentary
- B 12. Recessive genes
A. are often expressed in an organism's phenotype
B. are not usually expressed in an organism's phenotype
C. gradually disappear from an organism
D. none of these
- B 13. The process by which a parent's genes are divided and passed on to the offspring is
A. an acquired trait
B. meiosis
C. mutation
D. adaptation
- A 14. Dominant genes
A. are expressed in an organism's phenotype
B. are not expressed
C. gradually disappear
D. none of these
- C 15. "The present is the key to the past" is
A. the mutation theory
B. the theory of acquired traits
C. the principle of uniformity
D. the principle of segregation

Use the letters below to fill in the space provided. Worth 1 point each.

- | | | |
|------------------------|--------------------|-------------------------------------|
| A. acquired trait | E. homologous | I. principle of dominance |
| B. adaptations | F. igneous | J. principle of segregation |
| C. crossover | G. metamorphic | K. theory of use & disuse of organs |
| D. geologic time scale | H. mutation theory | |

- K 16. Organs that are heavily used become more prominent in an organism; those that are not gradually disappear.
- E 17. One of two chromosomes that carry genes for the same trait.
- H 18. Random changes in genes are the usual way a species changes.
- A 19. A new or changed organ supposedly developed through adaptation.
- I 20. States that if the factors (genes) for an organism's trait are different, one factor may prevent the other from being expressed.
- F 21. Rock formed from molten material.
- J 22. When hybrids are crossed, the recessive factor separates in some of the offspring.
- D 23. A calendar developed to try to outline the history of the Earth.
- C 24. A process in which homologous chromosomes come together to trade genes.
- B 25. Traits that organisms have that help them to survive in their environment.
- G 26. Rocks formed by heat and pressure.

Answer the following questions in complete sentences. Points vary per question

1. Give the four parts of Darwin's theory of evolution. (8 points)

1. *Traits vary among individuals of the same species.* _____
2. *There are limited natural resources to support these individuals.* _____
3. *Organisms tend to produce more offspring than can survive.* _____
4. *Therefore, nature 'selects' those organisms to survive that are best adapted to their environments.* _____

2. Explain why the principle Lyell developed was so important to a theory of evolution. (2 points)

Lyell's principle of uniformity was important because it supported the idea of an old Earth, which was absolutely necessary if evolution was going to have enough time to occur.

3. Give the contributions of the following men. (2 points each)

A. Weismann

He demonstrated that traits acquired in one generation could not be passed on to the organism's offspring.

B. de Vries

He proposed the mutation theory which states that mutations are the cause of changes in species.

Chapter 2

Suggestions for Beginning

Begin this chapter with a discussion of how information can be changed. You might give an example of a page within this book. If you have time, type a portion of the page on a computer or a sheet of paper. How can it be changed to say something different? Take suggestions as to how it can be made to say something somewhat different.

Your student(s) will no doubt suggest the addition of several sentences to change its meaning. If time permits, write some of these in the margins. After you have completed this, point out that they are adding information and ask if there is another way they can change the meaning of the text. Help them to see that the meaning can also be changed, sometimes dramatically, by simply subtracting words and/or sentences.

Demonstrate by erasing or marking through some key words from the text. You will need to choose a portion of text or some other selection ahead of time and plan carefully in order to demonstrate well. However, this exercise will help them to understand that change does not have to be due to the addition of information. Point out that Chapter 2 will deal with this issue of addition and subtraction of information in the genomes of all species.

It is also good to have a selection of fossils to show your pupil(s). Try to get enough of them to have a sample of each kind. The only one which may be difficult to get is an insect in amber, since these are prized for jewelry. However, your local university may have a few other fossils to spare, if you explain that you are teaching about fossils. These fossils are a valuable teaching tool.

Sections Question Key

Section One: The Agents of Evolution

1. State an accurate definition of evolution, as given by an evolutionist.

Evolution is the theory that all living forms in the world have arisen from a single source which itself came from an inorganic form.

2. Define devolution and evolution. What is the evolutionists' name for devolution?

Devolution is changes within genus or species brought about through loss of information. Evolution is change that goes beyond genus or species; it requires the introduction of massive amounts of new genetic information.

3. Name and define the six processes believed to interact to cause evolution.

Meiosis is a division of an organism's chromosomes that results in a reshuffling of genetic information. Natural selection: most species produce more offspring than can survive. Nature then selects for the best adapted and against the less adapted, so the "fit" organisms survive and reproduce more often than the "unfit." Genetic drift is the elimination of genes from a population due to chance. Migration is movement into or out of a population. Geographic isolation occurs any time a natural barrier comes between members of a population and prevents them from breeding. Genetic isolation is the prevention of members of a population from interbreeding freely.

4. Since both creationists and evolutionists agree that these things occur, why do evolutionists and creationists disagree? For example, how does the evolutionists' view of mutations differ from that of creationists'?

Mutations do cause some change, primarily through the loss of genetic information. However, for evolution to occur, there must be the creation of tremendous amounts of new genetic information, followed by the action of natural selection, migration, etc. Evolutionists believe change occurs which goes all the way to the kingdom level, primarily through a gain of information through mutation. Creationists believe that changes are limited to the lower taxonomic categories (like family, genus, and species) and are due primarily to the shuffling or loss of genetic information.

5. How does geographic isolation affect genetic isolation in a population? What does it do to the gene pool of separate populations over time?

Geographic isolation causes genetic isolation in a population. Over time the isolated gene pools will change somewhat.

6. How does migration affect the gene pool of a population?

Migration of organisms into a population adds to its gene pool. Migration of organisms out takes genes away.

7. Define divergent evolution, convergent evolution, and adaptive radiation.

Divergent evolution is the process of becoming less alike. Convergent evolution is defined as different organisms becoming more alike and developing similar structures as a result of adapting to similar environments. Evolutionists define the process by which members of a species adapt to different ecological “niches” as adaptive radiation.

Section Two: Spontaneous Generation

1. What element prevents the components of life from combining?

Free oxygen.

2. What elements and compounds did Oparin believe were present in the early atmosphere?

Oparin believed the early atmosphere contained water vapor, ammonia, methane, and hydrogen.

3. What would provide the energy needed for these elements and compounds to combine into organic compounds?

The ultraviolet rays of the sun, or perhaps lightning.

4. What would these organic compounds then do?

The UV rays or the lightning would first split these compounds apart and then recombine them into organic compounds. These compounds would then form an organic “soup” in which molecules would gradually combine into the types of macromolecules that could reproduce themselves.

5. What do evolutionists believe the first cell (protocell) probably resembled?

An anaerobic bacterium.

Section Three: Miller’s Experiment

1. What compounds and elements did Miller use in the experiment?

Water vapor, methane, ammonia, and hydrogen.

2. *What provided the energy needed for the chemical reactions to occur?*

An electric spark in a spark chamber.

3. *What captured the compounds after they were formed?*

A trap.

4. *What did Miller find in the liquid that was formed?*

Miller found tiny amounts of amino acids and several other compounds and a tarry mess.

Section Four: Two Examples of Evidence for Evolution

1. *Briefly describe the example of the peppered moth.*

In the early 1800's two varieties of peppered moth existed. Members of the light variety greatly outnumbered those of the dark variety because they blended better into their environment and were thus more difficult for predatory birds to see. However, the industrial revolution caused air pollution which killed the lichens on the tree trunks and turned the trunks dark. The dark moths then blended into the changed environment better, and they increased in number, while light ones decreased. They feel this is an example of Darwinian evolution or gradualism.

2. *Briefly describe the changes in the Galapagos finches after changes in the weather.*

These finches showed variation in beak size and length after shifts in the environment.

3. *Define punctuated equilibrium and gradualism? What is the main difference between these two theories?*

Punctuated equilibrium is the hypothesis that drastic environmental changes can occur which trigger very rapid genetic changes. Because the evolutionary change occurs very rapidly, there would be very few generations of intermediate forms so little chance that any were preserved as fossils. Gradualism is the idea that over long periods of time natural selection and mutation, together with the other agents of change, very slowly bring about large changes, necessitating many link fossils between different groups of organisms. The main differences are the speed with which change occurs and the number of resulting link fossils.

Section Five: Evolutionists' Evidence for Evolution from Other Disciplines

1. *How does comparative embryology seem to support evolution?*

Evolutionists believe that the embryos of different species in early stages show remarkable similarities to one another.

2. *How does comparative homology seem to support evolution?*

The arms of humans and the front legs or wings or flippers of various land and marine vertebrates have the same bone pattern. Evolutionists believe this points to a common ancestor.

3. *Give one example of how comparative biochemistry seems to support evolution.*

Evolutionists have found that the gene for cytochrome c in monkeys and in humans varies by only one nucleotide, while that of humans and turtles varied by 14 nucleotides. They feel this shows humans and monkeys have a close evolutionary relationship while humans and turtles do not.

Section Six: What is a Fossil?

1. *Name and describe each of the types of fossils described above.*

Imprints occur when soft body structures, such as leaves or feathers, are pressed into developing rock and leave an impression of their shape. A carbon film fossil occurs when a leaf is buried in sediments, and the weight of the upper sediments causes the leaf to turn to carbon. Molds are formed when hard body parts or pieces of wood are completely covered by sediments and then decompose, forming a hollow that is shaped like the original organism. Casts can then form if other materials later fill in the mold. Petrified fossils are created when minerals gradually replace the hard parts of an organism, such as bones.

Section Seven: Evolutionists' Evidence from the Fossil Record

4. *Give an example of a possible link fossil and explain why evolutionists considered it to be one.*

Archaeopteryx is considered to be a link fossil between reptiles and birds because it has fully developed wings (a bird feature) and also teeth, claws on its wings, and a flat breastbone (which evolutionists consider reptilian features).

5. *Describe the two fossil series given in the text.*

The whale series—Evolutionists believe whales evolved from a land dwelling carnivore called *pakicetus*. They also place *ambulocetus* (another land dweller), *rodhocetus*, (believed to spend much time in the water), and *basilosaurus* (a large, marine creature) as intermediate stages in whale evolution.

The horse series—Evolutionists believe the horse began as a small animal called *eohippus* (also called *hyracotherium*), which was about the size of a small dog. It then evolved through various stages such as *mesohippus*, *merychippus*, and *pliohippus* over a 55 million year period to become the horse we have today (*equus*). This required the loss of toes and changes in teeth and body size.

Section 1

Agents of Evolution

Fill in the blanks to explain the processes which are believed to lead to evolution and devolution.

Meiosis and Natural Selection

plus

Mutation (loss)

plus

genetic isolation

plus

genetic drift

plus

Migration



Devolution

(due primarily to a loss of information)

Meiosis and Natural Selection

plus

Mutation (gain)

plus

genetic isolation

plus

genetic drift

plus

Migration



Evolution

(due primarily to a gain of information)

Unscramble the words to fill in the blanks.

1. Genetic drift is the elimination of genes from a population due to chance.
teencig tifrd

2. The “reshuffling of genes that occurs each generation is meiosis .
someisi

3. Any time a natural barrier such as a river or mountain range comes between members of a population, geographic isolation occurs.
phocirageg nolasotii

4. Evolution refers to a change from one type of creature into a different type, due to
vloetuoin

a gain of genetic information.

5. A genetic mutation is a spontaneous change in a gene or chromosome.
tineceg nottimua

6. Evolution
tuloovein is often defined simply as change over time.
7. Very small changes within a genus or species are sometimes referred to as microevolution but might be more correctly called variation
ratiavino.
8. Genetic isolation
neegict lanoositi occurs when population members cannot interbreed.
9. Migration
notigrima is movement of organisms into or out of a population.
10. When organisms best adapted to their environment survive longer and reproduce more than those less adapted, natural selection
aturlan noletsic has occurred.
11. Scientists call the process of organisms becoming less alike divergent evolution
tivreegdn onutileo.
12. This refers to organisms adapting to different environments and becoming less alike. Adaptive radiation
vitedapa nodaitiar is often used almost synonymously with divergent evolution.
13. Scientists also believe that organisms become more alike as a result of adapting to similar environments. They call this convergent evolution
onrgevcent ovetuniol.
14. Analogous structures
souaangol serrtstucu in different organisms are similar in form but evolutionists believe they evolved differently.

Section 2

Spontaneous Generation

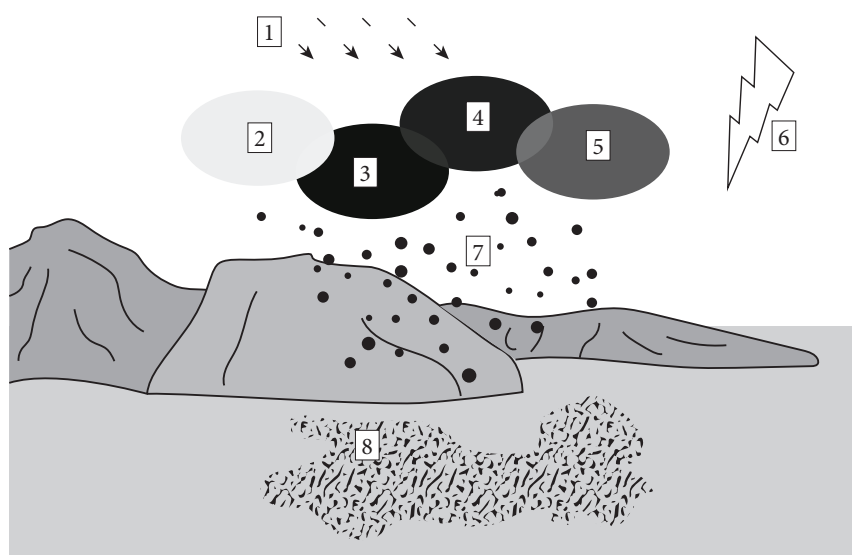
Oparin's Theory: Use the following terms in the proper locations on the illustration of Oparin's early Earth below.

methane
hydrogen
ammonia

water vapor
organic soup
organic molecules

ultraviolet rays
lightning

I. Fill in the blanks to make the following true statements according to the text.



1. UV Rays
2. Methane
3. Ammonia
4. Hydrogen
5. Water Vapor
6. Lightning
7. Organic molecules
8. Organic Soup

1. Because DNA will not form in the presence of free oxygen, Oparin knew the atmosphere must be very different from today's atmosphere.

2. The first cell is often called a(n) protocell.

3. Many scientists believe the first cell resembled a(n) anaerobic bacterium.

II. On the back of this page, list the five parts of Oparin's Theory.

Oparin's Theory:

1. The early atmosphere consisted of methane, ammonia, hydrogen, and water vapor with no free oxygen.
2. Energy from volcanic heat and lightning or the sun's ultraviolet rays would cause these substances to combine into the organic compounds.
3. Oparin hypothesized that these compounds would combine to form an organic soup.
4. In this soup the molecules would gradually combine into macromolecules.
5. These macromolecules would then combine to form the first cell.

Section 3

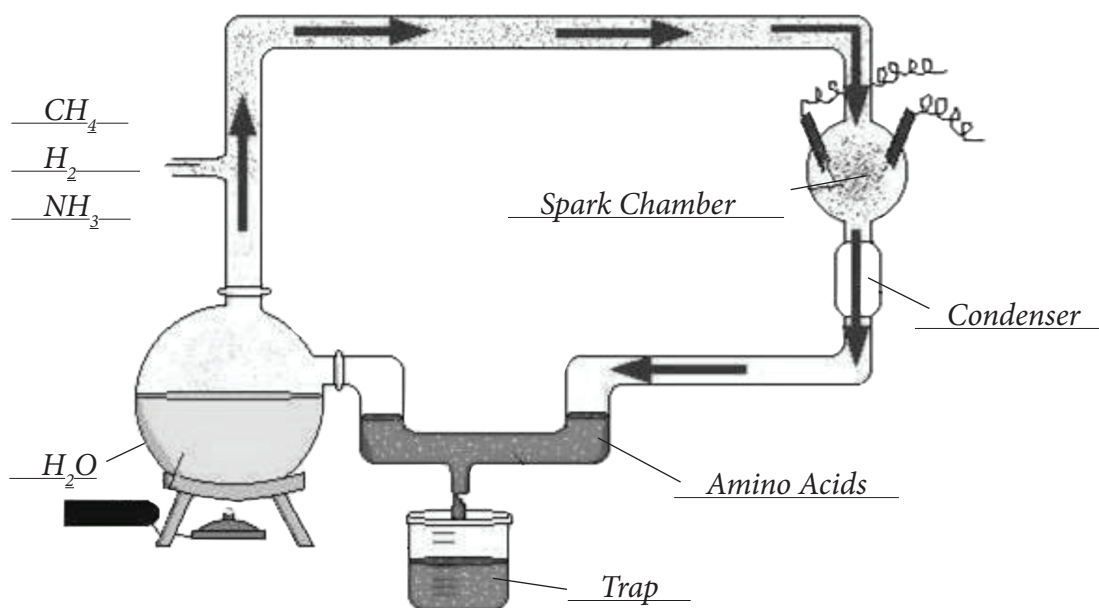
Miller's Experiment

Label the following illustration with the proper terms to show the reactants, equipment, and products of Miller's experiment. Use the terms below.

methane
spark chamber
ammonia

water vapor
amino acids
trap

hydrogen
condenser



Explain the purpose of each of these things below.

1. Methane, ammonia, hydrogen, water vapor

These were the reactants in Miller's experiment. He used them to produce amino acids.

2. Spark chamber

This provided the energy for the chemical reactions to occur.

3. Condenser

The condenser turned the experiment's products into a liquid.

4. Amino acids

These were some of the products of Miller's experiment.

5. The trap

The trap collected the products of the experiment.

Section 4

Two Examples of Evidence for Evolution

Use the following words to fill in the blanks of the paragraphs below them. One word will be used three times. Three words will be used twice.

punctuated equilibrium	up	state
gradualism	fossil record	many
for	against	air pollution
natural selection	birds	abundant
Darwinian	industrial revolution	changes
few	example	intermediate organisms
disadvantage	rapid	millions
predators	tree trunks	lichens
dark	link	blended
length	event	finches
mutation	catastrophic	beak
light	reptiles	macroevolution
peppered moth	moths	environment
eaten	characteristics	

Evolutionists believe that macroevolution occurs primarily because of the interaction of natural selection and mutation. A very common example is that of the peppered moth. In England in the nineteenth century these moths were abundant. Most were light in color, while a small percentage was dark. Evolutionists believe that the dark color of these moths was as a result of a genetic mutation. Since the tree trunks were light at that time, the dark colored moths were at a disadvantage if they landed on them. They could be easily seen and eaten by birds. Natural selection would thus be selecting against them. However, the industrial revolution brought air pollution to the area. The polluted air killed many of the lichens which grew on the tree trunks and turned the trunks darker. Now the dark peppered moths blended in while the lighter ones did not.

Over the next several years, natural selection selected against the light moths and for the dark moths. The percentage of light moths went down, while the percentage of dark moths went up. Evolutionists point to this event as

an example of a beneficial mutation and natural selection working together to cause evolution. They feel that many beneficial mutations together with natural selection will bring about major change. This particular type of evolution is called Darwinian evolution or gradualism.

Evolutionists also point to the finches of the Galapagos Islands as examples of evolution. The finches show a variation in beak size and length after changes in the environment. The changes in moths and finches occur over a short period of time, but evolutionists believe such changes occurring over much longer periods, with mutation and natural selection at work, would produce the major changes needed for macroevolution to occur.

The process of macroevolution would be very slow, and there would have to be millions of link fossils. For example, if birds evolved from reptiles there would have had to be many intermediate organisms which possessed some characteristics of both reptiles and birds.

Another theory of evolution is called punctuated equilibrium. Proponents of this theory state that catastrophic events led to rapid genetic changes. Thus, very few link fossils would survive in the fossil record.

Section 5

Evolution Evidence from Other Disciplines

Define each of the following and tell why evolutionists believe the first four support evolution.

1. Comparative embryology

Comparative embryology is the study of embryos of different species at similar stages in their development. Evolutionists cite the apparent similarities between embryos of different species as evidence of a common ancestor.

2. Comparative biochemistry

Comparative biochemistry is the study of molecules that make up living things. They point to cytochrome C, a protein in many organisms. They say that very little difference in the cytochrome c of two organisms indicates they are closely related from an evolutionary standpoint.

3. Homologous Structures

Structures in different species that are similar in pattern. Evolutionists believe this similarity indicates a common ancestor. Examples of this are a bird's wing, a dog's front legs, a whale's flipper and a human's arm and hands.

4. Analogous Structures

Structures that are similar in function but are structured differently—for example, the wings of birds and insects. These creatures are not believed to have a close ancestry. Instead, they are believed to have developed structures with similar functions as a result of adapting to similar environments.

5. Convergent evolution

According to evolutionary theory, it is the development of analogous structures that are the result of adaptation to similar environments.

Section 6

What Is a Fossil?

Match the following words with their definitions.

Fossils

Original Remains

Carbon film fossil

Mold

Imprints

Petrified fossils

Cast

1. Imprint fossils occur when soft body structures, such as leaves or flowers, are pressed into developing rock and leave an impression of their shape.
2. Petrified fossils created when minerals gradually replace the hard parts of an organism, such as bones.
3. Fossils—the remains of once living organism.
4. Carbon film fossils occurs when a leaf becomes buried in sediments, and the weight of the upper sediments causes the leaf to turn to carbon.
5. Cast occurs when minerals fill in a mold.
6. Mold is formed when hard body parts or pieces of wood are completely covered by sediments and then decompose, forming a hollow that is shaped like the original organism.
7. Original remains—larger organisms preserved in ice or tar, which prevents their decay.

Why do scientists search for, dig up, and examine fossils so carefully?

They search for the fossils of the intermediate or link species that are so necessary if Darwinian evolution actually happened.

Section 7

Evidence from Fossil Record

1. Describe *Archaeopteryx* and explain why evolutionists believe it to be a link fossil between the reptiles and the birds.

Archaeopteryx is a proposed link fossil between birds and reptiles. Evolutionists believe it to be a link fossil because it has bird features such as fully developed feathers and it also has features they consider reptilian: wing claws, teeth and a flat breastbone.

2. Briefly describe the proposed whale ancestors.

Pakicetus

The first *Pakicetus* fossil consisted of an incomplete skull, a partial jawbone and some teeth. Its ear bone supposedly resembled that of modern whales, but actually looks plate-like, similar to other land creatures. *Pakicetus* was primarily a land animal.

Ambulocetus

Ambulocetus is described as a “walking whale” about 3 meters long, with sharp teeth and short broad legs. It had a flexible neck, a long muzzle, and teeth similar to other animals believed to be whale ancestors.

Rodhocetus

Its skull was large and elongated, compared to the skeleton as a whole. The nostrils were further back along the snout, above the canine teeth, and it had ear bones that were similar in some ways to those of the cetaceans. The fossil's pelvis was still attached to the spine, so *Rodhocetus* could walk on land, although probably not as well as *Pakicetus* or *Ambulocetus*.

Basilosaurus

Basilosaurus appears to be a marine mammal with a long, slender body, flippers, flukes on its tail, tiny hind legs, and a flexible backbone. It was much larger than the other claimed whale ancestors, having a long, slender serpent-like body about 60 feet in length. It was a completely marine creature.

3. Why are the mesonychids no longer considered the whale's first land ancestor?

Since DNA evidence has indicated that whales and hippopotamuses are more closely related, many paleontologists now believe that a group of animals called the artiodactyls gave rise to the whales.

4. Briefly describe how the five members of the horse series listed in the book are different.

Eohippus is described as the size of a small dog, with four toes on its front feet and three on the back (55 million years ago). *Mesohippus* was the size of a sheep with three toes on the front and back feet (40 m.y.a). *Merychippus* was larger, with three toes on each foot, but the center toe was bigger (25 m.y.a.). *Pliohippus* was the size of a pony with only one toe, the center one, left (5 m.y.a.). Finally, *Equus* is our modern horse which stands on the middle toe and is believed to have evolved about 2 million years ago.

Group Activity

Punnet Square

Please note: If you have not dealt with Punnet squares in a while, consult your student's high school biology book. There should be a good explanation of Punnet squares in it.

A *Punnet square* is a chart used to determine possible combinations of genes in the offspring of two organisms. Following is a Punnet Square with letters listed on the side and top. These letters represent three traits found in two imaginary animals we will call “gorks”. These gorks have been bred together. Both the male (we will call him Fido) and the female (let's call her Duchess) have dominant and recessive genes for each trait.

The letters across the top represent all the possible gametes which Fido could produce. Along the side are all the possible gametes that Duchess could produce.

C = dark colored coat
c = light colored coat

N = long nose
n = short nose

E = long ears
e = short ears

Directions: Fill in the chart by listing all the possible combinations. You will do this by looking first at the letters listed above the column where a particular square is located and then at the letters listed next to the row in which the same square is located. Then combine these letters in the square. Put the dominant letters first for each trait. The second block has been done for you as an example. After you have finished, complete the questions listed on the next page.

	CNE	cNE	CnE	CNe	Cne	cNe	cnE	cne
CNE	CCNNEE	CcNNEE	CCNnEE	CCNNee	CCNnEe	CcNNEe	CcNnEE	CcNnEe
cNE	CcNNEE	ccNNEE	CcNnEE	CcNNee	CcNnEe	ccNNEe	ccNnEE	ccNnEe
CnE	CCNnEE	CcNnEE	CCnnEE	CCNnEe	CCnnEe	CcNnEe	CcnnEE	CcnnEe
CNe	CCNNee	CcNNee	CCNnEe	CCNNee	CCNnee	CcNNee	CcNnEe	CcNnee
Cne	CCNnEe	CcNnEe	CCnnEe	CCNnee	CCnnee	CcNnee	CcnnEe	Ccnnee
cNe	CcNNee	ccNNee	CcNnEe	CcNnee	CcNnee	ccNNee	ccNnEe	ccNnee
cnE	CcNnEE	ccNnEE	CcnnEE	CcNnEe	CcnnEe	ccNnEe	ccnnEE	ccnnEe
cne	CcNnEe	ccNnEe	CcnnEe	CcNnee	Ccnnee	ccNnee	ccnnEe	ccnnee

Answer the following questions in complete sentences.

1. What does it mean to be heterozygous for a trait? Explain, please.

To be heterozygous for a trait means that the organism possesses different genes for that trait. For example, an individual may carry a gene for dark hair which he inherited from one parent and a gene for light hair which he inherited from the other.

2. The term “genotype” refers to the actual combination of genes in an organism. When you are dealing with three genes only, how many possible genotypes are there? (Hint: What is $3 \times 3 \times 3$?)

There are twenty-seven possible genotypes.

Now, using colored pencils, lightly color all the squares in the following ways:

Blue—offspring with long ears, long noses, and dark coats

Yellow—offspring with short ears, long noses, and dark coats

Pink—offspring with long ears short noses, and dark coats

Green—offspring with short ears, short noses, and dark coats

Orange—offspring with long ears, long noses, and light coats

Red—offspring with long ears short noses, and light coats

Violet—offspring with short ears, long noses and light coats

Leave white the offspring with short ears, short noses and light coats

Remember: Where a gork is hybrid for a trait, the dominant gene will control the trait.

3. The term “phenotype” refers to the traits that are actually expressed in an organism. How many different phenotypes are possible when you are dealing with three genes only? Hint: look at the different colors in your Punnet square.

Because of the principle of dominance, there are only 2^3 .

4. Once again, where there are dominant/recessive combinations, which gene controls the trait?

The dominant gene controls the trait.

5. Does this mean the recessive trait gradually disappears from the population?

No, recessive genes generally remain in the population at approximately the same ratio, but their effect is masked by the dominant gene..

6. What happens to the recessive trait?

It may be passed on from parent to child when present in the parent's gene pool..

7. When does the recessive trait show up in the phenotype?

It shows up in the phenotype when only recessive homozygous alleles for that trait are present.

8. With humans, how can a blond-haired, blue-eyed child suddenly show up in a family that has had only dark-haired, dark-eyed people for several generations on both sides? (The genes for dark hair and eyes are dominant.)

Since the genes for light hair and eyes are recessive, they could be carried on both sides of the family through several generations without being expressed in the phenotype.

9. Suppose only one individual carried the recessive genes for light hair and eyes in a family and he never had children. What would happen to the genes for light hair and eyes in that family?

The genes would disappear from that family.

10. What would have to happen to return the genes for light hair and eyes to the family mentioned above?

If, later on, members of the family intermarried with individuals carrying these traits, they would again become a part of the family's genetic makeup.

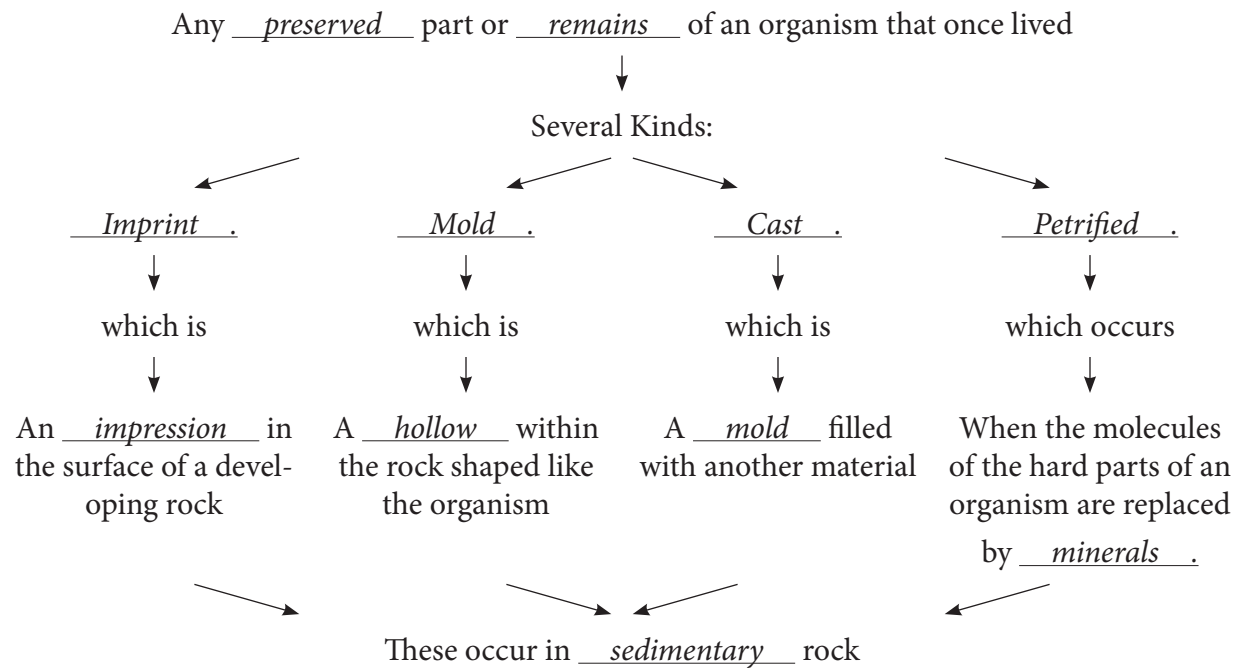
Add to this the phenomenon of pleiotropy.

This refers to a gene influencing a trait that is far removed from the trait under its primary control. Therefore, it is not just your individual genes that make up who you are but also how your genes work together. This adds further variety. That's how there can be several redheads in a family and they can all have different shades of red hair. The environment can also affect the expression of genes. For example, a person who suffers from malnutrition in his early years may not reach the full height he could have, if he had been properly fed.

Pleiotropy is a fascinating subject and one well worth the time to research it. You can check on the internet or at your local library. It is one important reason why radical change can often be accomplished in a species with the removal of a single gene.

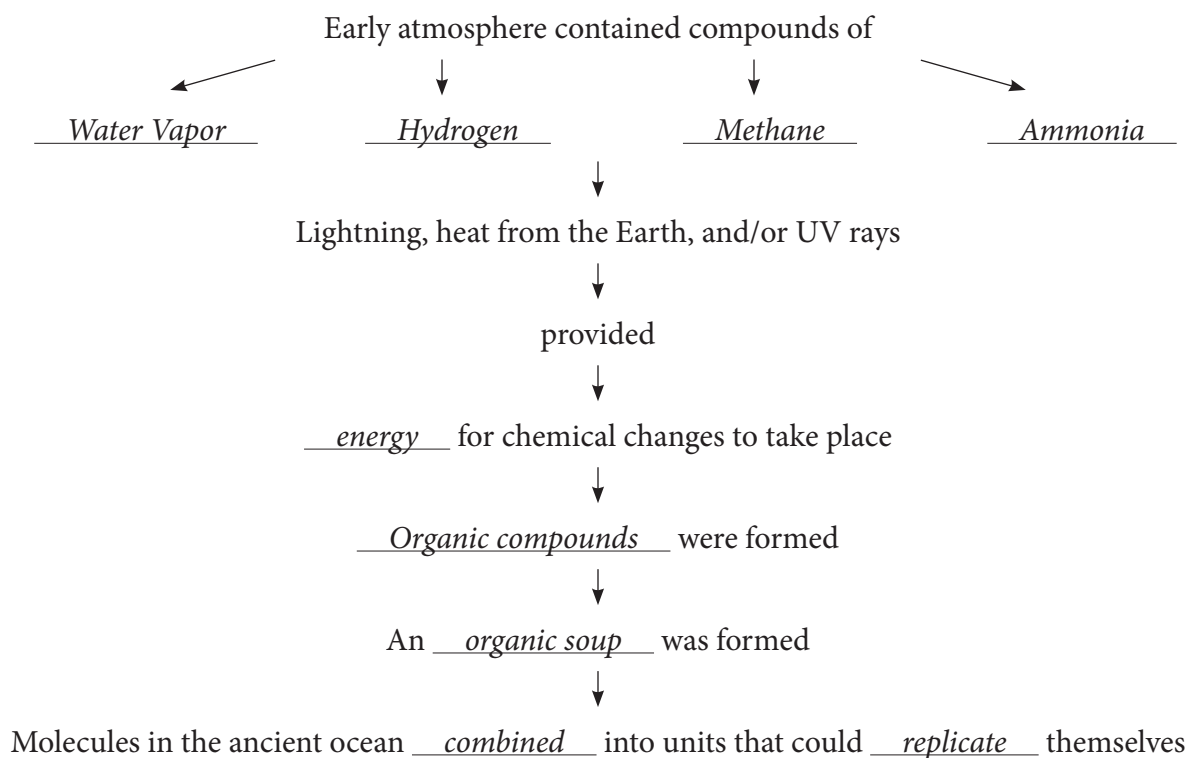
Concept Map One

What are fossils?



Concept Map Two

Oparin's Theory of chemical evolution



Vocabulary

In the spaces provided write in the words that fit the definitions that are given to you. Then use the letters in the highlighted boxes to spell out the answer to the problem below.

1. A study of the embryos of different species to see in what ways they are alike.

C O M P A R A T I V E E M B R Y O L O G Y

2. Occurs when populations of the same species cannot interbreed because of geographic barriers such as mountains or wide rivers.

G E O G R A P H I C I S O L A T I O N

3. Hardened tree sap which traps and preserves insects.

A M B E R

4. An impression left in a rock formed by soft structures such as leaves or feet before the rock hardens.

I M P R I N T

5. A cavity within a rock which has been formed by the body of an organism.

M O L D

6. Formed when hard body parts of a fossil are gradually replaced by minerals and turned into rock.

P E T R I F I E D F O S S I L

7. Occurs when members of the same species cannot interbreed—often due to geographic isolation.

G E N E T I C I S O L A T I O N

8. Deoxyribonucleic acid; the building blocks of life on Earth. It makes up our genetic material and contains all instructions for cell activity and growth which it passes on from generation to generation.

D N A

9. Occurs when plant leaves and sometimes other organisms are buried and decay only partially, leaving much of the carbon from their bodies.

C A R B O N F I L M F O S S I L

10. The developing form of an organism.

E M B R Y O

11. He performed a famous experiment to test Oparin's theory.

M I L L E R

12. Rapid evolutionary changes in a species, followed by long periods of stability and little change.

PUNCTUATED EQUILIBRIUM

13. Formed when material fills in a cavity after the body of the organism which formed the cavity decays.

CAST

14. A protein used in aerobic respiration and present in many different species.

CYTOCHROME C

15. Body parts of different organisms that have the same basic structure, even though they may be used for different functions.

HOMOLOGOUS STRUCTURE

16. The type of nuclear division in which the chromosome number is reduced to one half the original cell; it occurs in the sex cells.

MEIOSIS

17. Formed when organisms become trapped and preserved in tar, ice, or tree sap.

ORIGINAL REMAINS

18. Movement into or out of a population.

MIGRATION

19. Considered by some scientists to be a link fossil between reptiles and birds.

ARCHAEOPTERYX

20. Bacteria which do not require oxygen; believed to have been the first cells on Earth.

ANAEROBIC BACTERIA

21. The change in the frequency of different genes in a small population due to chance.

GENETIC DRIFT

22. Change over time, from a single cell to man.

EVOLUTION

23. The first cell on Earth.

PROTOCELL

24. The remains of a once-living organism.

FOSSIL

25. Any random change in a gene or chromosome.

MUTATION

26. Those organisms best adapted to their environment will survive and reproduce more often than those which are not.

N A T U R A L S E L E C T I O N

27. Change in a genus or species due to meiosis, genetic isolation, genetic drift, and natural selection.

D E V O L U T I O N

28. Change which goes beyond the genus; it is believed to be caused by mutation and natural selection. It is also believed to be influenced by genetic isolation and genetic drift.

E V O L U T I O N

29. He proposed a theory as to how life could have arisen spontaneously on Earth.

O P A R I N

This has had a great impact on the scientific communities of the nineteenth and twentieth centuries:

C H A R L E S D A R W I N ' S T H E O R Y O F E V O L U T I O N

Review

Know the vocabulary covered in your vocabulary sheet. Answer the following questions in complete sentences.

1. Explain how devolution and evolution differ.

Devolution occurs as a result of the interaction of meiosis and natural selection (along with genetic drift, genetic isolation, and migration). It occurs primarily through a loss of genetic information, sometimes through mutation. Evolution is believed to occur as a result of the interaction of mutation and natural selection (along with genetic drift, migration etc). It requires the addition of massive amounts of genetic information through mutation.

2. Explain Oparin's theory of spontaneous generation.

Oparin theorized that the early Earth had a reducing atmosphere (no free oxygen). Instead, it was composed primarily of ammonia, methane, water vapor, and hydrogen. Energy from the sun's UV rays or from lightning would split these molecules and then recombine them into organic compounds. These would then collect in an "organic soup." Over a long period of time these molecules would combine eventually to form the first cell.

3. Describe Miller's experiment. Include the reactants, the procedure, and the products.

Miller filled a flask with water and sealed it, allowing only a small opening in the top for water vapor to escape into a long tube. As the water vapor traveled through the tube, gaseous ammonia, methane, and hydrogen were added to it. The mixture was then passed through a spark chamber and a condenser and then collected in a trap. Miller found several amino acids in the liquid in the trap.

4. Explain why evolutionists cite each of the following sciences to support evolution.

Comparative embryology

Evolutionists contend that the embryos of different species such as fish, birds, dogs, and humans look alike at similar stages of early development. They say this is evidence of their having evolved from a common ancestor.

Comparative homology

Evolutionists point out that certain structures such as the front legs of dogs and cats, the wings of birds, the flippers of whales, and the arms of humans all have the same pattern of bones, and they feel this shows they had a common ancestor.

Comparative biochemistry

In comparing the cytochrome C, a protein commonly found in a wide variety of organisms, scientists found that the cytochrome C of humans was much more similar to that of monkeys than to that of turtles. They feel this shows their evolutionary relationship to each of these creatures.

5. Describe *Archaeopteryx* and explain why evolutionists believe it to be a link fossil between reptiles and birds.

Archaeopteryx is a proposed link fossil between reptiles and birds. Evolutionists think this because it has teeth, claws on its wings, and a flat breastbone—features they consider reptilian. It also has fully developed feathers and wings.

6. Name and briefly describe the four proposed whale ancestors described in this book.

Pakicetus: consisted of an incomplete skull, a partial jawbone and some teeth. *Pakicetus* was primarily a land animal.

Ambulocetus: about 3 meters long, with sharp teeth and short, broad legs. Called a “walking whale”.

Rodhocetus: Its skull was large and elongated, compared to the skeleton as a whole. The nostrils were further back along the snout, above the canine teeth, and it had ear bones that were similar in some ways to those of the cetaceans. The fossil’s pelvis was still attached to the spine, so *Rodhocetus* could walk on land, although probably not as well as *Pakicetus* or *Ambulocetus*.

Basilosaurus: a marine mammal with a long, slender body, flippers, flukes on its tail, tiny hind legs, and a flexible backbone. It was much larger than the other whale specimens, having a long, slender serpent-like body about 60 feet in length. It was a completely marine creature.

7. Explain how specimens of the fossil horse series differ.

The fossils of the horse series vary in size and number of toes. *Eohippus* was about the size of a dog, with four toes on its front feet and three on the back. Succeeding members of the series appear to lose toes on both front and back feet until the modern horse *Equus*, which has only one on each foot.

8. How do convergent evolution, divergent evolution, and adaptive radiation differ?

Evolutionists define convergent evolution as the process by which organisms become more alike due to adaptation to similar environments. With divergent evolution creatures become less alike due to adaptation to different environments. This is also referred to as adaptive radiation.

9. Explain why the peppered moth is considered by many evolutionists to be a classic example of evolution.

Evolutionists believe the dark peppered moth’s color came about as a result of a genetic mutation. Then the environment changed and natural selection selected for the darker moths. To evolutionists, this is a classic example of mutation (addition of information) and natural selection working together to bring about evolution.

10. Why do evolutionists consider the changes in the beaks of the Galapagos finches important?

Evolutionists point to the finches of the Galapagos Islands as examples of evolution. The finches show a variation in beak size and length after changes in the environment.

Test

Place the letter in the space provided that best completes the sentence.

Worth 1 point each

- D 1. Which of the following is a proposed ancestor of the whales?
- | | |
|-----------------------|------------------------|
| A. <i>Pakicetus</i> | C. <i>Basilosaurus</i> |
| B. <i>Ambulocetus</i> | D. all of these |
- B 2. Hardened tree sap which traps and preserves insects is
- | | |
|----------|---------------------|
| A. mold | C. cast |
| B. amber | D. original remains |
- A 3. Body parts of different organisms that have the same basic structure but are used for different functions are called
- | | |
|-----------------|------------------|
| A. homologous | C. analogous |
| B. evolutionary | D. none of these |
- C 4. This is created when minerals fill in a cavity after the organism that formed the cavity decays.
- | | |
|----------|------------|
| A. Mold | C. Cast |
| B. Amber | D. Imprint |
- C 5. Change within a genus or species due to meiosis, genetic isolation, genetic drift, mutation (loss of information) and natural selection is:
- | | |
|-------------------------|---------------|
| A. evolution | C. devolution |
| B. geographic isolation | D. mutation |
- D 6. Movement into or out of a population is:
- | | |
|----------------------|------------------|
| A. mutation | C. genetic drift |
| B. genetic isolation | D. migration |
- D 7. This occurs when members of the same species cannot interbreed.
- | | |
|--------------|----------------------|
| A. Migration | C. Meiosis |
| B. Mutation | D. Genetic isolation |

- A 8. He performed an experiment to test a theory of how the first cell was formed.
- A. Miller
B. Oparin
C. Darwin
D. de Vries
- B 9. An evolutionary theory which states that in the past there were rapid changes in a species, followed by long periods of stability and little change:
- A. gradualism
B. punctuated equilibrium
C. genetic drift
D. both A and B
- D 10. Cytochrome C is:
- A. a mutant gene
B. a protein used in aerobic respiration
C. present in a wide variety of species
D. both B and C
- B 11. This is a hollow cavity in rock formed by the body of a dead organism.
- A. Cast
B. Mold
C. Imprint
D. Amber
- C 12. This occurs when plants or plant leaves are buried and decay partially, leaving carbon from their bodies.
- A. Amber
B. Mold
C. Carbon film fossil
D. Cast
- A 13. The type of nuclear division in which the chromosome number is divided in half.
- A. Meiosis
B. Mitosis
C. Natural selection
D. Both A and B
- C 14. It is believed to be brought about primarily by mutation (adding information) and natural selection working together.
- A. Genetic drift
B. Devolution
C. Evolution
D. None of these
- C 15. He proposed a theory as to how the first cell on Earth could have arisen spontaneously.
- A. Miller
B. Redi
C. Oparin
D. Pasteur
- A 16. This is often defined as “change over time”.
- A. Evolution
B. Mitosis
C. Natural selection
D. Genetic isolation

- D 17. An impression left in a rock by a leaf or a foot before the rock hardens is:
A. a carbon film fossil C. a mold
B. a cast D. an imprint
- B 18. Bacteria which do not require oxygen; believed to have been the first cells on Earth.
A. Aerobic C. Mutational
B. Anaerobic D. Nucleic
- C 19. A random change in a gene or chromosome is:
A. meiosis C. mutation
B. mitosis D. natural selection
- D 20. Fossils can be trapped and preserved in:
A. tar C. tree sap
B. ice D. all of these

Modified True and False

*If, according to the text, the statement is true, circle T. If it is false, circle F and then change the underlined word to correct the statement in the space provided.
(One point for each correct true answer; two points for each corrected false answer.)*

- T 1. Change within species or genus due to lost information is devolution.

- F 2. Comparative homology is the study of similarities between embryos.

Comparative Embryology

- F 3. Miller's experiment produced proteins.

Amino acids

- T 4. Comparative biochemistry includes the study of Cytochrome C.

- F 5. According to evolutionists, organisms becoming more alike as a result of adapting to similar environments is an example of divergent evolution.

Convergent

- F 6. According to evolutionists, organisms becoming less alike as a result of adapting to different environments is an example of convergent evolution.

Divergent

- T 7. When the hard parts of a fossil are gradually replaced by minerals and turned to stone, the fossil is referred to as petrified.
-

- F 8. The change in frequency of different genes in a small population due to chance is called genetic isolation.

Genetic Drift

- T 9. Evolutionists call the first cell on Earth the protocell.
-

- T 10. *Natural* selection refers to organisms best adapted to their environments surviving and reproducing more often than those that are not.
-

Essay Questions

Instructions: Answer the following questions in complete sentences.

Three points per question

1. Explain why the peppered moth is considered to be a classic example of evolution.

Evolutionists believe that the first dark colored peppered moth occurred as a result of genetic mutation. Then since the environment had changed, new environmental conditions selected for the dark moths and against the light peppered moths. Thus, mutation (adding information) and natural selection are working together to cause evolution.

2. Explain Oparin's theory of the development of the first cell. Include the compounds in the early atmosphere, the chain of events, and the assumed results.

Oparin proposed that the Earth's early atmosphere was composed of ammonia, methane, hydrogen and water vapor. There was no free oxygen. Lightning or the sun's UV rays provided energy necessary to unite these compounds into organic molecules. As the organic molecules came together to form an organic "soup", the molecules gradually began to bond into more complex molecules, finally producing the first cell.

3. Choose one of the following and why evolutionists believe it supports evolution: comparative biochemistry, comparative embryology, or comparative homology.

Comparative biochemistry

Scientists have compared cytochrome C in many different species and found that humans and primates differ by only one nucleotide. On the other hand, humans and turtles differ by fourteen. They feel this demonstrates that humans and primates have a close evolutionary ancestry.

Comparative embryology

Evolutionists contend that embryos of many species show remarkable similarities in their early stages. They feel this is evidence of a common ancestor in the past.

Comparative homology

evolutionists point to the fact that certain structures in different species show remarkable similarities, even though they may be used for different functions. One of the most common examples is animals' front legs, birds' wings, whales' flippers, and man's arms, which all have the same bone pattern. They feel this demonstrates that they all had a common evolutionary ancestor.

Chapter 3

Suggestions for Beginning

Begin this chapter by displaying a large picture of a member of the ape family along with a picture of a teenage girl or boy. (You might also want to use the cover of *National Geographic*, August, 2002, as an example of the “common ancestor” between these two, but this is not absolutely necessary.) Lead a discussion with your pupil(s), using the following questions.

1. Compare these two pictures. Evolutionists believe that these two “organisms” evolved from a common ancestor. Would you consider this small scale or large scale change? Why?
(If they decide it is large scale change, they should bring up the difference in physical appearance, hand structure, brain size, intelligence, etc. as some of their reasons.)
2. Is it likely this type of change could be brought about primarily by a loss of genetic information?
(In the course of the discussion, help your student(s) to understand that only a limited amount of information can be lost without rendering the organism incapable of competing or even functioning.)
3. If it is true that they came from a common ancestor, would they consider the differences demonstrated here to be caused primarily by devolution or by evolution?
(Remind your pupil(s) that devolution occurs primarily due to a loss of information, while evolution requires a gain of massive amounts of information. They may decide that it is evolution that is required here. However, if they do not, tell them they have a right to change their opinion as they continue to study the following chapters.)
4. Explain to your student(s) that Chapter 3 is demonstrating the evolutionist position that man and the ape family came from a common ancestor.

Sections Question Key

Section One: Important Evolutionary Terms

1. Name and define the specialties of the following scientists: paleontologists, paleoanthropologists, geologists.

Paleontologists study fossils of all kinds. *Paleoanthropologists* concentrate on human fossils. *Geologists* use fossils (and other methods) to help determine the history of the Earth.

2. What are different names for paleoanthropologists, out of Africa model, and regional continuity model?

Paleoanthropologists are also known as physical anthropologists. *The Out of Africa model* is also known as the single origin model. Another name for the regional continuity model is the *multi-regional model*.

3. Explain the difference between the out of Africa model and the regional continuity model.

The out of Africa model states that modern humans evolved in Africa and then came out of the continent and replaced other, less-evolved hominids that had left Africa at an earlier time. Proponents of the *regional continuity model* state that groups of *Homo erectus* left Africa and dispersed into many areas of the old world; then each group fathered a line that gave rise to modern humans.

4. Define the following terms: primates, bipedalism, hominid, cranial capacity.

Primates: an order of approximately 200 species, including apes, chimpanzees, and orangutans. Evolutionists also place man in this order. *Bipedalism*: the ability to walk on two legs. *Hominid*: Until recently, the term hominid referred only to those creatures that were in the line of man. However, some anthropologists are beginning to classify gorilla, chimpanzee and orangutan ancestors as hominids also. In this chapter, the term hominid will refer only to those fossils believed to be in the line of humans.

Section Two: Early Hominids:

1. When, where, and by whom was *Ardipithecus ramidus* found?

A. ramidus was found in 1992 in the Afar Depression of Ethiopia by paleontologist Timothy White.

2. Give three characteristics of *A. ramidus*.

The fossil consisted of a mandible, some arm bones, and pieces of skull in one location. Together with bones found in another location, they had about 45% of a skeleton. Later researchers found fragmented remains from nine separate fossils they believe to be of the same species. White's specimen was that of a 100 pound female that he believed to have been bipedal. *A. ramidus* is also believed to have been omnivorous, have a brain capacity of only 300–350 cubic centimeters, and to have lived 4.4 million years ago. Many evolutionary paleontologists believe it to be a common ancestor of both apes and humans.

3. To whom is *Ardipithecus kadabba* assumed to be related?

A. kadabba is believed to have walked upright and to have been an ancestor of *A. ramidus*.

Section Three: Early Australopithecines

1. When, where, and by whom was *A. anamensis* found?

Australopithecus anamensis was found by Meave Leakey in Africa in 1994.

2. How much of the fossil was found? Was it all in the same place?

A mandible, upper jaw, parts of a tibia, and some skeletal fragments were found in three locations.

3. By what method was it dated, and how old is it believed to be?

It was dated radiometrically and given an age of 4.1 million years old.

4. What features does it have which appear to be ape-like, and what features does it have which appear to be human?

The mandible appears to be ape-like, while the tibia parts seem to demonstrate it was bipedal.

5. When, where, and by whom was *A. afarensis* found?

A. afarensis was found in Africa's Great Rift Valley in 1974 by Donald Johanson.

6. How much of the fossil was found? Were all the parts found at the same time and together?

Forty per cent of the fossil was found, a greater percentage than that of any other supposed human ancestor.

7. Name two characteristics that Johanson believes *A. afarensis* (Lucy) possessed.

Johanson believes it to be bipedal, but the arms were long and ape-like.

Section Four: Later Australopithecines

1. When, where, and by whom was *Kenyanthropus platyops* found?

The single specimen of this genus was found in 1999 near Lake Turkana, Kenya by Justus Erus, a member of Meave Leakey's team.

2. Give three characteristics of *K. platyops*.

It consists of a badly abraded skull and a partial upper jaw. Another jaw fragment, a lower jaw and some teeth and 33 other fossil fragments have been found nearby. The fossils has small ear holes, small molar teeth, a small brain, and a long, flat face.

3. Because *K. platyops* and *A. afarensis* appear to have lived at the same time, some paleontologists have changed their minds about how man evolved. What do they now believe?

Some paleontologists now theorize that there were several different hominid lines in existence in the past, though modern humans evolved from only one of these lines.

4. How is *A. africanus* different from *A. afarensis*?

It had a larger brain capacity.

5. What ape-like and human-like characteristics do evolutionists believe *A. africanus* has?

The teeth of the later *A. africanus* specimens are much like those of modern apes, not humans. However, a broad, flat thumb similar to humans. It is also believed to have used simple tools, and lived in groups.

6. The australopithecines are described as bipedal. What does this mean?

Being bipedal means walking on two legs.

Section Five: The First of the Genus *Homo*

1. When, where and by whom was *Homo habilis* found?

Homo habilis was found by Lewis and Mary Leakey in the Olduvai Gorge, East Africa, in the 1960's.

2. What does the name *Homo habilis* mean, and why was the fossil given this name?

Homo habilis means "handy human." It was named this because tools were found near the fossil and *Homo habilis* is believed to have used them.

3. *How old is Homo habilis believed to be?*

1.5 to 2.2 million years old.

4. *Name two human characteristics Homo habilis is believed to have possessed.*

Louis leakey analyzed the finger bones of the specimen and stated that the creature who once possessed them had an opposable thumb. The Leakeys found tools nearby and believed the fossil to have at one time used the tools.

Section Six: Archaic *Homo sapiens*

1. *Where was the first specimen of Homo erectus found, and why was it given this name?*

The first specimen, consisting of a skull plate and a leg bone, was found on the island of Java in Indonesia. It was given its name because its discoverer believed it to have walked upright.

2. *What evidence shows some of his behavior to be similar to modern humans?*

Later specimens classified as *H. erectus* appear to have been toolmakers. It is likely they were hunters, and to have used fire.

3. *Give two characteristics of Homo ergaster that resemble modern humans.*

H. ergaster had a brain capacity near that of modern humans. Males reached 6 feet tall. Specimens have been found with tools. They also appear to have lived in large groups.

4. *What do most paleoanthropologists consider H. ergaster to be?*

Most paleoanthropologists consider him just another variety of *Homo erectus* who failed to emigrate from the African continent.

5. *Give at least two characteristics of Homo heidelbergensis' behavior that resemble that of modern humans.*

H. heidelbergensis had a brain capacity equal to that of modern humans. He used more advanced stone tools and is believed to have used rituals and buried his dead.

6. *What physical characteristics of H. heidelbergensis resemble that of modern humans?*

Males ranged in height from 1.75 m (5 feet 9 inches) to 1.83 m (6 feet tall). Some specimens have been found with a broca's cap and other well-developed speech areas.

7. *Why did scientists at first consider Neanderthal to be a link fossil? What changed their minds?*

The first skeletons of *Neanderthal* that were found were bent. Later skeletons were straight, so scientists believe the first skeletons showed evidence of a crippling disease.

8. How were the Neandertals like modern humans, and how long ago were they believed to have lived?

Neanderthal brains were as large or larger than modern humans. They used simple tools, wore animal skins, buried their dead, had rituals and ceremonies, etc. They are believed to have lived from 130,000 to 35,000 years ago.

Section Seven: Modern Humans

1. Describe the Cro-Magnon.

Cro-Magnon were physically identical to modern humans. They had higher foreheads, small, even teeth, rounded skulls and protruding chins like modern humans.

2. What did the Cro-Magnon do that was typical of humans?

Cro-Magnon made and used simple tools and weapons, hunted in groups, shared rituals and ceremonies, and drew extensive pictures of their activities on cave walls.

3. What was the agricultural revolution? When do scientists believe it occurred?

The agricultural revolution refers to the time when mankind stopped hunting and gathering as a primary source of food and began to farm.

4. How did the agricultural revolution help humanity?

Because humans did not have to be constantly on the move, they could specialize more and do different tasks. Also, they had a steadier source of food.

5. What has happened to the Earth's population since that time?

According to evolutionary thought, the Earth's population has expanded greatly since that time.

Section 1

Important Evolutionary Terms

Match the following words with their definitions.

- | | | |
|--------------------------------------|------------------------------|----------------------------|
| A. geologist | F. paleoanthropologist | J. physical anthropologist |
| B. <i>Australopithecus afarensis</i> | G. regional-continuity model | K. bipedalism |
| C. primates | H. multi-regional model | L. single origin model |
| D. out of Africa model | I. paleontologist | |
| E. link fossil | | |

- C 1. Many scientists place man, apes, chimpanzees, orangutans, etc. in this taxonomic order.
- E 2. The remains of a common ancestor between two taxonomic groups.
- A 3. A scientist who studies rock formations to help determine the history of the Earth.
- B 4. A proposed link fossil between man and the apes.
- I 5. Scientists who study fossils of all kinds.
- J 6. Scientists who study primarily human fossils.
- F 7. Another name for physical anthropologists.
- D 8. Proposes that modern man evolved in Africa and then left the continent to replace other, less evolved hominids.
- K 9. Walking on two legs.
- G 10. Proposes that groups of *H. erectus* left Africa, dispersed into many areas, and fathered several lines of modern humans.
- H 11. Another name for the regional-continuity model.
- L 12. Another name for the out of Africa model.

Answer the following question in complete sentences:

1. Explain why it is much harder to believe in the multi-regional theory than to believe in the out of Africa theory.

The possibility of several lines of humans evolving simultaneously is far more remote than that of humans evolving from one line

Sections 2 & 3

Early Hominids & Early Australopithecines

Place the following terms in the proper blank. Read carefully.

<i>Ardipithecus kadabba</i>	bones	4.1
<i>A. afarensis</i>	40%	several
<i>A. anamensis</i>	4.4	3
Ardi	Lucy	disagree
300–350	3.18	jawbone fragments
skull	branches	<i>Ardipithecus ramidus</i>
female	ancestor	jaw
tibia	humans	mandible
bipedal	ground	
chinless	5.6–5.8	

In 1992 in the Afar Depression of Ethiopia paleoanthropologist Timothy White discovered a mandible, some teeth, and some arm bones of a creature he thinks was bipedal. He has dated it at 4.4 million years old and named it *Ardipithecus ramidus*. Nicknamed Ardi, the fossil is believed to be that of an 110 pound female. It had a brain size of only 300–350 cubic centimeters. Dr. White believes the fossil was bipedal on the ground but had a big toe that could grasp branches when climbing trees.

In 1997 members of another group of paleoanthropologists discovered a jawbone fragment, a mandible, some teeth, and several other fragments. These were located in several sites. White is now proposing that it be classified as a separate species, *Ardipithecus kadabba*. This specimen has been radiometrically dated to be 5.6–5.8 million years old.

Some scientists believe the oldest known australopithecine is *A. anamensis* which was discovered by Meave Leakey. Dr. Leakey found a mandible, an upper jaw, parts of a tibia, and skeletal fragments in three locations. She has dated the bones radiometrically and assigned an age of 4.1 million years to her specimen. Dr. Leakey believes the specimen to be a hominid because the tibia fragments demonstrated bipedalism, while the mandible (lower jawbone) showed the creature was chinless, an apelike characteristic.

Donald Johanson had found another specimen in 1974. Approximately 40% of the skeleton was found. He gave it the scientific name of *A. afarensis* but nicknamed the female skeleton Lucy after a popular song of the times. Johanson used both geologic time

scale dating and radiometric dating and assigned it an age of 3.18 million years old. Because he had no complete skull with the skeleton, Johanson returned to Africa in 1992 in order to find one. He found one that he believes belongs to this species. Johanson believes *A. afarensis* to be an early ancestor of humans, but Mary and Richard Leakey disagree.

Sections 4 & 5

Later Australopithecines & the First of the Genus *Homo*

In the blanks in front of each phrase, put the names, A. africanus, H. habilis or K. platyops, if the phrase applies to that hominid. Some phrases may apply to two hominids. If so, put both names in the blank. If the phrase does not apply to any of the hominids, put "does not apply" in the blank.

- | | |
|--------------------------------------|--|
| <u>H. habilis</u> | 1. Was found with artefacts that led evolutionists to believe they were toolmakers. |
| <u>A. africanus & H. habilis</u> | 2. Scientists believe it had a thumb similar to humans. |
| <u>Does not apply</u> | 3. Were earliest known hominids. |
| <u>K. platyops</u> | 4. Consists of a badly abraded skull and partial jawbone. |
| <u>H. habilis</u> | 5. Found by Louis and Mary Leakey. |
| <u>H. habilis</u> | 6. Believed to be 1.5 to 2.2 million years old. |
| <u>K. platyops</u> | 7. Has some features that resemble a chimpanzee. |
| <u>K. platyops</u> | 8. Is believed to have lived at the same time as <i>A. afarensis</i> . |
| <u>A. africanus</u> | 9. Some scientists believe it was bipedal. |
| <u>H. habilis & K. platyops</u> | 10. Some scientists consider this specimen to be another species of australopithecine. |
| <u>A. africanus</u> | 11. Southern ape-man of Africa. |
| <u>A. africanus</u> | 12. Is believed to have used tools, lived in groups, and eaten meat. |
| <u>K. platyops</u> | 13. Its condition has caused much controversy. |
| <u>H. habilis</u> | 14. Name means "handy human". |
| <u>K. platyops</u> | 15. The skull appears to have been affected by materials entering small holes in the bones and expanding them. |
| <u>A. africanus</u> | 16. Believed to have lived 2.5–3 million years ago. |

Section 6

Archaic *Homo sapiens*

Homo ergaster, *Homo erectus*, *Homo heidelbergensis*, and *Homo neanderthalensis* are all classified as archaic humans. In the spaces below, compare each specimen in the given area. In some cases, details about a particular specimen may not be in the book. In this case, write “not available” on that line.

I. Cranial Capacity:

1. *H. ergaster* _____ 900–1100 cc’s _____
2. *H. erectus* _____ 1000–1200 cc’s _____
3. *H. heidelbergensis* _____ 1200–1400 cc’s _____
4. *H. neanderthalensis* _____ 1350–1500 cc’s _____

II. Body Size and structure:

1. *H. ergaster* _____ Males reached 1.83 m (6 feet) tall. *H. ergaster* was similar to *H. erectus* but had thinner skull bones and a different brow ridge.
2. *H. erectus* _____ Not available
3. *H. heidelbergensis* _____ His skull was more elongated from front to back than modern humans. Males ranged from 1.75 m (5 feet 9 inches) to 1.83 m (6 feet) tall.
4. *H. neanderthalensis* _____ Neanderthals had thick skulls with heavy brows, slanting foreheads, and protruding jaws.

III. Use of tools:

1. *H. ergaster* _____ Specimens have been found with tools that scientists believe they used.
2. *H. erectus* _____ Information recovered at locations where *Homo erectus* fossils were discovered indicates that they were toolmakers.
3. *H. heidelbergensis* _____ They used more advanced stone tools and perhaps hunting spears.
4. *H. neanderthalensis* _____ They made and used simple tools.

IV. Social rituals (human behavior):

1. *H. ergaster* _____ Members of the species appear to have lived in large groups.
2. *H. erectus* _____ They appear to have been hunters and to have mastered the use of fire.
3. *H. heidelbergensis* _____ They used rituals and buried their dead.
4. *H. neanderthalensis* _____ They made and used simple tools, wore animal skins as clothing, buried their dead, had rituals and ceremonies, and made war.

Short Answer:**1. What is the meaning of the term, *Homo sapiens*?**

Homo sapiens means “wise humans”.

2. Why are archaic *Homo sapiens* classified as such? What about their brain capacity—what does that tell you about them?

Archaic humans are classified as such because of their thick skulls, prominent brow ridges, and recessive chins, even though their brain size was generally around 1300 cubic centimeters—well within the size of modern humans.

Section 7

Modern Humans

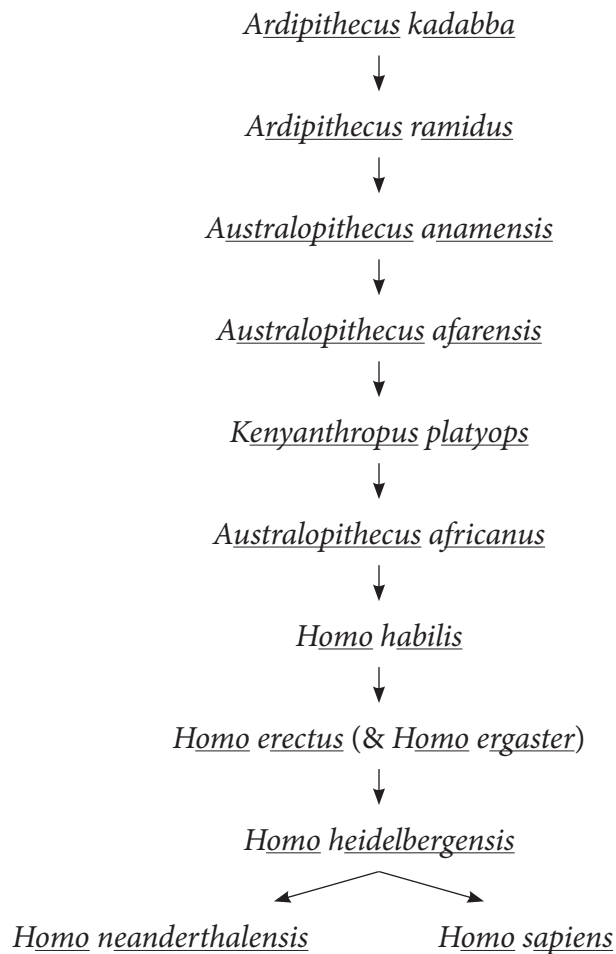
Following is a series of statements. If, according to Chapter 3, the statement is true about Cro-Magnon, put a "C" in that column; if it is true of Modern humans, put an "M" in that column. If it does not apply to either group, put a "D" in that column. See if you can figure out the group to whom the "D" column applies.

D	C	M	
D			Several specimens had a slightly larger brain capacity than modern humans.
	C		They produced beautiful cave paintings which showed a great deal about their lives.
		M	They are considered to have been the first to practise agriculture.
D			They were believed to have lived from 130,000 to 35,000 years ago.
	C		They are believed to be most closely related to modern man.
	C	M	They made and used tools.
	C	M	They practiced rituals and ceremonies.
	C	M	They made war.
	C		They hunted and also gathered wild plants for food.
D			They had thick skulls, with heavy brows and slanting foreheads.
D			Some scientists still categorize them as a separate species.
D			The first specimen of this group was discovered in a cave in Germany.
D			The first skeleton that was found of this group was at first believed to be a link fossil between the apes and humans.
	C		The first specimens of this group were found in a cave in France.
D			The first specimen of this group was an individual who suffered from a disease such as arthritis.
	C		They had rounded skulls, even teeth, high foreheads, and protruding chins like modern man.
	C		They are believed to have lived on Earth within the last 40,000–50,000 years.

The facts in the "D" column are describing Neanderthal.

Concept Map

Evolutionary Timeline: Evolution of Man



Group Activity

Brainstorming: What Makes a Good Hominid?

Begin by giving your student(s) a definition of a hominid. It is a good idea to have this definition on a computer or the blackboard for them to refer to during your discussion. You might use the following: “A hominid is a human-like species, a link fossil between man’s ape-like ancestors and modern humans.” Then give your student(s) the following assignment: they are to come up with some basic qualifications that a fossil must possess in order scientifically to be considered a “hominid.”

Use the following questions with the definition to stimulate their thinking and discussion:

1. What are some basic characteristics that a fossil must possess in order to qualify as a hominid?
2. What conditions of discovery should exist before a fossil is considered a legitimate hominid? In other words, where, how and how much of the fossil should be found?

Allow them to work for ten to fifteen minutes (as long as they appear to be productive). Then discuss all their ideas. Write all reasonable ones down. When your student(s) have finished their contributions, ask some additional questions to get them thinking more about what is scientifically acceptable as real evidence of a hominid. Make sure they consider the following as part of their list of qualifications.

1. A hominid should possess both ape-like and human characteristics.
2. All the bones of the fossil should be found in close proximity to one another.
3. The bones that are supposed to go together should fit properly.
4. Enough of the fossil should have been found to determine what it is. A skull is especially important. So are leg and hip bones.
5. The bones should not be put together if they have been found in different rock layers.
6. The bones should be found in lower rock strata than modern human bones.
7. A scientifically accurate way to date the age of the fossil would be helpful.

It is wise to make a corrected copy of your list of qualifications and save it for Chapter 8. Begin Chapter 8 with a brief review of your students’ suggestions and the ensuing discussion. It will serve as excellent background information as he discovers **all** the facts about his supposed hominid ancestors.

Vocabulary

Match the words with their definitions

A. <i>A. afarensis</i>	K. Hominid	T. Physical anthropologist
B. <i>A. africanus</i>	L. <i>Homo erectus</i>	U. Primates
C. <i>A. anamensis</i>	M. <i>Homo habilis</i>	V. <i>H. ergaster</i>
D. Agricultural revolution	N. <i>Homo sapiens</i>	W. <i>H. heidelbergensis</i>
E. <i>Ardipithecus ramidus</i>	O. Link fossil	X. regional-continuity model
F. <i>Australopithecus</i>	P. Paleoanthropologist	Y. Out of Africa model
G. Bipedal	Q. <i>A. kadabba</i>	
H. <i>K. Platyops</i>	R. <i>H. neanderthalensis</i> (Neanderthals)	
I. Cro-Magnon	S. Paleontologist	
J. Geologist		

- K 1. Human-like species: considered bipedal with both ape-like and human characteristics.
- R 2. Humans believed to have lived 130,000 to 35,000 years ago.
- N 3. The genus and species of modern humans.
- A 4. Forty percent of skeleton found; nicknamed Lucy.
- M 5. Discovered by the Leakeys; believed to be 1.5 to 2.2 million years old; “handy human”.
- P 6. Scientists who study ancient human bones.
- B 7. Believed to have had a rounded skull and a broad, flat thumb similar to humans.
- I 8. Physically identical to modern humans.
- C 9. Discovered by Meave Leakey; believed to have walked upright but also to have been “chinless”; specimen dated radiometrically to be 4.1 million years old.
- F 10. The genus to which the earliest known hominids may have belonged; some specimens classified in this genus are *A. anamensis* and *A. afarensis*.
- O 11. Fossil of a creature which is supposed to be intermediate between two groups, such as an ancestor of both apes and man. It possesses some characteristics of each group.
- T 12. Another term for paleoanthropologist.
- H 13. A badly abraded skull and a partial upper jaw believed to be between 3.2 and 3.5 million years old.
- S 14. Studies fossils of all kinds.

- J 15. Use fossils to study the Earth's history.
- D 16. The period of time when modern humans turned to farming.
- U 17. The order in which man and the apes are placed.
- G 18. Walks on two legs.
- L 19. Java Man
- E 20. Discovered by Timothy White; he believes it to be older than the Australopithecines—4.4 million years.
- Q 21. A jawbone fragment, a mandible, some teeth, a collarbone, and some fragments of hand, foot, and arm bones dated between 5.6 million and 5.8 million years old. Believed to have been an ancestor of *Ar. ramidus*.
- Y 22. A model of human evolution that proposes that modern humans evolved in Africa and then came out of the continent and replaced other, less-evolved hominids.
- V 23. A proposed hominid that was similar to *H. erectus* but had thinner skull bones and a different brow ridge; believed to have existed between 2 and 1.7 million years ago.
- X 24. A model of human evolution that proposes that groups of *Homo erectus* left Africa and dispersed into many areas of the old world; then each group fathered a line that gave rise to modern humans.
- W 25. Is considered to have given rise to two different species: the Neanderthals and modern man. Some specimens have been found that exhibit a broca's cap and other well-developed speech areas.

Review

Below are a list of names. After referring to your books (if necessary), give at least four pieces of information about each one. You may use words and phrases.

1. *Ardipithecus ramidus* (Need only two pieces of information for this one)

- A. Found by Timothy White
- B. Dated at 4.4 million years old.
- C. More primitive than *A. afarensis*
- D. Original specimen consisted of a mandible, some arm bones, and a skull piece.
- E. A 110 pound female; nicknamed Ardi
- F. Put with other bones found earlier, Dr. White stated he had about 45% of a skeleton.
- G. Brain size between 300 and 350 cubic centimeters.
- H. Believed to be bipedal on ground and go on all fours when climbing trees.
- I. Omnivorous
- J. Had big toe that could grasp branches like members of ape family.
- K. Teeth showed characteristics of both apes and *A. afarensis*.
- L. Many paleontologists believe it to be a common ancestor of apes & humans.

2. *Ardipithecus kadabba*

- A. consisted of fragments of a jawbone, hand, foot, and arm, together with a mandible, some teeth, and a collarbone.
- B. Skeletal parts found in several areas.
- C. Altogether, team found 11 specimens from at least 5 different individuals.
- D. At first thought to be specimens of *A. ramidus*
- E. Dr. White now proposing a separate species—*A. kadabba*
- F. Used radiometric dating to assign age of 5.6–5.8 m.y.o.
- G. One toe bone dated a few hundred thousand years younger.
- H. Believed to have walked upright and to have been *Ar. ramidus*'s ancestor.

3. *Australopithecus anamensis*

- A. Found by Meave Leakey
- B. Dated at 4.1 million years old.
- C. Found ape-like mandible (jawbone) and human tibia
- D. Believed specimen to have walked upright.
- E. Specimen chinless.
- F. Upper canine teeth more vertical, like humans.
- G. Found near Lake Turkana, Kenya.
- H. Cranial capacity: 350–400 cc's

4. *Australopithecus afarensis*

- A. Found by Donald Johanson
- B. Found 40% of the skeleton

- C. Believed fossil to have once been an erect walking female about 3 feet tall.
- D. Nicknamed fossil Lucy
- E. Dated by both geologic time scale and radiometric dating
- F. Dated to be 3.18 million years old
- G. Arms long and chimp-like
- H. Believed to have been bipedal
- I. Found the skull of a different specimen—a male.
- J. Classified by Johanson as an early Australopithecine and ancestor of humans
- K. Most complete individual skeleton found to date.
- L. Cranial capacity: 400 cc's

5. *Kenyanthropus platyops*

- A. Cranial capacity: 350–400 cc's
- B. One single specimen found by member of Meave Leakey's team
- C. Broad, flat face, so named *K. platyops*, “flat-faced man of Kenya”
- D. Specimen a badly abraded skull & partial upper jaw
- E. Dated at 3.2–3.5 m.y.o.
- F. Fossil has ear holes like a chimp.
- G. Teeth and face more like modern man
- H. Appears to have existed at same time as *A. afarensis*.
- I. Leakey believes modern humans evolved from *K. platyops*, not *A. afarensis*.
- J. Skull has been expanded by materials entering the bone.
- K. Fossil has been compressed.
- L. Some believe fossil just another australopithecine.

6. *Australopithecus africanus*

- A. Believed by many to be a direct descendant of *A. afarensis*
- B. Had more rounded skull and larger brain than *A. afarensis*
- C. Believed to have had a thumb like humans
- D. Believed to have lived in groups and eaten meat
- E. Believed to have been bipedal by some scientists
- F. Cranial capacity: 370–500 cc's
- G. Believed to have used simple tools
- H. Fossil estimated to have lived 2.5–3 m.y.a.
- I. Found by Raymond Dart in South Africa

7. *Homo habilis*

- A. Name means “handy human.”
- B. Found by Louis and Mary Leakey
- C. Named “handy human” because tools were found near specimens.
- D. Some scientists believe he had an opposable thumb like humans.
- E. Dated to be 1.8 to 2.2 million years old
- F. Believed fossil used tools found nearby
- G. Believed by some to be just another *Australopithecine*

- H. Widely accepted by other evolutionists as in the line of man
- I. Cranial capacity: 650 cc's

8. *Homo ergaster*

- A. Similar to *H. erectus* but with thinner skull bones & different brow ridge
- B. Males reached 1.83 m (6 feet) tall.
- C. Specimens found with tools scientists believed they used.
- D. Cranial capacity: 900–1100 cc's
- E. Believed to have lived 1.7–2 m.y.a.
- F. Believed to have lived in large groups
- G. Considered by some to be direct ancestor of modern humans
- H. Considered by some to be another variety of *H. erectus*

9. *Homo erectus*

- A. Made and used tools
- B. Were hunters
- C. First to use fire
- D. Believed to have walked upright
- E. Lived less than a million years ago, by evolutionists' dating methods
- F. First specimen called Java man—consisted of skull plate and femur
- G. Other specimens found in China
- H. Chinese specimens: several skulls with faces missing
- I. Have since found several other specimens of *Homo erectus*
- J. Cranial capacity: 1000–1200 cc's
- K. Believed to have lived less than a million years ago

10. *Homo heidelbergensis*

- A. Cranial capacity: 1200–1400 cc's
- B. First specimen found in Heidelberg, Germany
- C. Other specimens found in Spain, France, Africa, and other parts of world
- D. Is considered to have given rise to two species: Neanderthals and modern man
- E. Skull more elongated than modern humans
- F. Used advanced tools and perhaps hunting spears
- G. Used rituals and buried dead
- H. Males ranged from 1.75 m (5 feet 9 inches) to 1.83 m (6 feet) tall.
- I. Broca's cap indicates they may have spoken a language
- J. Believed to have lived 300,000–600,000 years ago

11. *Homo neanderthalensis* (Neanderthals)

- A. Considered the first of the *Homo sapiens* by some evolutionists
- B. Placed in a separate species by others
- C. Cranial capacity: 1350–1500 cc's
- D. Believed to have lived between 130,000 and 35,000 years ago
- E. Lived in Europe and central Asia
- F. Used simple tools

- G. Lived in groups
- H. Buried dead
- I. Had religious rituals
- J. Wore animal skins as clothing
- K. Made war
- L. Some specimens had a slightly larger brain capacity than modern man.

12. Cro-Magnon

- A. Physically identical to modern man
- B. Made and used tools
- C. Did cave paintings
- D. Lived and hunted in groups
- E. Shared ceremonies and rituals
- F. Believed to have lived on Earth during the past 40,000 to 50,000 years

Short answers

Answer the following in complete sentences.

1. What is a link fossil? Give an example and tell why it is considered a link fossil.

A link fossil is an intermediate fossil between two distinct species. It supposedly possesses some characteristics of both species. *Archaeopteryx* would be a good example because it has both supposed reptilian and bird-like characteristics. A hominid might be another, since it supposedly possesses both human and ape-like characteristics.

2. Contrast the “out of Africa” model with the “multi-regional model”.

Proponents of the “multi-regional model” state that groups of *Homo erectus* left Africa and dispersed into many areas of the old world; then each group fathered a line that gave rise to modern humans. There would have been some intermixing of these groups that would have maintained their basic “human” similarities. The second theory, called the “out of Africa” or “single origin” model, states that modern humans evolved in Africa and then came out of the continent and replaced other, less-evolved hominids that had left Africa at an earlier time.

3. What is believed to have come first, walking upright or a growth in brain capacity?

Walking upright is thought to have preceded a growth in brain capacity.

4. What hampers evolutionary scientists in their search for information on human origins?

Scientists are hampered in the field of human evolution by the lack of evidence. First of all, there are only a few hundred fossils and some related information such as the Lake Laetoli footprints of East Africa. Often, only a few pieces of a given fossil are found.

5. Why are Archaic humans classified as such?

Archaics are generally classified as such because of their thick skulls, prominent brow ridges, and recessive chins, even though their brain size was generally around 1300 cubic centimeters—well within the size of modern humans.

6. Who is believed to have started the agricultural revolution and what effect is it thought to have had on man?

Modern man is believed to have started the agricultural revolution. This supposedly led To a more settled lifestyle and an increase in population growth.

Test

Matching

Use the letters below to fill in the space provided. Two words will not be used.

- | | | |
|------------------------------|------------------------|-------------------------------|
| A. <i>A. afarensis</i> | F. <i>Ar. ramidus</i> | K. <i>K. platyops</i> |
| B. <i>A. africanus</i> | G. Cro-Magnons | L. <i>H. ergaster</i> |
| C. <i>A. anamensis</i> | H. <i>Ar. kadabba</i> | M. <i>H. neanderthalensis</i> |
| D. <i>Homo sapiens</i> | I. <i>Homo erectus</i> | |
| E. <i>H. heidelbergensis</i> | J. <i>Homo habilis</i> | |

- M 1. Archaic humans believed to have lived between 130,000 and 35,000 years ago in Central Asia and Europe; had a brain capacity slightly larger than modern humans.
- G 2. They were identical to modern humans in physical appearance; left beautiful cave paintings.
- J 3. This hominid got its name because the first specimens were found with tools nearby.
- I 4. They made and used tools, were hunters, and were the first to use fire.
- D 5. Modern humans; they are believed to be the first to use agriculture.
- L 6. This archaic human was similar to *H. erectus* but had thinner skull bones and a different brow ridge.
- A 7. The best example of this species is a fossil of a female nicknamed Lucy, dated to be 3.18 million years old.
- B 8. Had a rounded skull, a larger brain capacity than *A. afarensis*, and a thumb similar to humans.
- C 9. Specimen consists of a mandible, upper jaw and the upper and lower parts of a tibia; has been dated at 4.1 million years old.
- F 10. Found by Tim White; believed to have been a 110 pound female; dated to be 4.4 million years old.
- H 11. Believed to be the ancestor of *Ar. ramidus*.

Multiple Choice

In the space provided, place the letter of the answer that best completes the sentence.

- B 1. The name *Homo habilis* means:
- A. human-like
 - B. handy human
 - C. ape-like
 - D. none of these
- D 2. Neanderthals are noted for:
- A. using simple tools
 - B. walking upright
 - C. a large brain capacity
 - D. all of these
- B 3. A scientist who studies many types of fossils to learn about the Earth's history is a:
- A. geologist
 - B. paleontologist
 - C. physical anthropologist
 - D. paleoanthropologist
- C 4. A scientist who studies primarily human fossils is a(n):
- A. paleontologist
 - B. geologist
 - C. physical anthropologist
 - D. archaeologist
- A 5. *Homo erectus* appears to be much like modern man because:
- A. he had a brain capacity close to that of modern humans
 - B. he was as large as modern humans
 - C. he had a much smaller brain capacity
 - D. none of these
- D 6. *Homo erectus* also shows intelligence because:
- A. he used fire
 - B. he made and used simple tools
 - C. he used agriculture
 - D. both A and B
- B 7. The hominids are believed to have been bipedal. This means:
- A. they were able to do two things at once
 - B. they walked on two legs
 - C. they walked on four legs
 - D. none of these
- A 8. Humans, along with apes and several other creatures are placed in the order:
- A. primates
 - B. animalia
 - C. diptera
 - D. isoptera

- C 9. *A. africanus* is different from *A. afarensis* because:
- A. he is believed to have had legs like humans
 - B. he wore animal skins
 - C. he had larger, more rounded skull
 - D. both A and C
- B 10. *A. anamensis* is considered a hominid by its discoverer because:
- A. she found a complete skeleton
 - B. the mandible she found appeared ape-like, but the tibia she found demonstrated bipedalism
 - C. both the mandible and the tibia appeared to be similar to humans
 - D. she found forty per cent of the fossil
- B 11. Archaic humans are classified as such because:
- A. they are dated to be very old.
 - B. their facial features are different.
 - C. their brain capacity is small.
 - D. they were small in stature.
- A 12. In general hominids are:
- A. considered bipedal but retain some ape-like characteristics
 - B. very easy to find.
 - C. considered neither ape-like nor human-like
 - D. none of these

True and False

If, according to the text, the statement is true, circle T. If it is false, circle F and then change the underlined word to correct the statement in the space provided.

- T 1. Paleontologists and physical anthropologists all study fossils.
-
- T 2. Broca's area of *H. heidelbergensis* indicates it may have used language.
-
- F 3. Evolutionists believe the earliest known hominids belong to the genus Homo.
Australopithecus
-
- T 4. *A. afarensis* was dated using both the geologic time scale and radiometric dating.
-

T 5. Evolutionists generally believe bipedalism came before an increase in brain capacity.

F 6. *A. africanus* is believed to have lived in groups and eaten vegetables.
meat

F 7. The first-discovered specimen of *Homo erectus* is also called Timor Man.
Java Man

T 8. Several specimens have been found of *Homo erectus*.

F 9. The agricultural revolution is believed to have taken place around 50,000 years ago.
11,000

F 10. *Homo erectus* was believed to have begun the agricultural revolution.
Homo sapiens

Short Answers

Answer the following in complete sentences. Points are listed.

1. What is a link fossil? Define and give an example, explaining why it is considered a link fossil. (2 points)

A link fossil is an intermediate organism between two different species. Any example such as *Archaeopteryx* or coelacanth will do. However, they must explain that it possesses some characteristics of both species of which it is an intermediate.

2. What hampers evolutionary scientists in their search for information on human origins? (4 points)

Scientists are hampered in the field of human evolution by the lack of evidence. First of all, there are only a few hundred fossils and some related information such as the Lake Laetoli footprints of East Africa. Often, only a few pieces of a given fossil are found.

3. Who is believed to have started the agricultural revolution and what effect is it thought to have had on man? (2 points)

Modern man (*Homo sapiens*) is thought to have started the agricultural revolution. It is believed that this enabled him to settle down and specialize more in his labor. Also, it is believed the human population began to grow more rapidly at this time.

4. Contrast the “out of Africa” model with the “multi-regional model.” (4 points)

Proponents of the “multi-regional model” state that groups of *Homo erectus* left Africa and dispersed into many areas of the old world; then each group fathered a line that gave rise to modern humans. There would have been some intermixing of these groups that would have maintained their basic “human” similarities. The second theory, called the “out of Africa” or “single origin” model, states that modern humans evolved in Africa and then came out of the continent and replaced other, less-evolved hominids that had left Africa at an earlier time.

Relativism

Perhaps the greatest challenge you will have in teaching your student(s) about origins is to overcome their acceptance of the relativism that pervades our society. This is especially true if your student(s) have spent any time in a public school and heard evolution taught with deep conviction by their teachers. Many teens have trouble separating fact from theory. It is often difficult for them to think in terms of fact versus opinion in reference to science. Thus, it is well worth the time to have a discussion about the difference between fact and opinion.

Start by asking your student(s) to answer the questions on the next page and give reasons for their position. These should be written answers without your guidance. Save at least twenty minutes for a general discussion of the answers. Use your discussion to help your student(s) to differentiate between fact and opinion and to understand that truth—even scientific truth—is not decided by majority opinion.

The best place to have this discussion is just before you introduce creationism in Chapter 4.

Chapter 4

Suggestions for Beginning

Begin this chapter by showing your student(s) a picture of Miller's experimental apparatus shown in Chapter 4. Explain the purpose of each part of the apparatus, except for the trap. When you come to this part, ask them the following questions.

1. Why do you think the trap is there? (One good suggestion may be that the trap is there to collect the amino acids and examine them. This is one purpose.)
2. However, tell him there is another important reason. Ask your student what he thinks would happen if the amino acids were allowed to continue through the spark chamber again?
3. After discussing some suggestions, Read the following quotation from *Of Pandas and People* (p.4). Read it aloud. Then allow further discussion.

When a chemist exposes a mix of chemicals to heat or electricity, some compounds may form but others will break down. Since the process of destruction is actually more likely to occur, the net result will be only a small amount of chemical compounds. Those that do form will generally be simple ones, since any complex molecules that might form would quickly break back down to their simpler components.

Guide your student(s) to an understanding that the spark chamber would be destructive to the compounds after they formed.

4. Ask for suggestions as to where the trap could be in nature. Your student(s) may suggest the ocean or a lake or stream. Accept any seemingly reasonable suggestion. Then inform your student that Chapter 4 is going to deal with this question.

Sections Question Key

Sections One and Two: Redi & Pasteur

1. Name the first individual to challenge the theory of spontaneous generation and describe his second experiment.

Francisco Redi was the first to challenge the theory of spontaneous generation. He filled two sets of four jars with pieces of eel, veal, fish, and snake. He left the first set of jars uncovered, while he placed a fine mesh over the second. Flies could and did enter the uncovered jars but not the mesh-covered ones. After a few days maggots appeared in the uncovered jars, but they never appeared in the covered ones. Redi concluded that maggots came from fly eggs and were not spontaneously generated.

2. Who finally settled the question of spontaneous generation once and for all? Describe his laboratory experiment.

Louis Pasteur finally settled the question. He took a number of flasks and filled them with broth. Then he heated the neck of each flask and bent it into an “s” shape so that air could enter the flask but dust would be trapped in the curve of the “s.” Then Pasteur boiled the broth in each flask to kill any microorganisms present in it. After several days he observed no microorganisms in the broth. They appeared in a flask only after he tilted it and allowed the dust trapped in the neck to mingle with the broth. Pasteur concluded that microorganisms do not arise spontaneously but are carried on dust particles in the air.

3. Briefly state the principle that came out of this research.

The principle of biogenesis came out of this research. It states that living things can arise only from other living things.

Section Three: In the Beginning

1. Why does the absence of a trap in nature cause problems?

The trap is necessary to protect the amino acids from the energy that formed them. Otherwise they will break down again into simpler substances.

2. Why does the presence of other products in the experiment create problems?

The amino acids would be more likely to combine with the other products in cross reactions rather than combining with each other to form proteins.

3. *If amino acids could somehow be isolated from the other experimental products, why couldn't they spontaneously form proteins?*

Without enzymes and other factors to control protein production, proteins do not form.

Section Four: Additional Problems

1. *Why does the spontaneous production of both right- and left-handed amino acids create a problem for the production of proteins?*

Nature produces both varieties, but living things use only left-handed amino acids. If even one right-handed amino acid gets into a protein, it will not function. Also, DNA and RNA use only right-handed sugars. The question is who did the sorting in nature?

2. *What does the exclusive use of left-handed amino acids and right-handed sugars in living things indicate?*

It indicates the action of an intelligent being who set up the "sorting mechanism".

3. *Why would it be difficult for DNA and protein to evolve separately and independently?*

DNA is necessary to guide the production of proteins, but there must also be pre-existing protein for the formation of DNA.

4. *Why would it have been necessary for all the organelles to have been in the first cell?*

Many of the cell's organelles are mutually dependent on one another for their purpose.

Section Five: Photosynthesis

1. *Briefly describe the structure and function of the parts of a chloroplast.*

A chloroplast is an organelle within the leaves of green plants. Within the chloroplast are small structures called grana that contain chlorophyll. The grana absorb light energy that is used in a very complex series of reactions that produce glucose and release O₂ and water and send other products to the second phase of photosynthesis.

2. *What is important about the reactants and the products of the two phases?*

Each phase is dependent on the products of the other. Since one phase has no purpose or means of functioning without the other, both had to be present and operating in the first photosynthetic cell.

3. *What is the role of enzymes in the 2nd phase?*

By lowering the amount of activation energy required, enzymes permit reactions that otherwise would take place too slowly. In fact, it is because of enzymes that the activities within living things can proceed. Enzymes solve the problem of molecules being destroyed by the energy needed to combine them.

Section Six: A Reducing Atmosphere

1. *What is a reducing atmosphere and why was it necessary in order for spontaneous generation to occur?*

A reducing atmosphere is necessary because organic molecules will not react with each other to form the components of living things if they are exposed to free oxygen. Instead, they combine with the free oxygen to form other compounds.

2. *What have geologists found that indicates the early atmosphere did contain free oxygen?*

Iron oxide (and other highly oxidized minerals) within very deep layers of rock points to the presence of free oxygen at the time when the iron within the rock was being deposited. This evidence would indicate that the early Earth's atmosphere did contain free oxygen, making it impossible for life to have arisen spontaneously.

Section 1

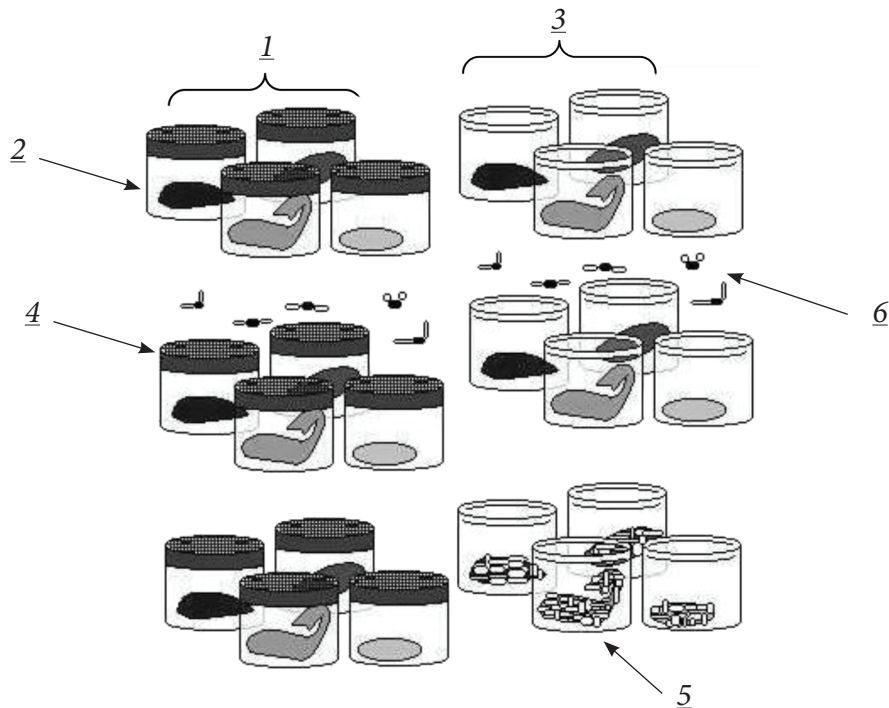
Francisco Redi

Below is a picture of the equipment used in Francisco Redi's second experiment. Label the different items for which there is a number. (Use the terms listed below.) Then briefly describe the experiment and how it helped to disprove spontaneous generation.

1. experimental jars
2. rotten meat

3. control jars
4. cloth covering

5. maggots
6. flies



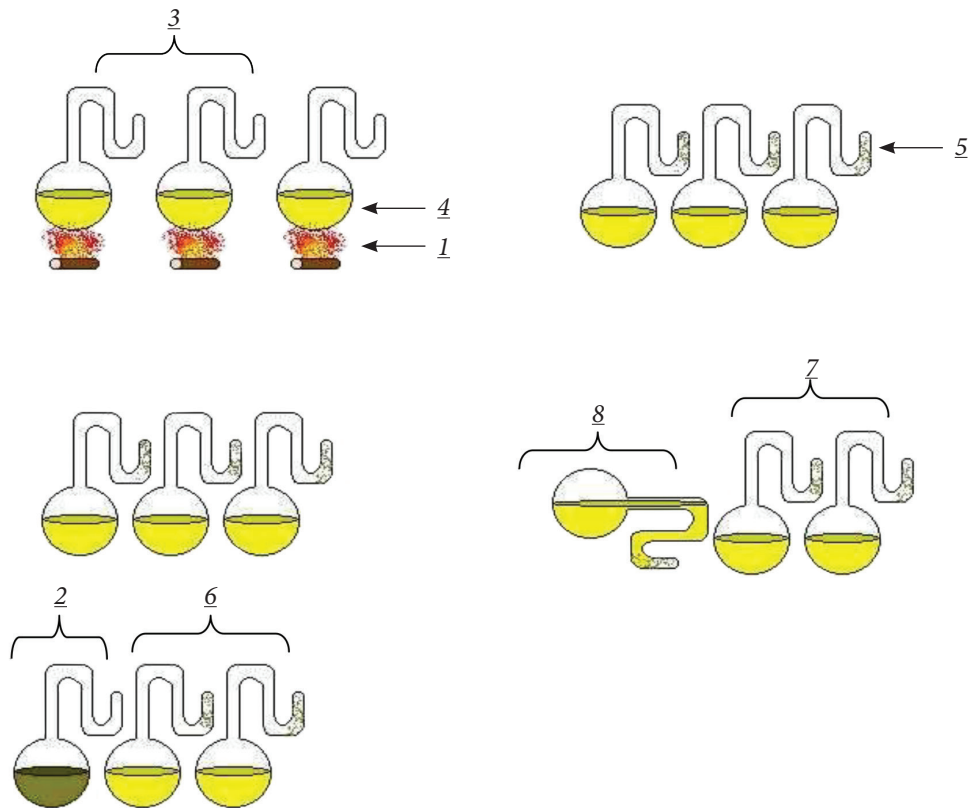
In Redi's second experiment, he put rotten meat in several jars and covered half of them with gauze, flies could get in the uncovered jars only. After several days, the meat in the uncovered jars had maggots. The meat in the covered jars never developed maggots. This showed that the maggots were caused by flies laying eggs on the meat rather than the maggots spontaneously generating from the rotten meat.

Section 2

Louis Pasteur

Below is a picture of Louis Pasteur's famous experiment disproving spontaneous generation of microorganisms. Please label the picture, using the terms listed below. Then give a brief synopsis of the experiment itself on the lines below. Use the numbers of the terms on the drawing.

- | | | |
|---|--------------------|---|
| 1. fire | 4. broth | 7. control flasks—second part of experiment |
| 2. spoiled broth | 5. dust | 8. experimental flask—second part of experiment |
| 3. experimental flasks—first part of experiment | 6. unspoiled broth | |



Pasteur took several flasks, bent the necks into an S- shape, and filled them with broth. He then boiled the broth to kill all the microorganisms. The flasks allowed air to enter, but the dust in the air was trapped in the neck. No microorganisms formed in the broth, except in one flask that he tipped to allow the dust to mix with the broth.

Section 3

In the Beginning

Correctly use the following words to fill in the blanks below.

catalysts	proteins	ocean
compounds	combine	stumbling block
cell	failed	isolated
Stanley Miller	ultraviolet rays	theory
destroyed	prevented	upper
dissolve	trap	pre-existing
form	cross reactions	
Alexander Oparin	nature	

In the early part of the twentieth century a man named Alexander Oparin developed a theory about how the first cell could have formed. However, he failed to consider several things. This became apparent when Stanley Miller conducted his famous experiment. First of all, Miller's apparatus had a trap to protect the amino acids that formed from being destroyed by the energy that produced them. There is no trap in nature. The ocean could not serve as one because ultraviolet rays penetrate water.

Another theory was that the sun's ultraviolet rays could have provided the energy to form amino acids in the upper atmosphere. However, the UV rays would also break them down again, even if they reached the ocean. Thus, the absence of a trap is a major stumbling block to spontaneous generation.

It is much more difficult to see how proteins could have formed from amino acids even if an organic soup were created. Miller's experiment produced many other compounds besides amino acids. The amino acids would have been much more likely to combine with these other substances than with each other. These cross reactions would have prevented the spontaneous formation of proteins.

In addition, if the amino acids were somehow isolated from the other products of the organic soup, proteins still would not form. Water is the last place any organic chemist would try to make proteins, because water drives the reaction in the opposite direction. In addition to many other agents, enzymes are necessary for proteins to form. Without enzymes to act as catalysts, proteins cannot be produced. Since enzymes are also proteins, this means it takes pre-existing proteins to make other proteins.

Section 4

Additional Problems

Fill in the blanks by unscrambling the words beneath them.

One of the major problems with Oparin's theory is one of interdependence.

A true cell must have DNA in its nucleus in order to direct its activities and NAD tiacsivtie

replication. However, before DNA can be formed, there must be pre-existing proteins

which are necessary in its production. On the other hand, in order for a protein to
doorpitcun

be formed, there must be DNA to guide its formation.

In much the same way, the cell's individual organelles are dependent upon

each other for their purpose.

A third problem is that of uniform orientation. When amino acids

were formed in Miller's experiment, they were produced in two types, left-handed
tefl-dedanh

and *right-handed*. Yet living things use exclusively *left-handed* amino acids.
thirg-naddeh telf-dedanh

On the other hand, living things use only right-handed sugars. Who did the sorting in
thirg-naddeh

nature? Each of these problems points to the need of an intelligent designer
teligenint gerndesi

guiding the development of the first cell.

Sections 5 & 6

Photosynthesis and a Reducing Atmosphere

*I. In the spaces below put the term that best suits the statement following it.
One answer will be used twice.*

<u>Photosynthesis</u>	1. The two phases of this process produce O ₂ and carbohydrates.
<u>Grana</u>	2. The small structures within the chloroplast; hold chlorophyll.
<u>Oxygen & water</u>	3. These are released into the atmosphere during photosynthesis' 1st phase.
<u>Grana</u>	4. These absorb light energy.
<u>NADPH₂ & ATP</u>	5. Products of photosynthesis' 1st phase; used in 2nd phase.
<u>NADP & ADP</u>	6. Products of photosynthesis' 2nd phase; used in 1st phase.
<u>Calvin-Benson</u>	7. In this cycle enzymes use energy from ATP, together with NADPH ₂ and CO ₂ and water from the air, to make simple carbohydrate molecules.
<u>Enzymes</u>	8. Specialized proteins needed for highly specialized jobs in this process.
<u>Reducing atmosphere</u>	9. This would have little or no oxygen.
<u>Iron oxide</u>	10. This has been found in deep layers of rock; points to the presence of free oxygen in the atmosphere when the rock was being deposited.
<u>Free oxygen</u>	11. This makes spontaneous generation of life on earth impossible.

Short answer

Answer the following questions in complete sentences.

1. What important fact about the two phases of photosynthesis make the process an important piece of evidence against evolution?

Each phase is dependent on the products of the other. Since one phase has no purpose or means of functioning without the other, both had to be present and operating in the first photosynthetic cell.

2. What is the role of enzymes in the 2nd phase?

Enzymes lower the amount of activation energy required and thus permit reactions that would otherwise take place too slowly. They solve the problem of molecules being destroyed by the energy needed to combine them.

3. What important fact about enzymes also make them strong evidence against evolution?

Photosynthetic enzymes are very complex; they perform highly specific jobs. How could these enzymes evolve? Without the photosynthetic process in place and function, there is no purpose for them. They have no function apart from photosynthesis.

4. What further statement did Clemmey and Badham make that also reduces the possibility of a reducing atmosphere on the early earth?

Clemmey and Badham explained, "Earth's aerobic and anaerobic environments are mutually sustaining; failure to acquire one would have resulted in failure of the other." In other words, one can't exist without the other. So how did they both evolve?

Group Activity Guide

Spontaneous Generation

The aim of this activity is to demonstrate how impossible it would be for nature's use of exclusively left-handed amino acids and right-handed sugars to have occurred by blind chance. I selected poker chips simply because they are easily and cheaply obtained. You can also use marbles or make some cardboard examples of left-handed and right-handed amino acids. The only prerequisite is that each piece be identical except in color. They especially must **feel** the same.

Group Activity

Blind Chance

Background:

Evolutionists will tell you that every living thing that exists on the Earth is a result of “blind chance.” They believe every protein that makes up these living things also came about in the same way. You have read that when Miller did his first experiment, he discovered that left- and right-handed forms of the different amino acids were produced in a roughly fifty/fifty ratio, as expected from chemical laws. Left-handed and right-handed amino acids are mirror images of each other. Yet living things use only left-handed amino acids. The opposite is true with sugars. Although sugars occur in both left- and right-handed forms, nature uses only right-handed sugars.

Could nature have come upon this system by chance? Today, we are going to try an experiment to see if “blind chance” is that effective. In this experiment you will be using poker chips to represent amino acids. Choose one color to represent left-handed and the other color to represent right-handed amino acids. With these “amino acids” you will be building a “protein” of only twenty amino acids.

Materials:

- ▶ twenty each of two different colored poker chips, well mixed up in a flat container **These chips must be identical in every way except for color.** One color will represent left-handed and one color will represent right-handed amino acids.
- ▶ material for an **effective** blindfold
- ▶ small container containing at least 15 **extra** chips of each color
- ▶ smaller, empty container to hold the amino acids of your “protein”
- ▶ scientific calculator

Procedure:

1. Choose one member of your group. This person must be willing to be totally blindfolded. Do a good job of covering his or her eyes. **NO PEEKING!**
2. Count the number of each color of chips in your flat container; make sure there are twenty of each color. Mix them up thoroughly.
3. Have your blindfolded student reach into the container and pick a chip. **Do not tell him what color he has chosen.**
4. Take the chip from him and place it in the smaller, **empty** “protein” container and set it aside.
5. **Then, before he has a chance to pick another chip,** replace the chip taken from the flat container with a chip of the same color from your supply of **extras**. You will now have twenty of each chip once again. Mix the chips thoroughly and have your blindfolded student choose another chip.

6. Place that chip in the protein container also, and then repeat the procedure until your student has chosen twenty chips from the large container. **Remember to place another chip of the same color in the large container each time one is chosen.**

Questions:

1. What does your blindfolded student represent?

Blind Chance

2. Did the two of you produce a “protein” of entirely one color of chip?

It is possible but rarely happens.

Actually, it is possible to do this, or at least to come close. Over a short number of tries, it is possible to pick the same color, just as you might flip a coin and have it land on “heads” several times in a row. However, even with only twenty tries, there are usually at least one or two chips of a different color. **NOTE:** The odds of picking a particular color on the first draw were 50/50 or 1 in 2. Each time the blindfolded person takes another chip from the container, **the odds against his drawing the same color double.** So the odds against drawing the same color two times in a row become 1 in 4 (2×2), and the odds against drawing the same color three times in a row become 1 in 8 ($2 \times 2 \times 2$). (Hint: if you are using a calculator, you would multiply 2 to the third power.)

Answer the following questions, using your calculator wherever necessary.

3. What are the odds against his drawing the same color:

5 times in a row?	<u>1 in 32</u>
10 times in row?	<u>1 in 1024</u>
15 times in a row?	<u>1 in 32,768</u>
20 times in a row?	<u>1 in 1,048,576</u>

4. As you can see, the odds were pretty much stacked against your choosing a mere 20 of the same color chips in a row. In a sense, choosing only chips of the same color is like picking only left-handed amino acids out of a large mixture of both left- and right-handed amino acids. *However, a protein of 100 amino acid units is considered small.* Calculate the odds against blind chance picking 100 left-handed amino acids out of a “soup” consisting of equal amounts of both right- and left-handed amino acids. Write as many numbers as your calculator is capable of giving you, or perhaps you might write it in terms of powers.

The odds of randomly picking 100 left-handed amino acids out of a “soup” are 1 in 2^{100} or 1 in 1.2676506×10^{30} .

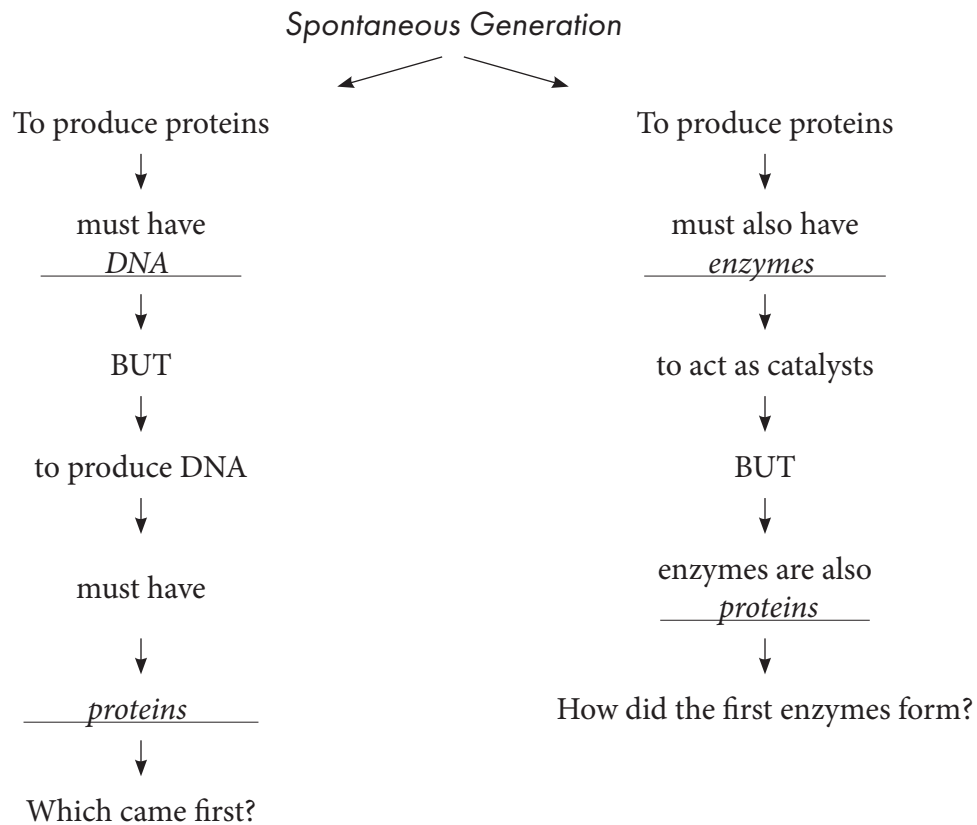
Bear in mind that production of a specific protein also requires the left-handed forms of several of 19 out of the 20 different amino acids hooked together in a highly specified way.

5. According to your text, what happens to a protein if even one incorrect amino acid is inserted into it?

The protein’s ability to function is reduced, generally completely.

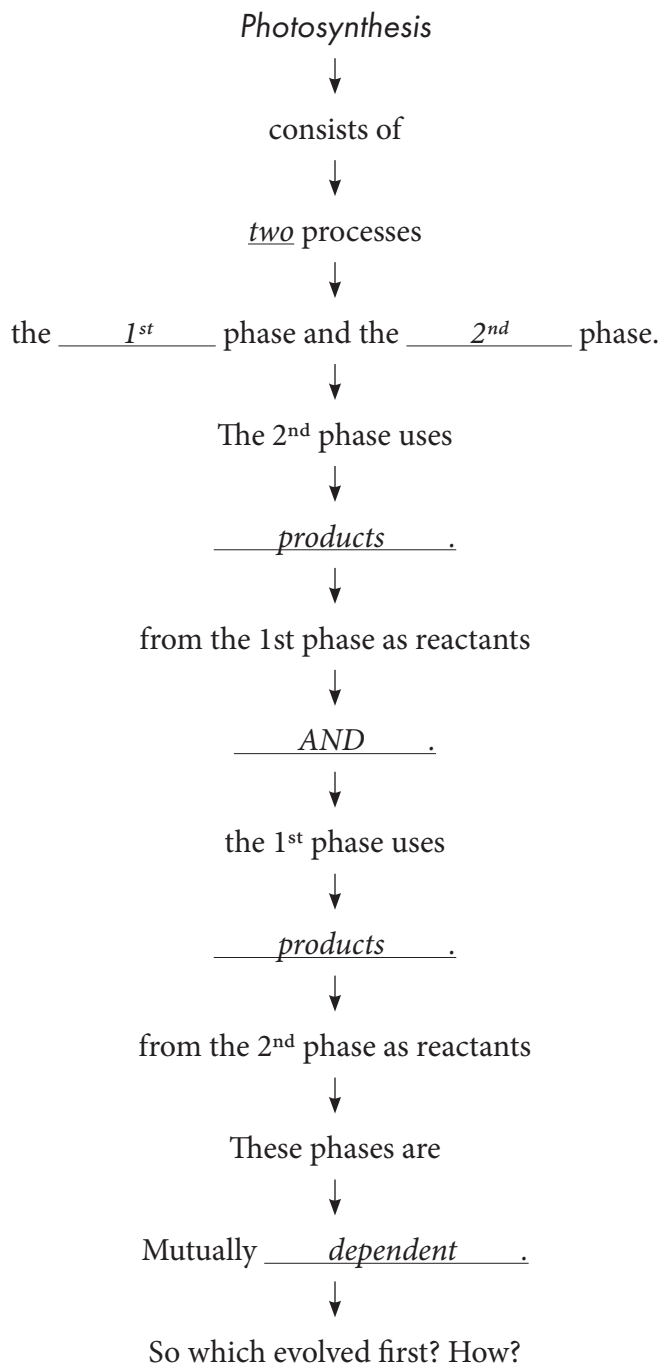
Concept Map One

Spontaneous Generation

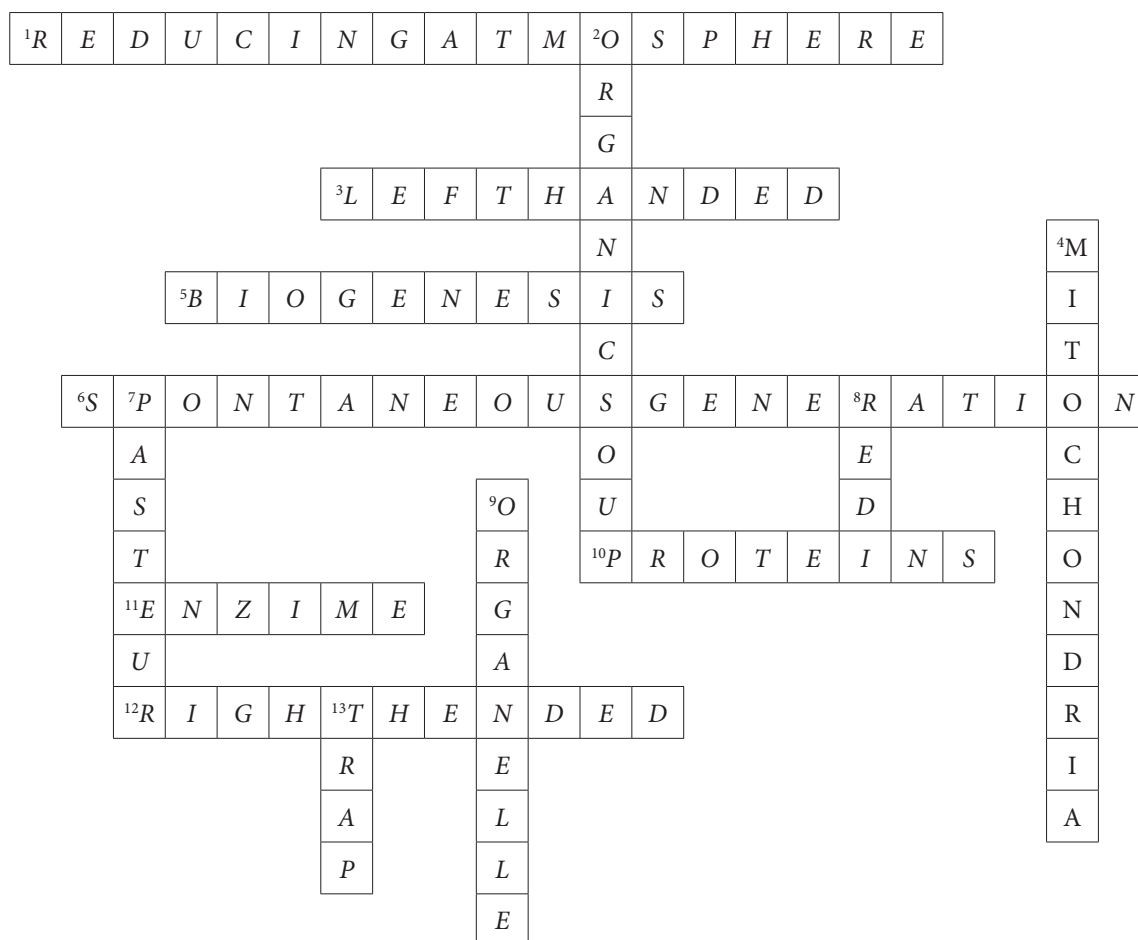


Concept Map Two

Spontaneous Generation



Vocabulary Crossword Puzzle



Across

- Oparin said the early Earth had this. (*Two words*)
- These are the only kind of amino acids living things use. (*Two words*)
- This states that all living things must come from other living things: the principle of?
- This has been disproved by science. (*Two words*)
- These cannot spontaneously arise from amino acids.
- Besides energy, this must be present for amino acids to combine into proteins.
- These are the only kind of sugars living things use. (*Two words*)

Down

- This is supposed to have been where the first cell was formed. (*Two words*)
- The powerhouses of the eukaryotic cell.
- The French scientist who disproved the spontaneous generation of microorganisms.
- The Italian scientist who disproved spontaneous generation of maggots from rotten meat.
- A structure that performs a specific function within a cell.
- Miller's experiment had this; nature does not.

Review

Modified True and False

If, according to the text, the statement is true, circle T. If it is false, circle F and then change the underlined word to correct the statement in the space provided.

- F 1. Francisco Redi was a French scientist who disproved the spontaneous generation of microorganisms.

Pasteur

- T 2. The principle of biogenesis states that living things can come only from other living things.

- F 3. Stanley Miller developed a theory about how the first cell could have spontaneously developed.

Oparin

- F 4. Proteins have arisen spontaneously from amino acids in experiments.

have not

- F 5. Amino acids are more likely to combine with other amino acids.

other products

- T 6. Without enzymes to act as catalysts, proteins do not form.

- F 7. Living things use only right-handed amino acids.

left-handed

- T 8. Living things use only right-handed sugars.

- T 9. The cell's individual organelles have no purpose without the presence of the other organelles.

F 10. Miller's experiment produced only left-handed amino acids.

both left & right-handed

T 11. The two phases of photosynthesis are mutually dependent on one another.

F 12. The chemical reactions necessary to form proteins occur easily.

do not occur

T 13. A reducing atmosphere would have little or no free oxygen.

T 14. The 2nd phase of photosynthesis requires several enzymes.

F 15. Organic molecules will react with each other in the presence of free oxygen.

will not

F 16. Photosynthesis is a relatively simple process.

very complicated

F 17. Louis Pasteur was an Italian scientist who proved that maggots could not arise spontaneously from rotten meat.

Redi

Short Answers

*Answer the following questions with complete sentences
(with the exception of number 3).*

1. Describe Redi's second experiment

In Redi's second experiment, he put rotten meat in several jars and covered half of them with gauze. Flies could get in the uncovered jars only. After several days, the meat in the uncovered jars had maggots. The meat in the covered jars never developed maggots. This showed that the maggots were caused by flies laying eggs on the meat rather than the maggots spontaneously generating from the rotten meat.

2. How did Pasteur disprove spontaneous generation of microorganisms?

Pasteur took several flasks, bent the necks into an S- shape, and filled them with broth. He then boiled the broth to kill all the microorganisms. The flasks allowed air to enter, but the dust in the air was trapped in the neck. No microorganisms formed in the broth, except in one flask that he tipped to allow the dust to mix with the broth. Thus he showed that microorganisms do not arise spontaneously but are carried on the dust in the air.

3. What did Stanley Miller's experimental apparatus contain that is absent in nature?

A trap

4. Why is this (see #3) so important?

Without a trap to protect the amino acids, they will be destroyed by the energy that created them.

5. Give two reasons why it would be impossible for proteins to arise spontaneously in Oparin's "organic soup".

A. The amino acids would be more likely to combine with other products in the soup than with each other.

B. The UV rays of the sun would destroy them.

C. Water prevents amino acids joining up.

6. What important fact about DNA and proteins makes it impossible for them to have evolved independently?

Proteins must have DNA to guide their formation and proteins are necessary for the production of DNA.

7. What important fact about the organelles of the cell makes it impossible for them to have evolved independently?

The organelles are mutually dependent on each other for their purpose. The cell is an irreducibly complex structure.

8. What does nature's use of only left-handed amino acids and right-handed sugars indicate?

An intelligent designer

9. Why couldn't photosynthesis have easily evolved?

It is an extremely complicated process with its two phases mutually dependent upon one another.

10. What does the presence of oxidized iron in very old rocks indicate, and why is this important?

It indicates the presence of free oxygen when the rocks were formed. This is important because amino acids could not have spontaneously formed in the presence of free oxygen.

Test

Multiple Choice

Place the letter in the space provided that best completes the sentence. Each question is worth one point.

- B 1. Louis Pasteur helped to disprove spontaneous generation by:
- A. showing that maggots could not arise spontaneously from rotten meat
 - B. demonstrating that microorganisms could not arise spontaneously
 - C. testing Oparin's theory
 - D. none of these
- C 2. Francisco Redi helped to disprove spontaneous generation by:
- A. Boiling beef broth in a jar
 - B. performing an experiment on amino acids
 - C. showing that maggots could not arise spontaneously from rotten meat
 - D. helping Stanley Miller test Oparin's theory
- D 3. In the experiment on rotten meat, maggots formed
- A. in all the jars
 - B. in none of the jars
 - C. in the covered jars only
 - D. in the uncovered jars only
- A 4. In the experiment on beef broth, microorganisms formed
- A. only in the flasks contaminated by dust
 - B. in all the flasks
 - C. in none of the flasks
 - D. only in the flasks uncontaminated by dust
- A 5. "Living things can come only from other living things" is
- A. the principle of biogenesis
 - B. the second law of thermodynamics
 - C. a description of spontaneous generation
 - D. none of these
- D 6. Oparin's theory:
- A. attempted to explain the principle of biogenesis
 - B. attempted to explain Stanley Miller's experiment
 - C. took into account all the chemical processes of life
 - D. attempted to explain how spontaneous generation of the first cell could take place

- C 7. Stanley Miller attempted to test Oparin's theory, but the experimental apparatus contained one thing not present in nature. This was:
- A. a condenser
 - B. an energy source
 - C. a trap
 - D. a heat source
- D 8. The ocean could not protect amino acids because
- A. the sun's ultraviolet rays could still destroy them
 - B. other chemicals would destroy them
 - C. neither of these
 - D. both A and B
- B 9. In order to form proteins from amino acids _____ are absolutely necessary.
- A. lactic acids
 - B. enzymes
 - C. UV rays
 - D. none of these
- A 10. Enzymes are:
- A. proteins
 - B. sugars
 - C. inorganic molecules
 - D. proteinoids
- B 11. One major difficulty with Miller's experiment is that it
- A. had no available heat source
 - B. produced a great deal of other compounds besides amino acids
 - C. had no way to turn the gases back into liquids
 - D. produced only left-handed amino acids
- B 12. In an organic soup the amino acids would be more likely to combine with
- A. other amino acids
 - B. other substances
 - C. proteins
 - D. none of these
- D 13. Nature uses exclusively:
- A. right-handed sugars
 - B. left-handed amino acids
 - C. left- and right-handed amino acids
 - D. both A and B
- D 14. Photosynthesis could not evolve because:
- A. It has one phase that is very complicated
 - B. It has two phases which are mutually dependent on one another
 - C. both its phases are very complicated
 - D. both B and C

- C 15. Without a trap, amino acids that were produced would:
- A. combine to form proteins
 - B. combine with other substances
 - C. be destroyed by the energy that formed them
 - D. be unaffected
- A 16. Oparin's theory stated that the early Earth had a reducing atmosphere. This was absolutely necessary because:
- A. Organic molecules will not combine in the presence of free oxygen
 - B. DNA requires free oxygen in order to combine
 - C. the organic soup had to be protected from the sun's UV rays
 - D. water vapor was not important to his theory

Matching

Use the letters below to fill in the space provided. (One point each)

- | | | |
|--------------------------|----------------------------|---------------------------|
| A. A reducing atmosphere | E. Organelles | I. Proteins |
| B. Amino acids | F. Organic soup | J. Right-handed |
| C. Left-handed | G. Photosynthesis | K. Spontaneous generation |
| D. Mitochondria | H. Principle of biogenesis | L. Trap |

- E 1. Structures that perform specific functions within the cell.
- D 2. The powerhouses of eukaryotic cells.
- K 3. Living things arising from non-living compounds.
- L 4. A structure to protect amino acids from energy.
- J 5. The only kind of sugars living things use.
- C 6. The only kind of amino acids living things use.
- F 7. The first cell is supposed to have formed in this.
- I 8. These have never been spontaneously produced in a laboratory experiment.
- A 9. This contains little or no oxygen.
- H 10. This states that living things can come only from other living things.
- B 11. These were one of the products in Miller's experiment.
- G 12. This is a very complicated process; scientists can offer no explanation of how it could have evolved.

Essay Questions

Answer the following questions with one or more complete sentences. Points vary per question.

1. What important fact about DNA and proteins makes it impossible for them to have evolved independently? (2 points)

Before DNA can be formed, there must be pre-existing protein which is necessary in its production. Likewise, before protein can form, there must be DNA present to guide its formation.

2. What does the presence of oxidized iron in very old rocks indicate, and why is this important? (2 points)

The presence of oxidized iron in precambrian rock indicates that there was free oxygen in the early Earth's atmosphere. If this is true, DNA could not have spontaneously formed

3. Give two reasons why it would be impossible for proteins to arise spontaneously from Oparin's "organic soup." (4 points)

A. Miller's experiment had a trap. Nature doesn't have one. Without a trap to protect them, the amino acids would have been broken down into simpler molecules again by the UV rays of the sun or dissolved by water.

B. Miller's experiment also produced non-biological amino acids and several other products. The amino acids would have been tied up in cross reactions with these and unable to combine as proteins.

4. Why couldn't photosynthesis have easily evolved? (2 points)

Photosynthesis is an extremely complex process involving two mutually interdependent phases. There is no explanation as to how each phase could have evolved separately and been present and functioning in the first cell.

Chapter 5

Suggestions for Beginning

Show a picture of Ernst Haeckel's drawings of embryos. Any secular high school biology textbook will have them. Or you may use the top half of Figure 5-1. Ask your student(s) the following questions and write his answers on a sheet of paper:

1. Do these drawings appear to give good evidence for evolution? Why?

Your student(s) will probably respond that they look alike, and appear to be much the same size, even though they are of widely different species.

2. What kind of facts would make this “evidence” seem false?

Spend some time discussing this with your student(s). Some of the things that should come up are as follows:

- A. The drawings being false
- B. The sizes of the embryos being different
- C. The shapes of the embryos being different
- D. The parts of the embryos growing into different things as adults

Explain to your student(s) that the true facts about comparative embryology will be explained to him in Chapter 5, along with information about the other so-called evidences for evolution.

Sections Question Key

Section One: Genetics

1. DNA has been described as highly compressed information. What problem does this create for evolutionists?

The DNA code communicates the information necessary to construct all the living organisms on the Earth. And this information is passed down with remarkable accuracy from generation to generation. This is the heart of the problem for many scientists who are not creationists but who recognize that information always has an intelligent origin. It does not arise randomly or spontaneously.

2. The presence of editing enzymes also presents a problem for evolutionists. What is it?

Since editing enzymes and DNA are interdependent, how could they have evolved separately? They must both be in place and functioning together from the beginning.

3. What is pleiotropy? How common is it?

Pleiotropy is the phenomenon of a gene affecting traits far removed from the one under its primary direction. For example, the gene for color in the house mouse affects the body size. In addition, the gene for eye color in the fruit fly also affects the sex organs. This phenomenon is species-specific and very common.

4. What did Hardy and Weinberg's research prove? Why is this a problem for evolutionists?

It showed that gene frequencies tend to remain stable over long periods of time. Evolution requires change on a large scale.

5. How many genetic mutations are believed not to be harmful? Are all of these beneficial?

Only one in one thousand genetic mutations is believed not to be harmful. Most of these are neutral, that is, neither harmful nor helpful.

6. It has been estimated that five beneficial genes would have to occur at the same time to cause a change in an organism. Why do some scientists think this makes it impossible for mutations to be the source of new genes for macroevolution?

Because the probability of one unharmed mutation is one in one thousand, the probability of five occurring at the same time in the same organism must be 1 in $1000 \times 1000 \times 1000 \times 1000 \times 1000$ or 1 in one thousand billion—effectively zero.

7. *To what does mutation generally lead—the gain or the loss of genetic information?*

The loss of pre-existing information.

8. *Name two other things mutation can cause.*

Mutations can sometimes be neutral or give occasional selective advantage. They can also result in genes “switching on” in the wrong places or even in the duplication of some genes. However, they do not add information; they do not add new genes. They merely alter existing ones.

Section Two: Comparative Embryology

1. *What did Ernst Haeckel do to create support for evolution?*

Haeckel published a series of forged drawings which made the embryos of several species look similar.

2. *What happened to his drawings?*

They disappeared for over twenty years, then reappeared in a comparative anatomy book. They have continued to show up in books teaching evolution since that time.

2. *Who discovered that there was something wrong with the drawings in current comparative anatomy books? How did he prove it?*

Dr. Michael Richardson, an embryologist and senior lecturer at St. George’s Medical School in London, made the discovery. He assembled a panel of scientists to study and photograph the embryos of species which Haeckel had drawn. The embryos were different in structure and size.

3. *Name two parts of the human embryo which evolutionists once thought were vestigial structures and describe their actual uses.*

A. The yolk sac—It produces red blood cells until the bone marrow develops and takes over the task.

B. The embryonic tail—It is simply the end of the spine before the legs begin to grow.

NOTE: Students may also point to the gill slits—These are really pharyngeal pouches that never grow into the respiratory system in humans as they do in fish. Instead, they develop into the palatine tonsils, the middle ear canals, the thymus, and the parathyroid glands. There are no openings in the pharyngeal pouches of humans as there are in fish! However, they are not considered vestigial.

Section Three: Comparative Homology

1. *What problem does the pentadactyl pattern in all four limbs of vertebrates pose for evolutionists?*

The forelimbs of land vertebrates supposedly developed from the pectoral fins of fish, while the hind legs (and human legs) supposedly developed from the pelvic fins. So why do they have identical patterns?

2. *What problem do evolutionists have with supposed homologous structures in embryos and in adults of the same species? Give one example of this.*

Often so-called homologous structures in adults come from non-homologous embryo parts. The reverse is also true. Often homologous parts of embryos develop into non-homologous adults parts. Any of the following examples:

A. The pharyngeal pouches in the fish embryo develop into its respiratory system; in the human embryo pharyngeal pouches develop into the palatine tonsils, the middle ear canals, the thymus and parathyroid glands.

B. The arms of man and the forelimbs of a newt and a lizard are considered homologous. Yet the forelimbs of the newt develop from trunk segments 2—5 of its embryo, while they develop from segments 6—9 of the lizard's embryo. In man, they develop from segments 13—18.

C. The kidneys in fish and amphibians develop from totally different embryonic tissue than the kidneys of reptiles and mammals. This phenomenon is also common in insects where there are many examples of homologous organs and structures that are developed in radically different ways.

3. *What problem do evolutionists have with homologous structures and the genes that control them?*

The genes controlling homologous structures are frequently found in different locations and on different chromosomes in various species.

4. *Why is pleiotropy a strong argument against homology?*

Pleiotropy is a strong argument against homology since it allows non-homologous genes to be involved in the expression of so-called homologous structures

Section Four: Comparative Biochemistry

1. *What problem does comparative biochemistry create for evolutionists?*

In comparing the cytochrome C of various species, it was found they fell into the same groups as they did when they were classified using more traditional methods. No species was intermediate to another.

Section Five: Examples of Evolution in Action

1. What do the examples of the peppered moth and the Galapagos finches actually demonstrate?

The peppered moth and the Galapagos finches simply demonstrate variations within genus and species caused by natural selection acting on the organisms' existing gene pool.

What Does the Evidence Show?

1. For what do each of the sciences mentioned above actually provide evidence?

They provide evidence for genetic stability and for clear and separate groups with variation within those groups only.

Section 1

The Scientific Facts—Genetics

Match the following terms with the statements describing them. One blank will require four answers.

- | | | |
|---------------------------|---------------------|------------------------|
| A. 5 beneficial mutations | F. Gene frequencies | K. Pleiotropy |
| B. Adenine | G. Guanine | L. Start & stop codons |
| C. Chromosomes | H. Genes | M. Thymine |
| D. Cytosine | I. Mutations | N. Watson & Crick |
| E. DNA | J. Nucleotide | O. Codon |

- L 1. The “punctuation” of DNA.
- J 2. This is made up of a base, a sugar molecule and a phosphate group.
- H 3. The “sentences” of DNA.
- C 4. These are composed of proteins and DNA.
- K 5. The phenomenon of a gene affecting more than one organ system.
- F 6. These tend to remain stable over long periods of time.
- A 7. The odds of this occurring in the same organism are one in one thousand billion.
- E 8. The “language” of life.
- I 9. Mistakes in the genetic code.
- N 10. They discovered the structure of DNA.
- B, D, G, M 11. The four bases of DNA.
- O 12. The “words” of DNA.

Short Answers

Answer the following questions in complete sentences.

1. How can DNA most accurately be described?

DNA is a great storehouse of integrated information—information that works together in a way not yet completely understood to create astounding uniqueness, even among the individuals of the same species.

2. What is pleiotropy? How common is it? Give an example.

Pleiotropy is the phenomenon of individual genes influencing more than one structure in an organism. It is very common and it is species specific. For example, the gene for coat color in the house mouse also affects body size. Mutations in the eye color of the fruit fly will also affect the shape of the sex organs.

3. What important fact about genetic stability did the Hardy–Weinberg Principle disclose?

Hardy and Weinberg pointed out that although a population's **gene frequencies** can be affected by outside influences, gene frequencies tend to remain stable over long periods of time. Populations are characterized by **genetic stability**.

4. What is the problem with mutations providing the genetic variety for evolution?

Mutations are overwhelmingly harmful (999 out of 1000). It is estimated it would take 5 favorable mutations to effect one change. The probability of 5 favorable mutations occurring in one organism's life cycle is effectively zero (1 in 1 trillion).

5. How is devolution primarily achieved—through the addition or loss of genetic information?

Devolution is achieved primarily through the loss of genetic information.

6. How must evolution be primarily achieved—through the addition or loss of genetic information?

Evolution must have the addition of massive amounts of genetic information in order to occur.

Section 2

Comparative Embryology

Use information from the text to fill in the blanks.

Evolutionists often cite information from comparative embryology as proof that evolution has occurred. Most biology books show pictures of embryos of different species drawn at the same stage of development (or synonym). These pictures look amazingly alike (or synonym). However, there is a major problem. These drawings are inaccurate (or synonym). They are the result of the fraudulent (or synonym) work of a man named Ernst Haeckel. He took drawings of the embryos of various species and altered (or synonym) them to make them look more alike (or synonym). When other scientists confronted him, he did not apologize or correct his work. The drawings disappeared for over twenty years then reappeared in a comparative anatomy book. Since that time, they have continued to be used, printed, etc. in books teaching evolution.

However, Michael Richardson, at that time an embryologist and teacher at St. George's Hospital in London, noticed something was wrong (or synonym). He assembled a panel of scientists to photograph embryos of the same species and at an age, stage, etc. comparable to that depicted by Haeckel. The embryos look remarkably different (or synonym).

It is also true that corresponding parts of embryos of different species often do not develop into similar (or synonym) body parts. For example, because of Haeckel's deception, the neck portion of the human embryo is still called gill slits. However, no slits are ever present in the human embryo. This area, more correctly called pharyngeal pouches, develops into the palatine tonsils, the middle ear canals, the thymus and the parathyroid glands.

Other parts of the human embryo have been compared to the embryos of different species. Scientists sometimes consider these parts vestigial (useless) because they do not play the same role in the human embryo. For example, the yolk sac has often been cited as vestigial in humans, a "leftover" part from our common ancestor with the birds. However, the yolk sac actually produces red blood cells until the bone marrow can take over this function. The so-called embryonic tail is nothing more than the end of the spine before the legs begin to grow. Comparative embryology gives little support to evolution.

Section 3

Comparative Homology

In the blanks at left, put an "X" next to the statements that agree with the book. Leave the other statements blank.

- ☒ 1. Homology is used selectively by evolutionists.
- ☐ 2. Evolutionists believe the arms and legs of man evolved from the pectoral fins of fish.
- ☒ 3. If evolution is true, man's arms and legs had to have evolved independently from two different types of fins to form structures with identical patterns.
- ☒ 4. The same pentadactyl pattern exists in the front and hind legs of many vertebrates.
- ☐ 5. Homologous parts of embryos always develop into the same types of structures in adults.
- ☒ 6. Structures which are considered homologous in adults of various species often develop from nonhomologous parts of their embryos.
- ☐ 7. The kidney in fish and amphibians develops from the same embryonic tissue as the kidneys of reptiles and mammals.
- ☒ 8. Homologous organs in insects are often developed in radically different ways.
- ☐ 9. The genes that control homologous structures are always found on the same chromosomes in different species.
- ☒ 10. Pleiotropy is an argument against evolution.
- ☒ 11. Because of the phenomenon of pleiotropy, non-homologous genes are involved in the expression of so-called homologous structures.
- ☒ 12. Evolutionists believe the hind legs of vertebrates (or man's legs) evolved from the pelvic fins of fish.
- ☐ 13. Evolutionists use hind legs as examples of homologous structures.
- ☒ 14. Charles Darwin defined homology as the "relationship between parts which results from their development from corresponding embryonic parts".
- ☐ 15. Using Darwin's definition, there appear to be many homologous structures.

Section 4

Comparative Biochemistry

Circle the term that correctly completes the sentence.

1. Comparative biochemistry is often mentioned as supporting (*evolution*,).
2. Cytochrome C is a protein involved in the production of (, *energy*).
3. Cytochrome C occurs in (, *many*) organisms.
4. Evolutionists point out that man's cytochrome C is (*close to*,) that of a monkey.
5. Other research has revealed that the different species could be classified using Cytochrome C, and they fell into (, *the same*) categories than they did using Linnaeus's method.
6. Indisputable transitional or intermediate classes are (, *completely absent*).
7. If all organisms evolved from bacteria, the percentage of difference in the Cytochrome C of bacteria and insects should be (, *smaller than*) the difference between the Cytochrome C of bacteria and humans.
8. In reality, the difference in the Cytochrome C of bacteria and insects is (*almost the same as*,) that of bacteria and humans.
9. According to cytochrome C research, (*no*,) species (*is*,) intermediate to others.

In the blanks provided, write in the percentage of difference between bacteria and the other organisms.

bacteria 65 human
 bacteria 64 bird
 bacteria 64 reptile
 bacteria 65 amphibian
 bacteria 66 jawless vertebrate

bacteria 64 fish
 bacteria 65 insect
 bacteria 67 plant
 bacteria 69 yeast

Section 5

Evolution Examples and What the Evidence Shows

I. The peppered moth and the Galapagos finches have an important thing in common. What is it?

The changes in the peppered moth and the Galapagos finch populations both demonstrate minor variations caused by natural selection acting on their existing gene pools. They remain moths and finches.

II. Why do creationists think genetics supports creation?

DNA is a language, complete with sentences, synonyms, and editors. Something this complex does not arise by accident. It is extremely accurate. Then there is pleiotropy which is the influence of a gene over structures not under their immediate control. How could this have evolved? The Hardy Weinberg research showed that gene frequencies tend to remain stable over long periods of time. Yet evolution requires a great deal of change. Mutations cause the loss of genetic information not its gain. Yet evolution requires the gain of massive amounts of genetic information.

III. For the following section you will need to look back at Chapter 2 as well as Chapter 4 to do the exercise. Following are the names of four "sciences" that evolutionists cite as support for evolution. Under the term, evolutionist, state briefly why they think it supports their position. Under the term, creationist, state briefly why creationists think it does not.

1. Comparative Embryology

Evolutionist

Evolutionists contended that the embryos of such species, in the early stages, show remarkable similarities in their structures. They felt this was evidence of a common ancestor.

Creationist

The embryos of different species generally do not look alike. They vary widely in size also. Often parts of the embryo that are similar grow into different structures in the adults.

2. Comparative Homology

Evolutionist

Some structures, such as the whale's front flippers, the dog's front legs and the human's arm and hands have the same basic pattern. Evolutionists believe this occurs because all of these creatures had a common ancestor with this bone pattern in its front limbs.

Creationist

Homologous parts of the embryos often do not develop into homologous parts of the adults of different species. Conversely, non-homologous parts of embryos often grow into so-called homologous structures in the adults. Also, homologous structures are often controlled by non-homologous genes.

3. Comparative Biochemistry***Evolutionist***

Evolutionary scientists have found that the cytochrome c of humans and monkeys differed by only one amino acid. In contrast, the cytochrome c of humans and turtles has 14 amino acids that differ. Evolutionists feel that this supports their theory that humans and other primates have a close evolutionary relationship, while humans and turtles do not.

Creationist

Research reveals that when the different species were classified using cytochrome C, they fell into the same distinct groupings as they did when they were classified using more traditional methods, such as that proposed by Linnaeus. "All sequences of each subclass are equally isolated from the members of another group. Traditional or intermediate classes are completely absent".

Group Activity

The DNA Code

DNA is the living blueprint that directs the development of all organisms. The purpose of this activity is to show a *simplified* model of how DNA and its messenger RNA work.

DNA is very similar to Morse code, which operates using a series of dots and dashes to represent letters. However, DNA uses groups of three bases. These are called triplets. Because there are four bases in DNA—cytosine, thymine, adenine, and guanine—there are 64 possible triplets—AAA, AGT, AGC, GTC, and so forth. These triplets are the “letters” of DNA. They are used to “write” out the instructions for creating the next generation. This replication is incredibly accurate. Nevertheless, mistakes can occasionally occur. However, the cell has specialized enzymes whose function is to “proofread” and repair these errors. Thus, the error rate is kept extremely low—only one per billion nucleotides. DNA triplets are also used to direct the production of the cell’s needed proteins from the twenty amino acids. During this second process, the double strands of DNA separate. Then each base on the DNA strand pairs up with its RNA partner (See Figure 1). Once all the RNA bases are in place and attached to each other, they separate from the DNA strand and move into the cell’s cytoplasm with the “written instructions” for making proteins out of amino acids. There are 64 possible triplets of RNA. These triplets are called *codons*. Below is a chart with each RNA base written on the top and on both sides. Use this information to write in each codon in the boxes given you. The first box has been done for you as an illustration. In determining the letters in each triplet, *start with the top row (marked 1st base), then the left side (marked 2nd base) and finally the right side (marked 3rd base).*

→ 1 st Base	G	A	U	C	3 rd Base
↓ 2 nd Base G 3 rd Base →	GGG GGA GGU GGC	AGG AGA AGU AGC	UGG UGA UGU UGC	CGG CGA CGU CGC	G A U C
A	GAG GAA GAU GAC	AAG AAA AAU AAC	UAG UAA UAU UAC	CAG CAA CAU CAC	G A U C
U	GUG GUA GUU GUC	AUG AUA AUU AUC	UUG UUA UUU UUC	CUG CUA CUU CUC	G A U C
C	GCG GCA GCU GCC	ACG ACA ACU ACC	UCG UCA UCU UCC	CCG CCA CCU CCC	G A U C

You have just written all the possible triplet combinations that code for amino acids. Some of these codons are “synonyms” which code for the same amino acid. Each amino acid has at least two triplet combinations that code for it. Some amino acids, such as leucine, have as many as six different triplets that are able to produce it. However, suppose we used only **half** the possible RNA triplet combinations and set them up to code for letters of the alphabet instead of amino acids. Then you would be able to use the DNA and RNA codes to translate a message from DNA to English. This is what you are going to do next.

Procedure:

1. Below is a DNA sequence. Using a pencil, break the sequence into triplets by putting a diagonal slash (/) after every three letters.

G C C/T T G/C C C/G G G/C T A/A A C/G G G/C C C/G G G/C T G/C C C/T A C/T A T/C C T
G T A/A T G/C A T/A A C/A G A/G G G/G T A/C T A/T A T/C T A/T T G/A C T/G G G/G T A
C C C/T T G/A C T/C A T/C C C/A C T/C C T/T G G

2. Use Figure 1 to “translate” the DNA into RNA (working from *left to right*). For example GCC in DNA code would “translate” into CGG in RNA code.

RNA code:

C G G/A A C/G G G/C C C/G A U/U U G/C C C/G G G/C C C/G A C/G G G/A U G/A U A/G G A
C A U/U A C/G U A/U U G/U C U/C C C/ C A U/G A U/A U A/G A U/A A C/U G A/C C C/C A U
G G G/A A C/ U G A/G U A/G G G/U G A/G G A/A C C

3. Use the information in Figure 2 to “translate” the RNA into English. Do this by finding the first letter of the triplet across the top of the chart. For example, if the mRNA codon is CGG, the C indicates that the English letter they want is in the fourth column.

4. Next, find the second letter of the codon on the left side of the chart. For example with CGG, the G tells you that the English letter is in the first row. You now know that the letter you want is in the fourth column of the second row.

5. Finally, use the last G of CGG and go to the right of the chart to tell you which letter you need from that box. In this case, the letter is “D.” Thus, the DNA triplet, CGG is translated here to mean “D.”

6. Put the English translation of the RNA triplet code (from #2) on the lines below.

DNA is a marvelous, living language.

IF ENOUGH TIME REMAINS, DO THE FOLLOWING:

7. Now that you have “deciphered” the DNA code, reverse the process. Write a simple sentence in English *on a separate sheet of paper*.

8. Use *Figure 2 (next page)* to “translate” the English letters of your sentence into the RNA code. Put your RNA code on the paper with your English sentence.

9. Finally, use *Figure 1 (next page)* and work from right to left to “translate” the RNA code into the DNA code on the lines below on this page. Once you have completed this translation, hand your lab to your parent/teacher and have him translate the message you have written, using the same method you used. Then compare your answer to his.

DNA sentence:

Answers will vary.

NOTE: Harvard University recently translated a book into DNA and then translated it back into English. They wanted to see if this would work. It did. DNA can store information so much more efficiently and take up so little space! In your cells, the information density is 1,000 terabytes per cubic millimetre (Tb/mm³). Outside the constraints of the cell, the storage capacity could be million Tb/mm³.

Use the chart below to translate the DNA code into the RNA code.

Figure 1

DNA	RNA
Cytosine (C)	Guanine (G)
Thymine (T)	Adenine (A)
Adenine (A)	Uracil (U)
Guanine (G)	Cytosine (C)

Use the chart below to translate the RNA code into English. In determining the English letters represented by each triplet, start with the top row (marked 1st base), then the left side (marked 2nd base) and finally the right side (marked 3rd base) to determine which of the two letters in the box is the correct one.

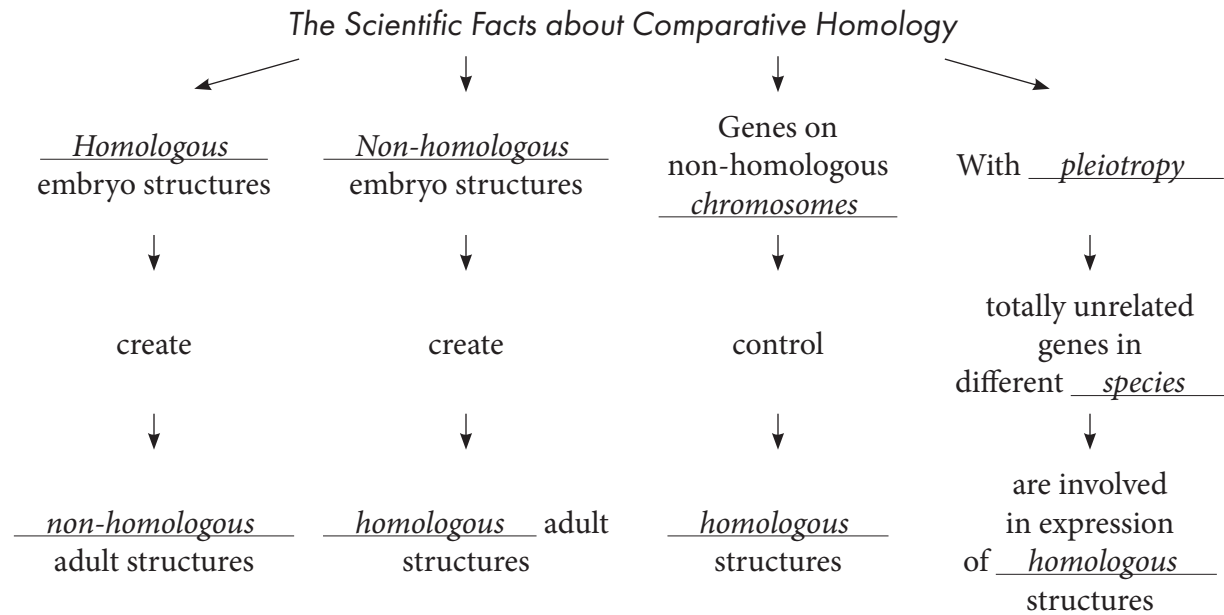
For example: GGG = A.

Figure 2

1 st Base →	G	A	U	C	3 rd Base
2 nd Base ↓	A	B	C	D	G A
G 3 rd Base →	E	F	G	H	
A	I	J	K	L	U C
	M	N	O	P	
U	Q	R	S	T	G A
	U	V	X	X	
C	Y	Z	,	;	U C
	.	!	?	space	

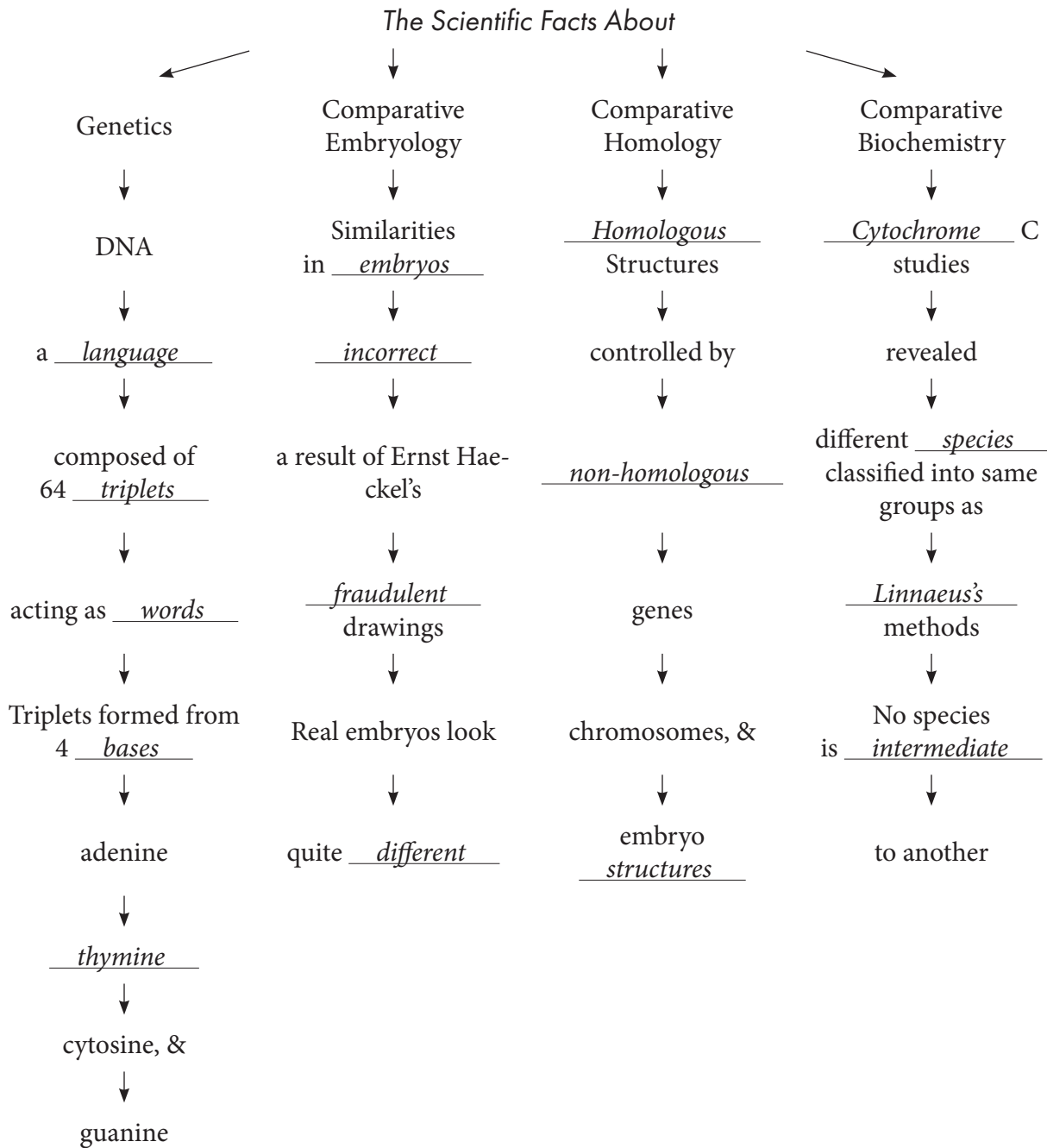
Concept Map One

The Scientific Facts



Concept Map Two

The Scientific Facts



Vocabulary

Fill in the blanks with the words whose definitions are below. Then copy the letters in the highlighted boxes to spell out a message.

1. One unit of hereditary information located on a chromosome, it controls the production of a specific protein; the “sentence” of DNA.

G E N E

2. Body parts of different organisms whose similarities suggest they may have had a common ancestor.

H O M O L O G O U S S T R U C T U R E S

3. The end of the embryo’s spine before the legs begin to grow.

E M B R Y O N I C T A I L

4. The language of life.

D N A

5. The source of the embryo’s red blood cells before the bone marrow is formed.

Y O L K S A C

6. This is change within species or genus; achieved primarily through a loss of genetic information.

D E V O L U T I O N

7. Organic compounds made up of chains of amino acids; the building blocks of living things.

P R O T E I N S

8. These are often called gill slits in human embryos even though there is no opening and they do not develop into the respiratory system.

P H A R Y N G E A L P O U C H E S

9. A protein used in aerobic respiration which is found in a wide number of organisms.

C Y T O C H R O M E C

10. The phenomenon of a gene affecting the development of organs not under its specific control.

P L E I O T R O P Y

11. This is made up of a sugar, a base and a phosphate group; a building block of nucleic acid.

N U C L E O T I D E

12. The relative number of a specific gene that exists in a population.

G E N E F R E Q U E N C Y

13. A mistake in the copying of the DNA.

M U T A T I O N

14. This states that gene frequencies tend to remain stable over long periods of time.

H A R D Y - W E I N B E R G P R I N C I P L E

15. The “punctuation” of DNA.

S T A R T & S T O P C O D O N S

16. This is a result of intelligent action.

L A N G U A G E

Puzzle answer:

N O T A S U P P O R T F O R D A R W I N

In the space below, please state the three ways that bacteria are known to acquire immunity to certain antibiotics.

1. *Bacteria acquire immunity through a mutation which removes information from its DNA.*

2. *Bacteria acquire immunity through plasmid transfer.*

3. *Bacteria have an “inborn” resistance to certain antibiotics.*

Review

Complete the following sentences from your knowledge of the text. It is possible to have more than one correct answer to some of these questions.

1. Chromosomes are made up of proteins and DNA
2. In order for evolution to have occurred, there must have been the addition of genetic information.
3. The drawings of embryos in textbooks are based on Ernst Haeckel's drawings and are inaccurate, fraudulent, etc.
4. The same parts of embryos of different species look different and vary widely in size.
5. Evolutionists never mention human legs or the hind legs of vertebrates as examples of comparative homology.
6. So-called homologous structures in adults of different species often develop from non-homologous parts of their embryos.
7. The genes which control homologous structures in different species are frequently found in different locations and on different chromosomes.
8. When scientists tried to link species through the study of Cytochrome C, they discovered: they fell into the same groupings as they did when they were classified using Linnaeus' methods. No species is intermediate to another. They were all equidistant from bacteria.

Short Answers

Answer the following questions in complete sentences.

1. Why is pleiotropy a strong argument against comparative homology?

Pleiotropy is the phenomenon of individual genes influencing more than one part of an organism. Because of this, non-homologous pleiotropic genes help control homologous structures. How can this occur, if evolution is true?

2. Why is genetic stability a problem for those who believe in evolution?

Evolution requires the addition of massive amounts of genetic information. For this to occur through mutation requires tremendous change. Genetic stability with only minor change makes this impossible.

3. Explain two (2) problems that prevent comparative embryology from supporting evolution.

The textbook drawings are inaccurate; the embryos do not look alike and are different in size. Homologous embryonic parts often do not develop into homologous adult parts.

4. What are vestigial organs? Name two embryonic organs once thought to be vestigial and tell what their functions are.

Vestigial organs are defined as organs which are reduced in size and have no apparent function. The yolk sac which is attached to the human embryo was once thought to be vestigial, but it is responsible for making the red blood cells until the embryo's bone marrow can do the job. The embryonic "tail" is not vestigial. It is merely the end of the spine before the legs begin to grow.

Reminder: you are also responsible for the information on bacterial evolution for this test, as well as for the vocabulary.

Test

Modified True and False

If, according to the text, the statement is true, circle T. If it is false, circle F and then change the underlined word to correct the statement in the space provided. (One point for each correct true answer; two points for each corrected false answer)

T 1. DNA is the “language” of life.

T 2. Chromosomes are made up of proteins and DNA.

F 3. An intron is a series of nucleotides that controls the production of a specific protein.
gene

F 4. Pleiotropy is a spontaneous change in a gene or chromosome.
mutation

F 5. Information is sometimes the result of intelligent action.
always

T 6. The Hardy–Weinberg principle states that gene frequencies tend to remain stable over time.

F 7. Devolution is achieved primarily through an addition of genetic information.
loss

T 8. In order for evolution to occur, there must have been the addition of great amounts of genetic information.

F 9. The drawings of embryos seen in comparative embryology textbooks today are accurate.
inaccurate, fraudulent

- F 10. When classifying organisms using Cytochrome C, several species appeared to be intermediate to the others.

no

Multiple Choice

Place the letter in the space provided that best completes the sentence. (One point each)

- A 1. These form the “punctuation” of DNA.
- | | |
|------------------------|----------------|
| A. Start & stop codons | C. Nucleotides |
| B. Proteins | D. Genes |
- C 2. DNA has often been compared to:
- | | |
|--------------|------------------|
| A. a factory | C. a language |
| B. a gene | D. none of these |
- B 3. It has been said that the probability of five favorable mutations occurring within a single life cycle of an organism is:
- | | |
|---------------------|----------------------------|
| A. very likely | C. not likely but possible |
| B. effectively zero | D. moderately likely |
- D 4. Michael Richardson has shown that the same parts of embryos of different species:
- | | |
|-------------------------|------------------------|
| A. do not look alike | C. vary widely in size |
| B. look very much alike | D. Both A and C |
- A 5. The same parts of the embryos of different species often:
- | | |
|---|----------------------|
| A. do not develop into similar body parts in adults | C. look very similar |
| B. always develop into similar body parts in adults | D. both A and C |
- C 6. What evolutionists call “gill slits” in humans are more accurately called:
- | | |
|---------------|-----------------------|
| A. the throat | C. pharyngeal pouches |
| B. the coccyx | D. all of these |
- B 7. The yolk sac was once thought to be vestigial. This means:
- | | |
|--|---------------------------------|
| A. it is too large | C. it is too small to be useful |
| B. it is reduced in size and has no function | D. it has a use only in adults |

- D 8. The yolk sac:
- A. is truly vestigial
 - B. is marginally useful
 - C. is useful late in the pregnancy
 - D. supplies red blood cells early in the pregnancy
- D 9. These are never mentioned as homologous structures by evolutionists.
- A. The fingers
 - B. The legs of humans
 - C. The hind legs of most vertebrates
 - D. Both B and C
- A 10. So-called homologous structure in adult organisms:
- A. often develop from different parts of their respective embryos
 - B. always develop from the same parts of their respective embryos
 - C. always develop from the same parts of respective vertebrate embryos
 - D. never develop from the same parts of their respective embryos
- B 11. The genes that control so-called homologous structures:
- A. are always homologous
 - B. are frequently found in different locations and on different chromosomes
 - C. are always found on the same chromosomes
 - D. none of these
- C 12. Pleiotropy is :
- A. the phenomenon of one gene affecting multiple traits
 - B. a strong argument against homology
 - C. both A and B
 - D. neither A nor B
- D 13. Scientists are trying to use a protein which is present in many organisms to determine which are intermediate or link species. This protein is:
- A. leucine
 - B. praline
 - C. glutamine
 - D. cytochrome C
- A 14. When evolutionists tested different organisms using this protein (see # 13), they found that:
- A. different species appeared to be equidistant from bacteria
 - B. there were several species which could be considered intermediate
 - C. there were one or two species that could be considered intermediate
 - D. most of the species could not be considered intermediate

- E 15. Which of the following provides evidence that supports evolution?
- | | |
|---------------------------|-----------------------------|
| A. Genetics | D. Comparative biochemistry |
| B. Comparative embryology | E. none of these |
| C. Comparative homology | |

Essay Questions

Answer the following questions in complete sentences. Points vary per question.

1. What is pleiotropy and why is it a strong argument against comparative homology. (4 points)

Pleiotropy is the phenomenon of genes partially controlling structures far removed from the structure they are primarily responsible for. This is a strong argument against comparative homology because non-homologous pleiotropic genes are responsible for helping to form so-called homologous structures.

2. Why is genetic stability a problem for those who believe in evolution? (2 points)

Genetic stability is a problem for evolutionists because evolution requires the input of massive amounts of genetic information. For mutation to accomplish this would require tremendous change in the gene pool, not genetic stability.

3. Explain two problems that prevent comparative embryology from supporting evolution. (4 points)

The drawings which are found in textbooks are inaccurate. Embryos of different species generally do not look alike and also vary in size. B. The same parts of embryos of different species often do not develop into similar organs in the adult. Example: so called “gill slits” in humans do not develop into the respiratory system as they do in fish

4. Name two parts of the embryo once considered vestigial and tell what their function really is. (4 points)

The yolk sac—It provides the embryo with red blood cells until the bone marrow can take over.
The embryonic tail—This so-called “tail” is the end of the spine before the legs begin to grow.

5. The discussion of bacterial immunity that you read gave three reasons why bacteria have immunity to antibiotics. List them here.

1. Some bacteria are born with the resistance.
2. Other bacteria obtain it through plasmid transfer.
3. Some develop it through a genetic mutation which damages the pump they use to draw materials into their cells. (This mutation is a loss of information.)

Chapter 6

Suggestions for Beginning

Engage your student(s) in discussion using the following questions. As they give input, draw a rough “geologic column” on a computer or blackboard and write in what should be found in each layer.

1. Evolutionists state that the first cell arose by spontaneous generation and that all the organisms we have today arose gradually over time from that cell. They also say the fossil record supports evolution. If this were the case, how would you expect the fossils to be deposited? For example, what kind of fossils would you expect to find in Precambrian rock—the rock evolutionists say was laid down when life was just beginning on Earth?

2. What would we expect to find in Cambrian rock—the layer just above the Precambrian?

3. Continue on with subsequent layers. You do not need to name each individual layer. However, if your student(s) are following the “pattern” of evolution, they should be filling each higher layer with progressively more “advanced” forms of life. Since students tend to think primarily in terms of the animal kingdom, the drawing below generally reflects this. You may need to consult a drawing of a geologic column, just in case they do bring in the plants, etc. When you have completed your “geologic column,” save it for comparison later, after your student(s) have read this chapter. Tell them the structure of the geologic column is discussed in Chapter 6.

4. What also should be in the rocks in great quantities if Darwinian evolution is true? (Link fossils or intermediate forms)

Sample “geologic column”:

Man
Link fossils, link fossils
Mammals
Link fossils
Birds
Intermediate forms
Reptiles
Link fossils, link fossils, link fossils
Amphibians
Intermediate forms
Fish
Link fossils
Worms, etc.
Anaerobic bacteria

Sections Question Key

Section One: The Creation & Structure of the Geologic Time Scale

1. How is a geologic column for an area put together?

To form a geologic column for an area, a geologist compares the order of the layers of sedimentary rock in two or three different locations. By examining the types of rocks and the fossils within them, he or she can determine with relative accuracy which rocks were laid down at the same time and the order in which they were deposited. He also attempts to determine which layers have been eroded and puts all the layers in these two or three locations in the order in which he believes they were laid down.

2. What method did scientists use for determining an old age for most sedimentary rock strata?

In the past they used the principle of uniformity to determine an old age for most sedimentary rock layers. Now they generally examine the fossils within the rock strata and assign an age to the rocks based on their fossils.

3. What is wrong with using the principle of uniformity to determine the ages of rocks?

The principle of uniformity fails to take into account the fact that catastrophic occurrences can deposit thick layers of rock within a short period of time.

4. What is an index fossil and how is a fossil determined to be one?

Species that existed during a relatively short period of time. In order to be classified as an index fossil:

1. A particular fossil species has to be found in already dated rock layers in several areas.
2. These fossils have to be restricted to only a few rock layers, vertically.
3. It is also helpful if the fossil is found on more than one continent.
5. What is wrong with the method of reasoning described in the text?

Using the rocks to date the fossils and the fossils to date the rocks is known as circular reasoning. Without knowing for sure either the age of the rocks or the age of the fossils within them, it is impossible to know the age of the other.

6. Describe one discrepancy creation scientists have discovered?

As a result of using index fossils to date rock strata, evolutionists have often assigned dates to rock layers that put older rock strata on top of younger ones.

Section Two: The Fossil Record

1. Describe four main characteristics of the fossil record. Give details.

The Cambrian explosion—representatives of 95% of all the phyla in the fossil record are represented in Cambrian rock, which is considered very old.

Stasis—Once organisms show up in the fossil record, they remain relatively unchanged throughout it and are essentially the same as today's living representatives.

Absence of link fossils—If Darwinian evolution were true, we should expect to find millions of intermediate stages represented in the fossil record. Instead, we have very few, and all of these are contested.

Fossils that aren't fossilized—In 2005, a team led by Dr. Mary Schweitzer of North Carolina State University discovered blood vessels and intact protein in a fossilized *T. rex* leg bone. *T. rex* supposedly became extinct over 60 million years ago. It is a reasonable assumption that soft tissue, especially blood vessels and protein, could not survive more than ten thousand years. In fact, this was the estimate made by evolutionists prior to this discovery.

2. Describe punctuated equilibrium. Why is it a poor substitute for Darwinian evolution?

Punctuated equilibrium is the hypothesis that species remain stable over long periods of time only to evolve rapidly in response to some cataclysmic event and then settle back into another long period of stasis. It is a poor substitute because it has absolutely no evidence to support it. Its main reason for existence is to explain the lack of link fossils in the fossil record.

Section Three: How Do We Interpret the Facts about Fossils?

1. What major factor influences how scientists view the facts?

Evolutionists and creationists have a different worldview, a preconception of how the world operates, and they both use their particular world view to guide them in their work.

2. Give at least three questions an individual should keep in mind as he reads of a fossil find?

Any three of the following:

1. How much of the fossil was found?
2. Were the fossil parts found in pleonasm, or were they brought together from several locations?
3. How were the fossils dated?
4. How much of the fossil shows proof of its being a link fossil?
5. Do the fossils appear to be examples of devolution, or do they truly illustrate evolution in action?
6. Is the artist's drawing truly representative of the fossil bones that were actually found or does it rely more on the artist's imagination.

Section Four: Link Fossils?

1. *What did some scientists believe the coelacanth to be? What happened to change their minds?*

At first they thought it was an extinct link fossil between fish and amphibians. When they saw live specimens, however, they realized it was just a fish.

2. *What do some scientists consider Archaeopteryx to be?*

Some evolutionary scientists believe *Archaeopteryx* to be a link fossil between reptiles and birds.

3. *Why is Archaeopteryx considered a link fossil by some scientists?*

It is considered to be a link fossil because it has fully developed feathers, (an avian characteristic) and also teeth, claws on its wings, and a flat breastbone, (features that are considered reptilian).

4. *Why is Archaeopteryx not considered to be a link fossil by others?*

It has no half-way features between scales and wings. Some fossil birds have the so-called reptilian features. In addition, modern ostriches have claws on their wings; the chicken has a gene for teeth, and several other birds have flat breastbones. Yet all of these are indisputably birds.

Section Five: Evolutionary Series?

1. *What is one problem with the position of the horse fossils in the fossil record?*

There is no location in the world where all the representatives of this series are found in successive rock strata. In addition, they are often found out of order in the fossil record, with older specimens found above younger ones. In an excavation in Nebraska the fossilized hoof of a one-toed horse was found together with that of a three-toed horse. The animals had both been trapped in the same volcanic eruption. If both species existed at the same time, or if the supposed older species has been found out of order in younger rock, that hardly gives evidence of the three-toed variety being the ancestor of the one-toed variety.

2. *If "Eohippus" is excluded from the series, what do some scientists believe the horse series to be?*

Excluding "Eohippus," the horse series is considered by some scientists to be merely an example of change due to loss of genetic information, since horses of all sizes with different numbers of ribs exist in the world today, and the fossils specimens have lost toes.

3. *Briefly describe Pakicetus, Rodhocetus, Basilosaurus and Ambulocetus and tell why they are questionable as ancestors of the whales.*

Pakicetus. The first fossil consisted of a few jaw and skull fragments, hardly enough to put it in any creature's ancestry, let alone the whale's. After an almost complete skeleton was found, it was

determined that Pakicetids were terrestrial mammals. The only reason *Pakicetus* was considered a whale ancestor was that the auditory bulla, a portion of the fossil's inner ear is somewhat like that of a whale.

Rodhocetus. Rodhocetus had some ear bones that were considered similar to those of whales. This is the main reason it was included in the whale series.

Ambulocetus. Again, some of the bones in fossil's ears were similar to those of modern cetaceans. Some scientists also believe its teeth resembled whale teeth. Another "proof" that is often given is its similarity to *Pakicetus*, a fossil whose own whale ancestry is questionable. Although there is more of this fossil, there is still very little to justify it as an ancestor of the whales. Nevertheless, it is assumed to be one.

Basilosaurus. The fossil has very small hind legs which do not attach to the skeleton, so it could not use them to walk. It appears to be a marine creature that used these tiny legs for grasping during reproduction. Its body shape is different from that of whales. There is no sign of a fluke or dorsal fin. It probably moved like an eel. Its nostrils are on its snout, not on the top of the head like a whale. Its sole claim to a place in the whale ancestry: it was a marine mammal and it had teeth that are somewhat similar to whales.

4. Name at least four major changes that would have to take place in order for whales to evolve from land animals.

Any of the following: A whale's ears are specially designed and protected from the enormous pressures encountered when the whale makes deep dives. Its eyes are designed with a much higher refractive index so it can see clearly under water. When they return to the surface, dolphins and whales have a different air exchange system which allows them to avoid the bends, even though they dive to extreme depths. A whale's nostrils are on top of its head, allowing it to breathe without raising its head out of water. It can hold its breath under water for 1 and ½ hours! Its fins and tongues have special counter-current heat exchangers to minimize heat loss. Its blubber provides insulation from the cold waters the whales travel. It has a specially structured mouth that allows the baby to be breastfed under water. Many whales have a tremendously effective echolocation system. Their "sonar" is so accurate it can detect a tiny fish 70.1 m (230 feet) away. These whales have a melon, a sound lens that enables them to direct sound waves wherever they choose. All of these things would have to evolve from a land animal that has none of them.

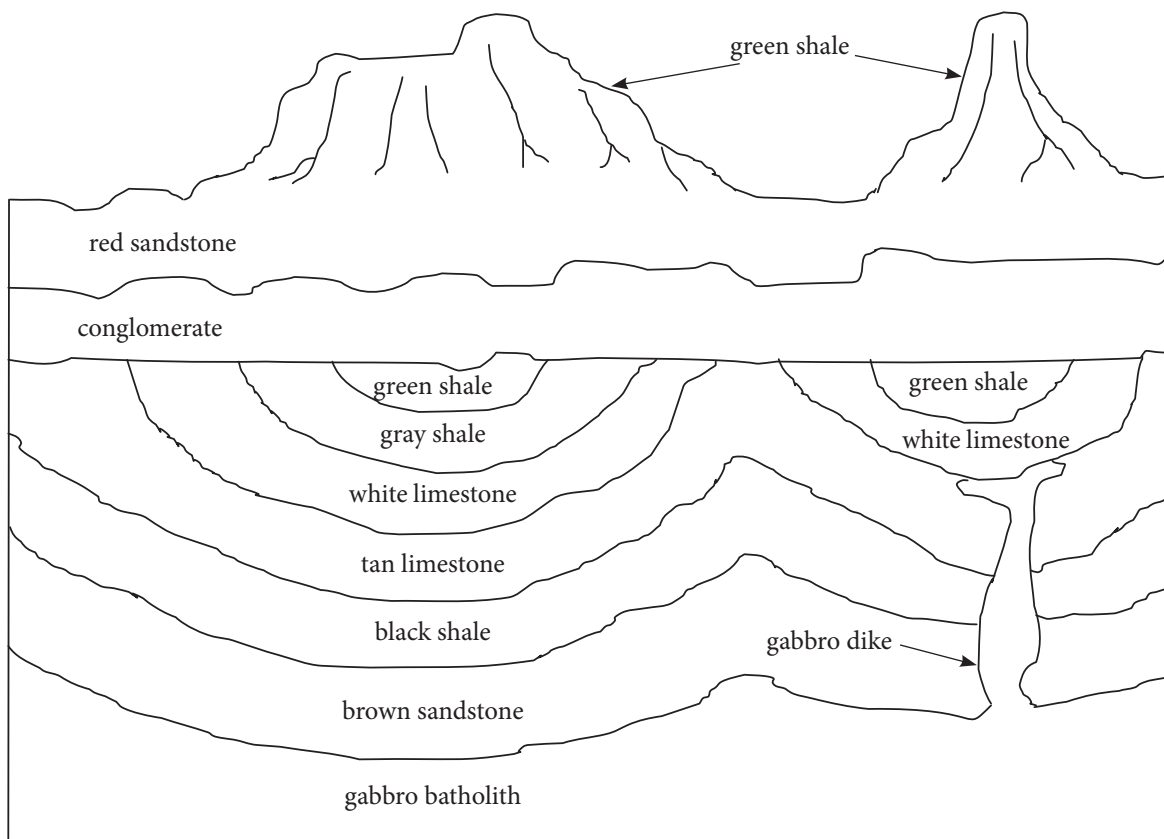
Section Five: What Does the Evidence Show?

1. What major problem prevents scientists from really looking at the scientific facts and perhaps drawing different conclusions?

Because of a preconceived belief system, it is possible to read too much into the fossil record. The same is true of geologic time scale dating. Yet if a preconceived belief system precludes any other interpretation, then the facts can often be ignored.

Section 1

The Structure of the Geologic Time Scale



After reading and gaining an understanding of how scientists study rock strata, examine the cross sectional view of the rock layers in the diagram above. Then put the following events in chronological order from the earliest (#1) to the latest (#12). Remember the Law of Superposition states that generally the lowest layer of rock was deposited first. **The batholith and dike are igneous and were not laid down, as the other layers were.** Remember also what the uneven lines below and above the conglomerate indicate.

- 6 A. The green shale was laid down.
- 3 B. The tan limestone was deposited.
- 4 C. The white limestone was deposited.
- 2 D. The black shale was laid down.
- 7 E. The shales, sandstone, and limestones were folded.
- 1 F. The brown sandstone was deposited.
- 5 G. The gray shale was laid down.
- 11 H. The red sandstone was deposited and partially eroded.
- 10 I. The conglomerate was partially eroded.
- 9 J. The conglomerate was laid down.
- 8 K. The folded strata were eroded.

Generally, batholiths form when igneous material is forced up from deep in the Earth under great pressure. Given this information and the information in this picture, what is the likely cause of the folding of the layers? Also, why is it likely that the gabbro dike (intrusion) occurred at approximately the same time as the folding of the sedimentary layers?

A. It appears that the batholith was responsible for pushing up and folding the sedimentary rock layers above it.

B. It is likely that the gabbro dike formed at about the same time, since it is an extension of the batholith.

Geologists say that an *unconformity* has occurred when several layers of rock strata have been laid down and then tilted by some force within the Earth. This is followed by upper parts of the rock layers being eroded and new layers of sedimentary rock strata being deposited on top of the original layers. Write down the layers that are nearest the unconformity pictured in the diagram above.

The unconformity lies between the green shale and the conglomerate.

The law of superposition states that in an undisturbed rock layer (one that hasn't been turned over), the oldest rocks will be on the bottom and the youngest rocks will be on the top. Does this law tell you anything about the actual age of the rocks?

No

You will learn in this chapter that the principle of uniformity is not reliable as a basis for determining the ages of rocks. Without employing the principle of uniformity, can scientists still attempt to assign an approximate age to these rock strata? If so, what would they use? Name one possibility.

Scientists might attempt to use radiometric dating on the gabbro dike. They might also use fossils they found in the sedimentary rock layers. However, fossil use largely depends on first dating of rocks using the principle of uniformity.

Section 2

The Fossil Record

Use the following words correctly to fill in the blanks below.

rapid	very few	today
punctuated equilibrium	stasis	transitional
same	intermediate	evidence
exploration	long	dinosaur
expected	transitional forms	tissue
gradual transition	first	60 million
95%	true structure	protein
uncontested	last	ten thousand
complex	explosion	leg
geologic column	millions	blood vessels
species	absence	

The typical geologic column in a museum or textbook shows a gradual transition from simple to complex as one moves from the bottom to the top. If evolution is true, this is to be expected because the bottom layers were laid down first and the top layers were laid down last. However this is not the true structure of the fossil record. In fact, there is a sudden explosion of highly complex forms in Cambrian rock. Representatives of 95% of all the phyla found in the fossil record show up here.

In addition, the species which died and were buried in this rock are essentially the same as the species we have today. More than anything else, the fossil record demonstrates stasis, a state of equilibrium with very little change.

Also, if Darwinian evolution is true, there should be millions of link fossils that represent the transitional forms between the species we have today. However, after extensive exploration and study of the fossil record, scientists have found very few fossils which they consider intermediate and none of these are uncontested.

Because of the absence of transitional forms, well-known paleontologists, Stephen J. Gould and Niles Eldredge, developed an alternative theory called punctuated equilibrium. They believe that species remain in a state of stasis for long periods of time until some event triggers rapid evolution. This does not allow time for link fossils to be trapped and preserved. However, the only evidence for this theory is an absence of evidence—no link fossils! This theory seems to be simply a way to explain the absence of transitional forms in the fossil record.

Finally blood vessels and protein have been found in a *T. rex* leg bone previously dated to be over 60 million years old. Yet prior to that time evolutionists had insisted that soft tissue like this could not survive more than ten thousand years. This is only one finding of such tissue in dinosaur bones. The evidence points to the probability that the bones are not that old.

Sections 3 & 4

Interpreting the Facts and Link Fossils

Fill in the blanks in the following sentences by unscrambling the words beneath the blanks.

1. Most link fossils are contested.
deestonct
2. This occurs because transitional fossils are often found to be something else entirely.
thomegins seel
3. A good example of this is the coelacanth.
loncaecaht
4. This creature was once thought to be a link fossil between fish and amphibians.
binasphami
5. It was also thought to be extinct.
nittecx
6. Then a fisherman caught two living coelacanths and brought them to scientists to study.
vilign
7. Once scientists had the soft parts, they found the coelacanth was merely a fish.
hifs
8. Michael Denton points out in his book that because scientists do not have the soft parts, the status of even the most convincing intermediates is insecure.
senucier
9. Yet this practice of assigning link fossil status still continues today.
klin sisofl tutsas
10. Often scientist make assumptions about link fossils based on two or three bones.
senbo
11. Another proposed link fossil, Archaeopteryx is believed to be a transitional form between reptiles and birds.
seprtile dridb
12. Since this bird has claws on its wings and also teeth, some consider these features reptilian.
scawl etteh

13. However, baby ostriches and hoatzin also have this trait.
 ossethric thaoniz

14. *Archaeopteryx* also has a flat breastbone, but many other birds possess this trait.
 rebbeasont

15. In addition, *Archaeopteryx* has teeth, but chickens have a gene for teeth,
 heett icchknes

as did some extinct birds; the gene for tooth expression in this modern bird is simply turned off.

16. Perhaps the most important thing to remember is that evolutionists and creationists have a different worldview, a preconception of how the world operates, and
 oviewwrld treconpnnoipc tpersaeo

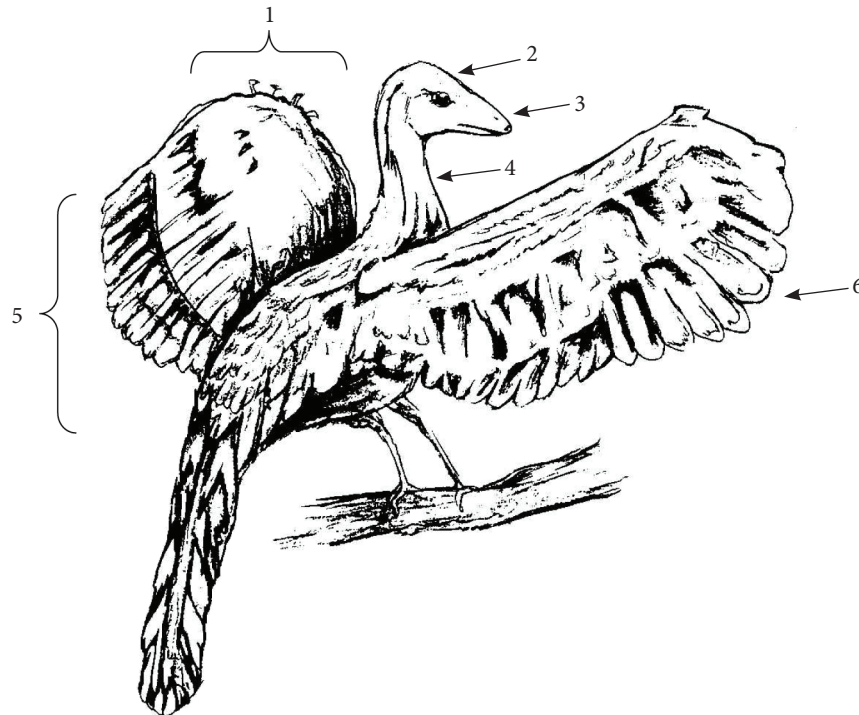
they all use this to guide them in their work. This is especially true in the study of
 degui

the fossil record. To get an accurate picture of the facts, it is wise to
 sosfil cucareta scatf

keep certain questions in mind as one reads of a new fossil find.
 teuqssnoi ndif

Section 4

Archaeopteryx



Archaeopteryx

In the drawing above, several body parts of Archaeopteryx are numbered. In the spaces below list the body part and explain why the evolutionists feel three of the parts indicate it is a link fossil. Why don't creationists feel this way? (Creationists have something to say about all six parts.)

Body Part	Evolutionist Position	Creationist Position
1. Claws on wings	reptilian feature	Baby ostrishes and the hoatzin do too
2. Brain		Brain essentially that of a bird
3. Teeth	reptilian feature	Extinct birds & hoatzin have teeth; chickens have a gene for teeth.
4. Flat breastbone	reptilian feature	Some modern birds have flat breastbones.
5. Wing		Wing essentially that of a bird
6. Feather		No half-way feature, all feathers

What do creationists think Archaeopteryx is?

Simply a bird

Short Answers

Answer the following questions with complete sentences:

1. What did paleontologist Sankar Chatterjee find and how does this affect *archaeopteryx*'s status as a bird ancestor?

Chatterjee found what he believes to be the skeleton of a modern bird in rock strata that appear to be older than the rock layer in which *Archaeopteryx* was found. Therefore, the birds would have existed before their ancestor.

2. Why is it difficult to determine the exact nature of *archaeopteryx*?

Scientists do not have the soft parts of the organism, and without them it is very difficult to determine exactly what it is. The case of the coelacanth proves this well.

Sections 5 & 6

Evolutionary Series & What Does the Evidence Show?

I. Put an "X" in front of each statement that agrees with the textbook.

- ☒ 1. Scientists, being human, are often prone to admit that ... undetected biases can creep in.
- ☐ 2. The horse series looks like a good example of evolution.
- ☒ 3. Perhaps excluding *Eohippus*, the horse series could be an example of devolution.
- ☐ 4. The specimens of the horse series have been found all together in the right order.
- ☒ 5. The specimens of the horse series have been found out of the proper order.
- ☒ 6. Variety in the horses' toes could be explained by the fact that genes can be turned "on" or "off" by other genes.
- ☐ 7. Evolutionists believe that whales evolved from an ancient marine mammal.
- ☒ 8. There would have to have been thousands of transitional organisms in whale evolution.
- ☒ 9. One proposed example of a whale ancestor is *Pakicetus*.
- ☒ 10. *Pakicetus* lived on land.
- ☒ 11. Often specimens are put in the whales' ancestry because they appear to have one or two traits in common with whales.
- ☐ 12. Evolutionists believe *Rodhocetus* was a "walking whale".
- ☐ 13. *Rodhocetus* is a large, marine creature.
- ☐ 14. The fossil of *Pakicetus* shows features of both land and marine mammals.
- ☒ 15. *Ambulocetus* is described as a "walking whale".
- ☒ 16. *Ambulocetus* is defined as a whale based on the assumption that it has an ancestor in common with the whales.
- ☐ 17. There are thousands of link fossils in the fossil record tracing the evolution of the whales.

II. List at least three evolutionary changes that would have to occur in order for a land mammal to evolve into a whale.

Any of the following: A whale's ears are specially designed and protected from the enormous pressures encountered when the whale makes deep dives. Its eyes are designed with a much higher refractive index so it can see clearly under water. When they return to the surface, dolphins and whales have a different air exchange system which allows them to avoid the bends, even though they dive to extreme depths. A whale's nostrils are on top of its head, allowing it to breathe without raising its head out of water. It can hold its breath under water for 1½ hours! Its fins and tongues have special counter-current heat exchangers to minimize heat loss. Its blubber provides insulation from the cold waters the whales travel. It has a specially structured mouth that allows the baby to be breastfed under water. Many whales have a tremendously effective echolocation system. Their "sonar" is so accurate it can detect a tiny fish 70.1 m (230 feet) away. These whales have a melon, a sound lens that enables them to direct sound waves wherever they choose. All of these things would have to evolve from a land animal that has none of them.

III. In the spaces below, summarize the significance of the fossil record and the geologic time scale. Refer to "What Does All This Mean?" at the end of the chapter.

1. Fossil record

The fossil record supports creation because it shows a sudden "explosion" of highly complex forms in Cambrian rock, with very few link fossils, all of which are contested. In addition, it exhibits stasis, a state of equilibrium with very little change. Yet evolution requires massive change over time.

2. Geologic time scale

The geologic column is of use in correlating rocks. However, using the geologic column to assign an age to the rocks is ineffective because the principle of uniformity does not work. Also, using the rocks to date the fossils and the fossils to date the rocks is circular reasoning. It doesn't work!

Group Activity

Making Geologic Columns

If geologists want to develop a geologic column for a given area, they may look for exposed sections of rock layers. Often they find these in canyons or cliffs, or in areas where construction crews have exposed rock strata while building roads. Today, you are going to look at two imaginary cliffs that have been drawn for you on an attached paper. Using your text and the information from these cliffs, you will construct a geologic column for the area.

Materials:

- ▶ Pictures of two sections of rock strata
- ▶ Group activity sheet
- ▶ Pen or pencil

Procedure:

1. Reviewing the principle of superposition will help you in this activity. Look up this principle in your textbook and write it in the space below.

The principle of superposition states that in an undisturbed layer of rocks, the oldest rock will be on the bottom and the youngest will be on the top.

2. Look at the pictures of the rock strata demonstrated for you on the last sheet of your group activity. Develop a geologic column for the area of these imaginary cliffs. Write it in on the spaces below. Make sure the lowest rock layer is on the bottom line and work your way up. Then answer the questions given below.

Topmost layer: gray limestone
 pink sandstone
 gray shale
 tan limestone
 red sandstone
 black shale
 green shale

Bottom layer: white limestone
Geologic column for the area

3. Which layer of rock was laid down first?

white limestone

4. Which layer of rock was laid down last?

gray limestone

5. Given information from both cliffs, what can you assume the uneven lines between the tan limestone and pink sandstone and between the red sandstone and green shale signify?

An eroded surface; a rock layer that has been eroded.

6. In order to create the column, what did you assume once went between the pink sandstone and the tan limestone in cliff #2?

gray shale

7. What does the black area in the middle of cliff #2 signify?

An igneous rock intrusion

8. Based on the information you have, can you accurately determine the last geologic event to occur in these cliffs?

No

Why or why not?

Answers will vary. Perhaps the deposition of the gray limestone is the last event because it is on top. However, you cannot positively determine the last geologic event to occur because you do not have a reliable dating method. For example, you can tell that the basalt dike occurred after the tan limestone was laid down because the basalt has intruded into it. However, the dike could have occurred later than the deposition of the gray limestone and been the last event. Some kids may point out that it looks like erosion has occurred between the two cliffs because they assume them to be in close proximity. If you accept this theory then that may have been the last geologic event.

9. What does it mean to correlate rocks?

Scientists examine rock strata in two or more locations and determine through the character of the rocks and fossils they hold, that they are of the same age.

10. What is the principle of uniformity, and how was it used to determine an old age for sedimentary rocks?

“The present is the key to the past.” In other words, the processes that are at work today are also the processes that were at work in the past, and they work at the same slow rate that we experience under normal conditions today. Therefore, if it would take several thousand or even several million years to lay down some rock strata under normal conditions today, then it would have taken this long in the past.

11. Why is using this principle an unreliable way of determining the ages of rocks?

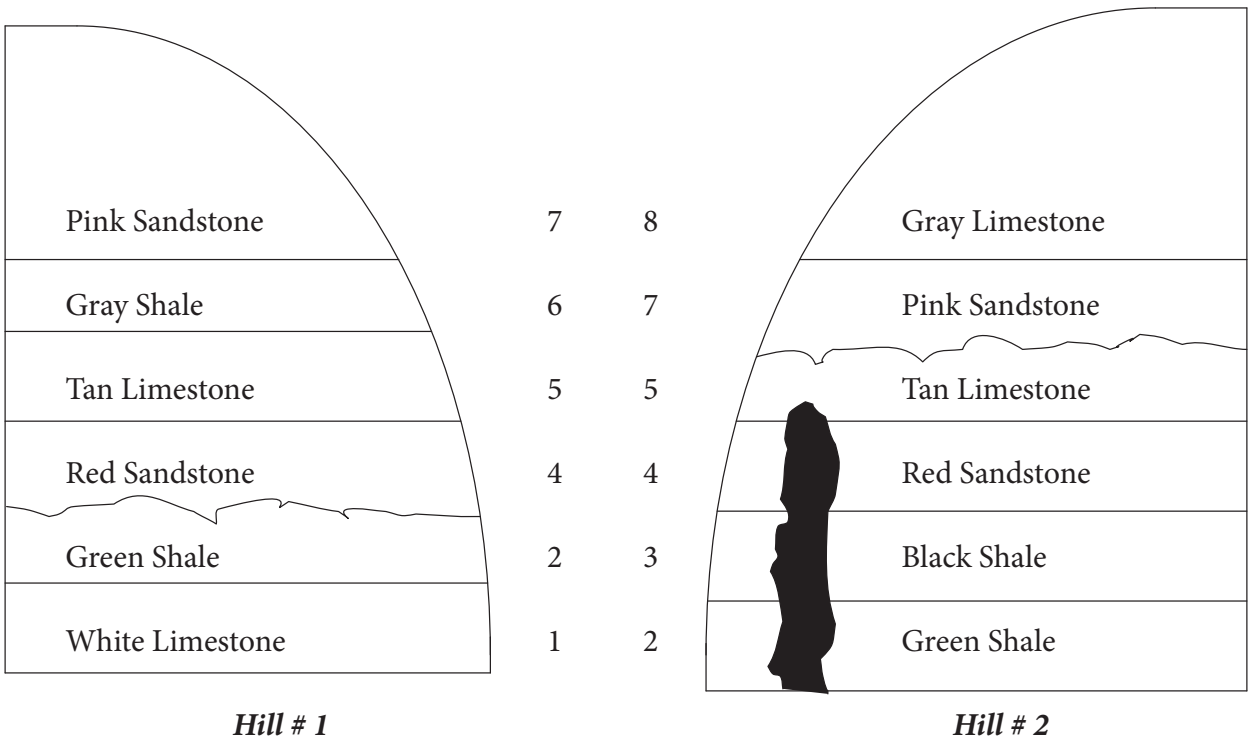
It fails to take into account the rapid sedimentation rates that occur during catastrophic events.

12. Early geologists assigned an old age to much of the Earth’s sedimentary rock using the principle of uniformity. Then they started earmarking index fossils whose ages they had determined from the rocks in which they were found. They used these index fossils to date other

rocks. What problem occurs when using the rocks to give ages to the fossils and then using the fossils to assign an age to other rocks?

This is a matter of circular reasoning. They must first determine accurately the age of either the rocks or the fossils. Then they can perhaps use that information to determine the age of the other. However, if they do not know positively either the rock or the fossil's age, how can they determine the age of the second one?

Below are two imaginary hills which you are to assume come from the same general area. Examine the rock layers in each hill and correlate the rocks to form a geologic column for the area. *The irregular lines between rock layers signify erosion. The black object is an igneous rock intrusion.*



Rock Layers are labeled for you starting with the lowest (oldest) as number 1 and the highest (youngest) as number 8. The uneven lines show a rock layer has been eroded. Since this layer is present in the other hill, a geologic column can still include the eroded layers.

Concept Map One

Geologic Time Scale

Scientists use the geologic time scale to determine the ages of rocks.



BUT



They developed the time scale using the principle of uniformity



This states that the same slow processes we see at work today
also operated in the past



HOWEVER



The principle of uniformity does not allow for the catastrophic events
that also occur



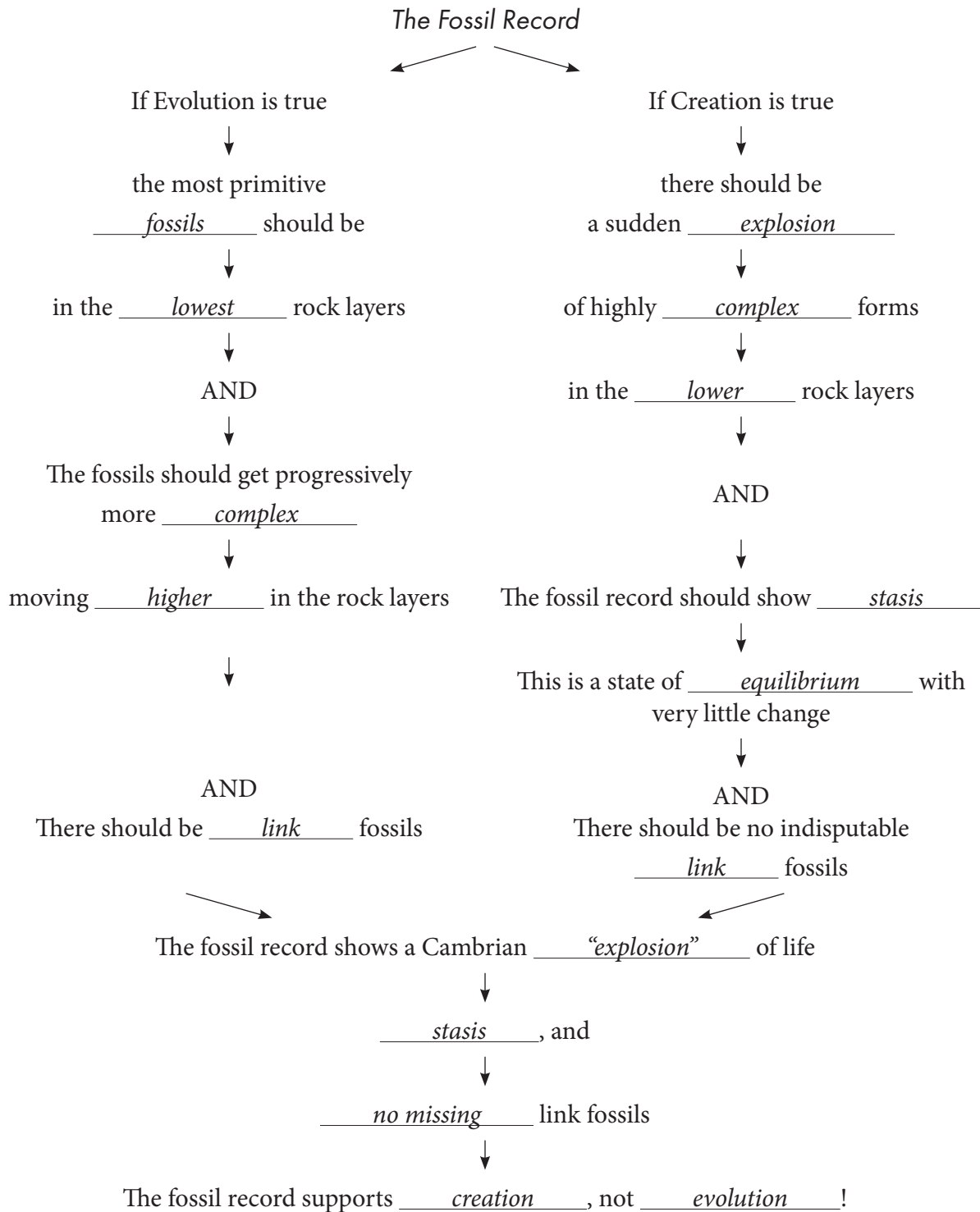
SO



The geologic time scale is unreliable for determining the ages of rocks

Concept Map Two

The Fossil Record



Vocabulary

Using the letters provided, match the following words with their definitions.

- | | | |
|-------------------------|----------------------------|----------------------------|
| A. Ambulocetus | G. Circumstantial evidence | M. Pakicetus |
| B. <i>Archaeopteryx</i> | H. coelacanth | N. Principle of uniformity |
| C. Assumption | I. Correlating the rocks | O. Stasis |
| D. Basilosaurus | J. Eohippus | P. Transitional Form |
| E. Chicken | K. Extinct | |
| F. Circular reasoning | L. Rodhocetus | |

- D 1. Basilosaurus is a proposed ancestor of the whales which has hind limbs that do not connect to the rest of its skeleton.
- I 2. When scientists examine rock strata in different locations and determine through the character of the rocks and the fossils they contain that they are of the same age, this is called correlating the rocks.
- E 3. The chicken is a modern bird which has genes for teeth.
- N 4. The principle of uniformity states that the processes that we see at work today were at work in the past at the same rate of speed.
- K 5. Organisms which have no living examples are said to be extinct.
- O 6. The fossil record shows that organisms remain stable over long periods of time; this is called Stasis.
- J 7. Eohippus is a proposed horse ancestor that resembles the bones of a hyrax.
- A 8. Scientists admit that Ambulocetus's relationship to the whales is uncertain but assume it is related.
- L 9. Rodhocetus also had some ear bones that were considered similar to those of whales. One species exhibited such features as a large pelvis fused to the vertebrae, hind legs, and differentiated teeth.
- P 10. Transitional form is another term for link fossil.
- H 11. A proposed link fossil between fish and amphibians, the coelacanth was discovered to be simply a fish, when two were caught alive.
- B 12. Archaeopteryx is a proposed bird ancestor because it has some features which some scientists consider reptilian.
- G 13. Known facts that are hard to explain otherwise are known as Circumstantial evidence.

- C 14. An individual who accepts something as fact without proof is making an Assumption.
- M 15. Pakicetus is a proposed ancestor of the whales which is a land mammal.
- F 16. Using rocks to date fossils and then using the fossils to date other rocks is an example of circular reasoning.

Review

Answer the following questions in complete sentences.

1. How does devolution primarily occur?

Devolution occurs primarily through a loss of genetic information. As organisms lose genes that they have in common, they get less alike.

2. Why is the principle of uniformity a poor method of determining the age of a rock?

The principle of uniformity is a poor method of determining a rock's age because it relies on present slow rates of deposition without taking into consideration that catastrophic occurrences cause fast rates of deposition.

3. In looking at a typical geologic column in a museum, the fossils appear to start out simple on the bottom and get progressively more complex as one goes to younger rock. What does the fossil record really look like?

The fossil record shows an "explosion" of highly complex forms at the Cambrian level. From that point on it demonstrates stasis. That is, the organisms show very little change, moving progressively through younger rocks. This is stasis. There are also very few fossils listed as transitional, and all of them are contested.

4. Give one recent discovery about fossils that supports creation and a young earth.

Scientists are finding soft tissue and protein in the bones of many fossils, indicating they are not millions of years old. The fossil record provides excellent circumstantial evidence for creation.

5. Why did Stephen Gould and Niles Eldredge feel it was necessary to come up with the theory of punctuated equilibrium? What is wrong with this theory?

The theory of punctuated equilibrium proposes that species remain stable for long periods of time, only to evolve rapidly during a period of stress and change within the environment. Then the organisms settle down to another long period of stasis. This theory has absolutely no proof whatsoever. It was made up to explain the lack of link fossils in the fossil record. Its only proof is an absence of evidence.

6. List two pieces of information from the book that indicate the horse series is a poor example of an evolutionary series.

- A. All of the specimens of this series have never been found together in the proper order in any rock formation in the world.
- B. the different specimens have actually been found out of order.
- C. Three-toed and one-toed variety have been found in the same rock layer.
- D. Variety in toes could be explained by the fact that genes can be turned "on" or "off" by other genes.
- E. Perhaps leaving out Eohippus, many scientists think it likely that the other specimens are examples of devolution only.

7. What appears to be a common reason that evolutionary scientists place certain fossils in the ancestry of the whale?

The most common reason appears to be that they have some bones in the ear that evolutionists believe resemble those of a whale. Occasionally, teeth similarities are also mentioned.

8. Give at least 3 reasons why it would be difficult for a land animal to evolve into a whale.

Any of the following: A whale's ears are specially designed and protected from the enormous pressures encountered when the whale makes deep dives. Its eyes are designed with a much higher refractive index so it can see clearly under water. When they return to the surface, dolphins and whales have a different air exchange system which allows them to avoid the bends, even though they dive to extreme depths. A whale's nostrils are on top of its head, allowing it to breathe without raising its head out of water. It can hold its breath under water for 1½ hours! Its fins and tongues have special counter-current heat exchangers to minimize heat loss. Its blubber provides insulation from the cold waters the whales travel. It has a specially structured mouth that allows the baby to be breastfed under water. Many whales have a tremendously effective echolocation system. Their "sonar" is so accurate it can detect a tiny fish 230 feet away. These whales have a melon, a sound lens that enables them to direct sound waves wherever they choose. All of these things would have to evolve from a land animal that has none of them.

9. List two major problems associated with fossil study.

Without soft parts, it is difficult to see how the organism really looked. Also, link fossil status is often made solely on the basis of a few fragments rather than a complete skeleton.

10. List three reasons why some evolutionary scientists consider *Archaeopteryx* to be a link fossil between reptiles and birds.

Archaeopteryx has teeth, claws on its wings, and a flat breastbone, features evolutionists consider to be reptilian in nature.

11. List three reasons why creationists consider *Archaeopteryx* to be simply a bird.

It has no half-way features between feathers and scales. Other birds in the fossil record have socketed teeth. The chicken has genes for teeth. Baby ostriches have claws on their wings. Many modern birds have flat breastbones and still are birds and fly. Fossils of birds have been found in older rock strata

12. Give at least 3 questions a thinking person asks himself on hearing of a new fossil find.

1. How much of the fossil was found?
2. Were the fossil parts found in close proximity, or were they brought together from several locations?
3. How were the fossils dated?
4. How much of the fossil shows proof of its being a link fossil?
5. Do the fossils appear to be examples of microevolution (devolution), or do they truly illustrate macroevolution in action?
6. Is the artist's drawing truly representative of the fossil bones that were actually found or does it rely more on the artist's imagination.

13. You will also be asked to develop a geologic column for an area, based on information from three hills. Use the worksheet on the geologic column that you did earlier in the unit as your guide. You may want to attach it to this review sheet.

14. You are also responsible for the vocabulary worksheet which you did earlier.

Test

Matching

Use the letters below to fill in the space provided.

- | | | |
|-------------------------|----------------------------|----------------------------|
| A. Ambulocetus | G. Circumstantial evidence | M. Rodhocetus |
| B. <i>Archaeopteryx</i> | H. Coelacanth | N. Pakicetus |
| C. Assumption | I. Correlating the rocks | O. Principle of uniformity |
| D. Basilosaurus | J. Eohippus | P. Stasis |
| E. Chicken | K. Extinct | Q. Transitional form |
| F. Circular reasoning | L. Hoatzin | |

- J 1. A proposed horse ancestor that looks like a hyrax.
- F 2. Using the rocks to date the fossils and the fossils to date the rocks.
- K 3. Organisms which have no living examples.
- D 4. A proposed ancestor of the whales with hind limbs that do not connect to its skeleton.
- L 5. A modern bird which lives in South America and has teeth.
- M 6. Had some ear bones that were considered similar to those of whales. One species exhibited such features as a large pelvis fused to the vertebrae, hind legs, and differentiated teeth.
- I 7. The process of examining the rocks in different locations to determine if they are the same age.
- N 8. A proposed ancestor of the whales that is a land mammal.
- H 9. A proposed link fossil between fish and amphibians.
- O 10. It states that the processes we see at work today were at work in the past at the same speed.
- G 11. Known facts that are hard to explain otherwise.
- P 12. Stability over a long period of time.
- A 13. Its only relationship to the whales is based on a presumed ancestry.
- B 14. A proposed link fossil between reptiles and birds.
- Q 15. Another term for link fossil.
- C 16. An idea accepted as fact without proof.

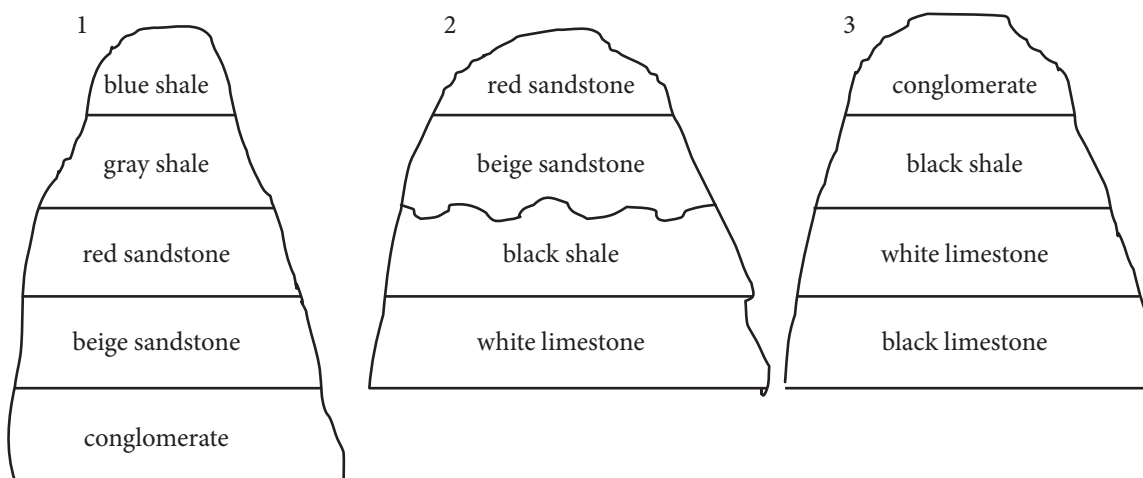
D 9. Creationists consider *Archaeopteryx* to be simply a bird because:

- A. some modern birds have claws on their wings
- B. some modern birds have flat breast-bones
- C. it has no halfway features between scales and feathers
- D. all choices are correct

A 10. One problem with the horse series is:

- A. the different specimens have been found out of order
- B. the specimens are too small for study
- C. there are too many specimens to work with
- D. the specimens make a good example of evolution

Below is a drawing of the layers of sedimentary rock on three neighboring hills. Use this information to make a geologic column for this area.



Geologic Column for the Area:

<u>Blue Shale</u>	Top layer
<u>Gray Shale</u>	
<u>Red Sandstone</u>	
<u>Beige Sandstone</u>	
<u>Conglomerate</u>	
<u>Black Shale</u>	
<u>White limestone</u>	
<u>Black limestone</u>	Bottom layer

Short Answers

Answer the following questions in complete sentences:

1. Why is using the principle of uniformity a problem in determining the ages of rocks?

The principle of Uniformity relies solely on present slow rates of deposition without making any allowances for catastrophic occurrences which have a very fast deposition rate.

2. Give two important facts about the fossil record which make it good circumstantial evidence for creation.

There is a sudden explosion of highly complex life forms in Cambrian rock, rather than a gradual progression from very simple forms to complex forms as one moves up in the rock strata. B. Once the organisms show up, they remain virtually the same throughout the fossil record. They show stasis, not change. Also, there is a lack of link fossils. Finally, fossil bones are being found with soft tissue and protein in them, indicating they are not millions of years old.

3. Why is the theory of punctuated equilibrium a poor explanation for the structure of the fossil record?

Punctuated equilibrium is a poor explanation for the structure of the fossil record because there is absolutely no evidence to support it. It is simply a way to explain the absence of link fossils in the fossil record.

4. Give at least three questions an individual should keep in mind as he reads of a fossil find.

1. How much of the fossil was found?
2. Were the fossil parts found in close proximity, or were they brought together from several locations?
3. How were the fossils dated?
4. How much of the fossil shows proof of its being a link fossil?
5. Do the fossils appear to be examples of microevolution (devolution), or do they truly illustrate macroevolution in action?
6. Is the artist's drawing is truly representative of the fossil bones that were actually found or does it rely more on the artist's imagination.

Chapter 7

Suggestions for Beginning

For this discussion you will need an apple and an orange or two other different kinds of fruit. You will also need six boxes wrapped in different colored paper. Label the boxes Rubidium, Strontium, Uranium, Lead, Potassium, and Argon. Ask the following questions to stimulate thinking and discussion.

1. Is there any way to turn this apple into an orange? (You may have some “serious” wisecracks with this one and can have some fun with it.)
2. Take the “uranium,” and “lead,” then the “potassium” and “argon,” and finally the “rubidium” and “strontium.” Show them successively to your student(s) and ask the same question. Many students may not know that radioactivity involves the changing of one element into another.
3. Explain that radioactive decay is actually the process of changing one element into another. Scientists use this decay process as a clock to measure how old the rock is. However, does this dating method work? Chapter 7 explains.

Later, you might also use the apple and orange demonstration as a concrete example of how radioactive dating takes place. For example, you could give as an illustration that you bought a basket of 32 unstable apples that began turning into oranges. Half the remaining apples turn into oranges each hour. There are now 2 apples left in the basket. Then ask your student(s) how long ago you bought the apples. (The answer is 4 hours. See below.)

After 1st hour—16 left

After 3 hours—4 left

After 2 hours—8 left

After 4 hours—2 left

If you are unfamiliar with radiometric dating methods, please consult your local library or the internet. A basic understanding of how it works is all you need.

Sections Question Key

Section One: How Does Radiometric Dating Work?

1. Why do unstable elements break down into stable ones?

Unstable elements decay into other elements because they have too many more neutrons than protons, their nuclei are too large, or they have an excess of protons.

2. Explain how a radioactive sample is tested.

To get an age for an igneous rock intrusion, a scientist first uses geologic column dating to develop an age for the sedimentary rock surrounding it. Knowing that the intrusion must be younger, the scientist then estimates an age for the igneous intrusion. Then he sends a sample of the intrusive rock to the lab along with his estimate. If, after testing the sample, the lab comes up with a date which is close to the estimate of the scientist, it assigns this date to the sample. If the error margin is too great, the lab says there has been contamination which makes it impossible to date the rock correctly.

3. Define parent element, daughter element, and half-life.

The radioactive element is often called the parent element while the stable element into which it decays is referred to as the daughter or decay element. Half-life refers to the time it takes for one half of the radioactive atoms in a rock to decay into the atoms of a stable element.

4. What is one restriction on the use of radiometric dating?

Only igneous rock can be dated. Currently only igneous rock is tested.

Section Two: Three Assumptions of Radiometric Dating

1. State the three assumptions upon which radiometric dating is based, and explain what is wrong with them.

A. The original composition of the rock is known. There is absolutely no way to ascertain this unless someone was there at the time of the formation, taking samples.

B. The rate of decay has always been constant. This has some credibility, since decay rates have not changed over the past century that they have been checked. However, it is a big step to project these rates back over 4.5 billion years as evolutionary scientists attempt to do.

C. There is no other way that radiometric material has gotten out of the rock. Many radioactive elements as well as decay elements can be leached from rocks by ground water.

Section Three: Reviewing the Long Range Dating Methods

1. Is it possible to determine how much uranium there was in a sample to begin with? Why or why not?

It is not possible to determine how much uranium there was in a sample at the beginning unless the tester assumes a given amount without proof. Again, to know for sure, the tester must be there at the rock's formation.

2. Is there any other problem that might make uranium-lead dating unreliable? Explain.

Uranium and lead, as well as the intermediate isotopes, can be leached out of rocks by groundwater.

3. What two problems concerning argon gas in rocks make potassium-argon dating unreliable?

A. Rocks can absorb argon from the atmosphere, making the rock appear older.

B. Argon can migrate from the lower levels of the rock to the upper, making the upper layers appear older.

4. What can happen to both rubidium and strontium in a rock which can alter the apparent age?

Isotopes of rubidium and strontium can be leached out of the rock, affecting the apparent age.

5. Describe isochron dating.

It is a variation of Uranium-Lead or Rubidium-Strontium dating. Scientists attempt to measure the ratio of all the intermediate isotopes as well as the uranium and lead or rubidium and strontium in a sample.

6. What problems arise with this method?

Contamination can produce a false isochron. Failure of isotopes to spread evenly throughout the rock can produce a false isochron. Rocks known to be young have produced isochrons which date them to be millions of years old.

7. What can happen when different dating methods are used on the same rock formation? Give an example.

Using different radiometric dating methods on the same rock formations leads to different ages for it. For example, the Western Grand Canyon flows were tested using Rubidium-Strontium, Lead-Lead, and Potassium-Argon methods. The Rubidium-Strontium method gave a date of 1.34 billion years old. The Potassium-Argon method yielded results of 10,000 years to 117 million years. The Lead-Lead method gave results of 2.6 billion years.

Section Four: The Most Common Short-range Method—Radiocarbon Dating

1. *What does radiocarbon dating measure?*

Radiocarbon dating measures the ratio of radioactive carbon to stable carbon in an organic sample.

2. *How is carbon-14 formed?*

Carbon-14 is formed in the upper atmosphere by the bombardment of nitrogen by cosmic rays.

3. *What kinds of materials are tested by radiocarbon dating?*

Materials to be tested are usually once living things, artifacts such as clothing or wood which would still contain some radioactive carbon. Most fossils cannot be tested using carbon-14 because most are formed of rock.

4. *What is the half-life of carbon-14 and what is its testing range?*

The half-life of carbon-14 is only 5730 years, so its testing range is 50,000 or younger.

5. *What is one problem with ^{14}C dating?*

For it to be totally accurate, atmospheric levels of carbon-14 have to have been the same in the past as they are today. If radioactive carbon is still building up in the atmosphere, that means there was less for organisms to absorb in the past, making artifacts appear to be older than they actually are. Carbon-14 is still building up in the atmosphere. Also, levels of radiocarbon appear to have fluctuated in the past.

6. *Is there any way that radiocarbon dating can be used with a degree of accuracy? Explain.*

Since the half-life of carbon-14 is only 5730 years, none should be detectable in a sample after 50,000 years. Therefore, scientists can determine with a degree of accuracy whether an artifact is less than or older than 50,000 years using this method. Determining how much less, however, can be a problem.

Section Five: Other Short-range Methods

1. *What is dendrochronology? What problems occur with this method?*

Dendrochronology involves the practice of counting tree rings to determine how old a tree is. By comparing the rings of various trees of great age and attempting to correlate the ages in which they live, scientists attempt to determine the times at which certain climatic events occurred in the past. The problem is that trees don't always show the same tree ring patterns due to variable weather patterns, and accessibility to water and nutrients.

2. How does thermoluminescence work? Are there any problems?

This method relies on the fact that certain minerals which have previously been exposed to radiation will give off an “explosion” of light energy when they are heated to high temperatures. When a researcher reheats the sample, the amount of light released is supposed to reveal the sample’s age. However, scientists must first estimate the annual dose of radiation that the sample received, and this hurts the reliability of the results.

Section Six: Young Earth Indicators

1. How does the amount of salt in the ocean indicate a younger Earth.

Using the present accumulation rates, the amount of salt in the ocean could have accumulated in only 62 million years, far too little time for evolution to have occurred.

2. What is special about the Dynamic Decay Theory of planetary magnetism, and what does it indicate about the age of the earth?

The creationist Dynamic Decay Theory has accurately predicted which planets in our solar system have magnetic fields while the evolutionary Dynamo Theory has not. This accurate theory has assessed the earth’s magnetic field at less than 100,000 years old and possibly at 6,000 years old, definitely a young earth.

3. How does the presence of short period comets in our solar system indicate a young solar system?

Short period comets lose some of their mass each time they orbit the sun. Eventually, they break apart, leaving only meteoroids to orbit in their original paths. There is no known source of new short period comets.. Therefore, if the solar system were more than approximately 10,000 years old, there should be no short period comets left. There are still short period comets orbiting the sun, indicating the solar system is less than 10,000 years old.

4. Explain how the diffusion of helium from rock crystals indicates a much younger Earth than assumed by old Earth enthusiasts.

Helium atoms diffuse rapidly out of the crystals in rock. Yet, when these crystals were tested at the Oak Ridge National Laboratory in the early 1980’s, it was found that they retained large amounts of helium. Later tests indicated that at the present rate, this diffusion from the rock crystals had only been taking place for 6,000–8,000 years.

5. How does the presence of carbon-14 in coal, diamonds, and fossils indicate a young earth?

With their short 5,700-year half-life, no carbon-14 atoms should exist in organic materials that evolutionists have dated to be millions of years old. Yet, independent laboratories have confirmed

that carbon-14 existed in coal samples and even in a dozen diamonds that were tested. Carbon-14 has also been found in some fossils.

6. *Is there any totally reliable scientific method of dating the Earth's age?*

No, there is not.

Section 1

How Radiometric Dating Works

After reading Chapter 7, Section 1, use the words below to fill in correctly the blanks. One word will not be used; three words will be used twice.

element	daughter	lead
nuclei	decay	foolproof
protons	sedimentary	4.5 billion
neutrons	unstable	stable
rocks	one half	estimate
igneous	remaining	geologic time scale
fossils	formed	date
intrusions	clock	error margin
parent	time	contamination
half-life	uranium	

Radiometric dating is used to date rocks and fossils. However, scientists are at a disadvantage because fossils are found primarily in sedimentary rock, while radiometric dating is performed primarily on igneous rock. Scientists often date igneous rock intrusions in sedimentary rocks. These occur when magma forces its way up through a crack in sedimentary rock.

Radiometric dating is possible because certain elements are unstable. They break down over time into stable elements. Certain elements are unstable because their nuclei have more neutrons than protons or their nuclei are too large, or they have an excess of protons.

The radioactive element is usually called the parent element, while the element it turns into is called the daughter element or the decay element. The half life is the time it takes for one half of a radioactive sample to break down into its daughter element. The concept of half-life is interesting. It is important to understand that during each half-life only one half of the remaining radioactive element decays into its daughter element.

Scientists look on radioactive decay as a clock which has kept track of time that has passed since the rock was formed. For example, if scientists were to find a rock which is one half uranium and one half lead, and he knows the half-life of uranium is 4.5 billion years, he might assume the rock is 4.5 billion years old. However, this method is not foolproof.

A review of testing methods is enlightening. A scientist requesting that a sample be tested is asked to give his own estimate of the age of the rock based on geologic time scale dating. If, after testing the sample, the lab comes up with a date which is close to the estimate of the scientist, it assigns this date to the sample. If the error margin is too great, the lab says there has been contamination which makes it impossible to date the rock correctly.

Section 2

Three Assumptions of Radiometric Dating

I. Pick out the three assumptions of radiometric dating from those listed below. Put an "X" in front of these assumptions.

- ☒ The rate of decay has always been constant.
- ☐ The rate of decay has fluctuated over time.
- ☐ Radioactive material can be leached out of the rock.
- ☒ The original composition of the rock is known.
- ☐ Radioactive materials are stable.
- ☐ Radioactive materials are unstable.
- ☒ There is no other way that parent or daughter material has gotten out of the rock.

II. Now that you have selected these assumptions, write a sentence telling what is wrong with the last two assumptions.

1. There is no way to know the original composition of a rock unless you were there at its formation.
2. Rubidium, strontium, uranium, and lead can all be leached out of rocks, altering apparent ages.

III. Why does the first assumption stretch scientific reasoning somewhat?

It is true that the rates of decay have been constant for the past century. However, to project these rates back over billion of years is stretching scientific reasoning.

IV. Why is it virtually impossible to "set the radioactive clock"?

To set the radioactive clock, you have to be there when the rock is formed. Then you can find out its original composition. Without this information, you cannot get accurate results.

Section 3

Long Range Dating Methods

Briefly explain what each long-range method tests.

1. Uranium—lead

This tests the ratio of uranium to lead in an igneous rock.

2. Potassium—argon

This tests the ratio of radioactive potassium to argon in an igneous rock.

3. Rubidium—strontium

This tests the ratio of rubidium to strontium in an igneous rock.

4. Isochron dating (Which isotopes are tested.)

It plots ratio of daughter to a stable isotope of the daughter against the ratio of daughter to parent.

Match each dating method with the problem(s) that plague it by putting the letter of the problem(s) (see below) it has on the line of the dating method.

Each dating method will have more than one letter in front of it. Each letter may be used more than once. Some will be used several times.

Methods:

_____ B, C, E, J

1. Uranium—lead

_____ A, D, E, F, H, J

2. Potassium—argon

_____ B, C, E, F, J

3. Rubidium—strontium

_____ E, G, I, J

4. Isochron dating

Problems:

A. Daughter element can be forced up from the bottom to the top of the rock.

B. Parent element can be leached out of the rock.

C. Daughter element can be leached out of the rock.

D. Daughter material can be trapped in the rock.

E. It gives dates that do not agree with other radiometric dating methods.

F. It has given very old ages for igneous rock deposited in historical times.

G. It tests isotopes, but it is impossible to know how much of each isotope was present at the beginning.

H. Daughter element can be absorbed from the air.

I. Leaching of different isotopes occurs.

J. There is no way to know the original composition of the rock.

Sections 4 & 5

Short Range Dating Methods

Match the words with the terms that fit them.

- | | | |
|-----------------|---|---|
| A. 50,000 years | F. Dendochronology / tree-ring dating | J. Radiocarbon dating |
| B. Artifacts | G. Half-life of ^{14}C | K. Stabilized |
| C. Carbon-12 | H. Nitrogen | L. Thermoluminescence |
| D. Carbon-14 | I. One effective use of ^{14}C | M. This process creates ^{14}C |
| E. cosmic rays | | N. What ^{14}C dating tests |

- D 1. Eight neutrons, six protons.
- K 2. In a steady state in the atmosphere; same amount all the time.
- M 3. A proton turning into a neutron.
- C 4. Six neutrons, six protons.
- N 5. Ratio of ^{14}C to ^{12}C in an artifact.
- G 6. 5730 years.
- B 7. The organic remains of once living things; a piece of cloth, for example.
- I 8. To determine if an artifact is younger or older than 50,000 years.
- L 9. Measures the light released from a cooling mineral.
- H 10. The element which is changed into carbon-14.
- F 11. Counting the growth rings in a tree trunk to determine its age.
- J 12. Another term for carbon-14 dating.
- A 13. No detectable ^{14}C should remain in an artifact after this time.
- E 14. These things cause carbon-14 to be created.

Section 6

Young Earth Indicators

Describe in your own words the six indicators of a young Earth given in the textbook and explain their significance.

1. Salt in the ocean

The present amount of salt in the ocean could have accumulated in only 62 million years. This is much too short a time for evolution to have occurred on the Earth

2. The Dynamic Decay Theory and the earth's magnetic field

The creationist Dynamic Decay Theory has accurately predicted which planets in our solar system have magnetic fields while the evolutionary Dynamo Theory has not. This accurate theory has assessed the earth's magnetic field at less than 100,000 years old and possibly at 6,000 years old, definitely a young earth.

3. Short period comets

Comets are held together by ice. When their orbit brings them near the sun, they lose some of this ice. If the solar system were older than 10,000 years, there should be no short period comets left, but there are several, indicating the solar system to be younger than 10,000 years.

4. Diffusion of helium from rock crystals

Helium atoms diffuse rapidly out of the crystals in rock. Yet, when these crystals were tested at the Oak Ridge National Laboratory in the early 1980's, it was found that they retained huge amounts of helium. Later tests indicated that at the present rate, this diffusion from the rock crystals had only been taking place for 6,000–8,000 years.

5. Carbon-14 in fossils, coal, and diamonds

With their short 5,700-year half-life, no carbon-14 atoms should exist in organic materials that evolutionists have dated to be millions of years old. Yet, independent laboratories have confirmed that carbon-14 existed in coal samples and even in a dozen diamonds that were tested. Carbon-14 has also been found in some fossils. The presence of carbon-14 indicates a young age for the object.

Group Activity

Radiometric Dating

Object:

To learn how radiometric dating specialists date radioactive rocks.

Materials:

1. Two small boxes, each containing pieces of paper with the terms “radioactive element x” and “daughter element y” written on them. You are to consider the boxes to be your radioactive “rocks” and the pieces of paper to be **all** the atoms of that rock.
(TEACHERS: Box 1 should contain 28 daughter atoms and 4 parent atoms. Box 2 should also contain 28 daughter atoms and 4 parent atoms.)
2. Lab Instruction Sheet

Procedure:

1. Since your ability to do this lab depends on your understanding of half-life, renew its definition in your mind by looking it up in your textbook. Write the definition on the lines below.

Half-life: Half life is the time it takes for one half of the unstable atoms in a radioactive rock to break down into its stable daughter element. Remember: during each half life, only one half of the remaining unstable material will decay into daughter element.

2. The half-life of “radioactive or parent element x” is **30 minutes**. Assume that **all of the atoms in the “rock” were radioactive to begin with.**

3. Open “rock” A and count your “atoms.” Total # of atoms: 32

4. Calculate the age of your “rock” based on this information. You may not need all the spaces for half-lives given below, or you may need more. If so, write them in.

- A. Number of atoms of parent element that were present in the beginning. **Remember what was said in number 2!** 32
- B. Number of atoms of parent element which should be left after one half life? 16 left.
After 2 half-lives? 8 left. After 3 half-lives? 4 left. After 4 half-lives? 2 left.
- C. How many radioactive atoms do you actually have left? 4
How many half-lives have occurred? 3 (Based on actual # of daughter atoms you have left and your calculations above)
- D. **Number of half-lives** 3 x **duration of each half-life (30 minutes)** = **age of rock:** 90 minutes.

5. Open “rock” B. Count the total number of all “atoms.” This time you are to assume that **half** of **all** the atoms in “rock” B were **daughter element to begin with**. The half-life of the radioactive element is still **30 minutes**. Based on this information, calculate how old the “rock” is. Total # of all atoms 32

- A. Number of radioactive atoms which were present at the beginning? **Remember what was said in #5!** 16
- B. Number of atoms of parent element which should be left after one half-life? 8 left. After 2 half-lives 4 left. After 3 half-lives? 2 left. After 4 half-lives? 1 left.
- C. How many radioactive atoms do you actually have left? 4
Number of half-lives? 2
- D. Number of half-lives 2 x duration of each half-life (30 minutes) = age of rock: 60 minutes.

6. Answer the following questions based on what you have learned through this lab and **from the book**:

- A. You had the same number of radioactive “atoms” and daughter element “atoms” in both rocks. The “rocks” also had the same half-life. What did changing the assumption about the original composition of the rock do to the age of the rock?

It changed the age of the rock by thirty minutes.

- B. We have been dealing with half-lives of 30 minutes in this lab. In contrast, the elements which are tested in real rocks have half-lives of millions or billions of years. (Even carbon-14’s half-life is 5,700 years.) Suppose the half life of the “rocks” in our lab were millions of years instead of minutes. What would miscalculating the initial composition of the rock do to the age of the rock?

It would change the estimated age of the rocks by millions of years.

- C. Before you were told to assume what the initial composition of the rock was, did you have any way of finding out how many atoms had originally been radioactive?

No

- D. Suppose you had been asked to throw away half of the **radioactive** “atoms” before you started calculating half-lives. What would eliminating half the radioactive atoms do to the apparent age of the rock? **THINK!**

Since the age of a rock is based on the ratio of parent to daughter element, the lower the ratio of parent element to daughter element, the older the rock would appear to be.

- E. What does this elimination of some of the radioactive atoms in the rock represent in nature?

It represents leaching.

- F. Suppose you had been asked to **add more atoms of daughter element** before you started calculating half-lives. What would adding atoms of daughter element do to the apparent age of the rock? **THINK!**

Again, raising the ratio of daughter element to parent element would make the rock appear older.

- G. In what method of radiometric dating is the addition of daughter element a problem?

It is a problem in potassium-argon dating.

- H. You were also to assume that the half-life of “radioactive element x” was 30 minutes. Which of the three assumptions about radioactive dating does this represent?

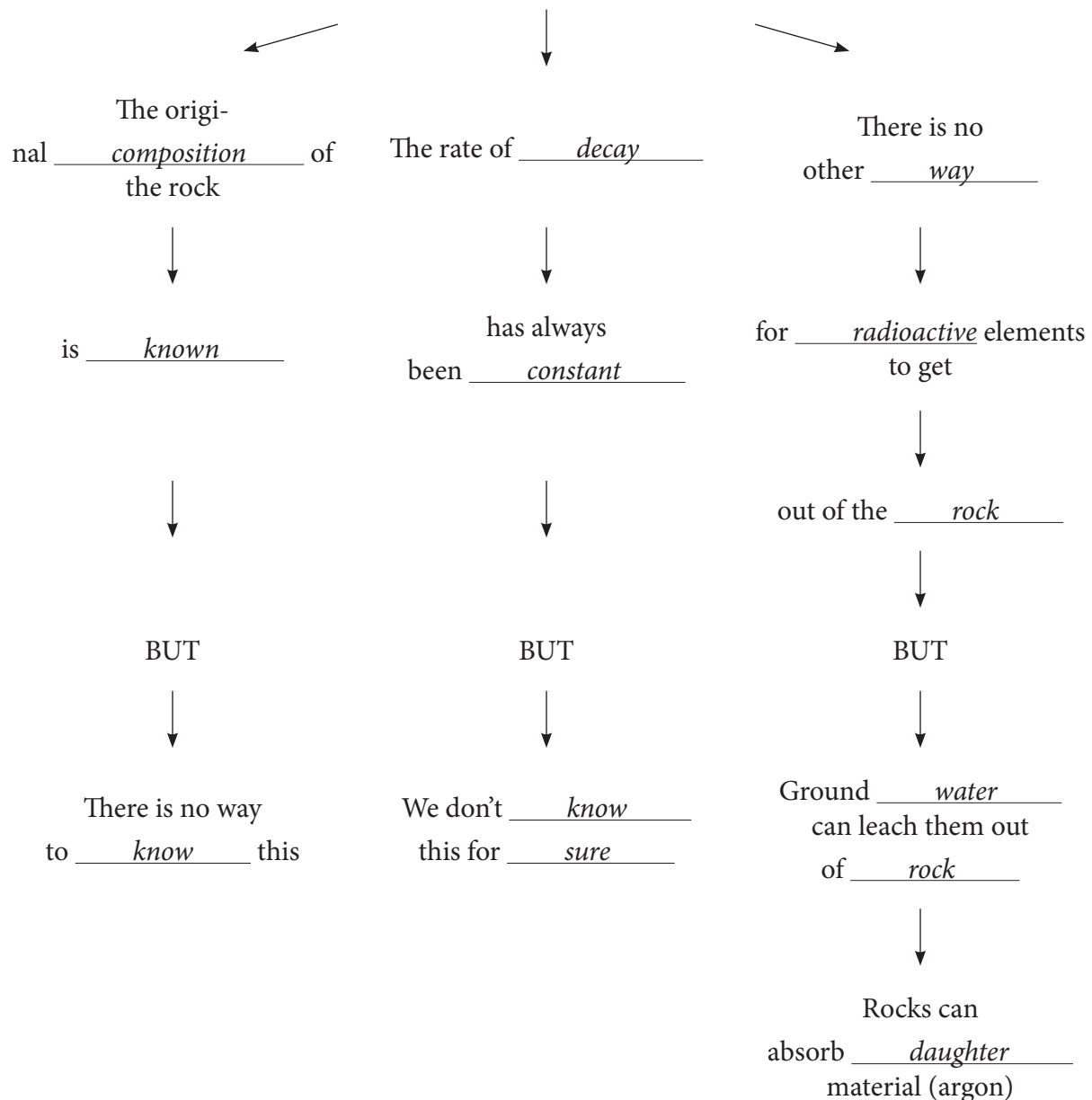
The rate of decay has always been constant.

Remember: If radioactive element is removed or if daughter element is added, the age of the rock is altered and appears to be much *older*. **THIS IS VERY IMPORTANT TO UNDERSTAND.** If you have any problems with any of these questions, check your book.

Concept Map One

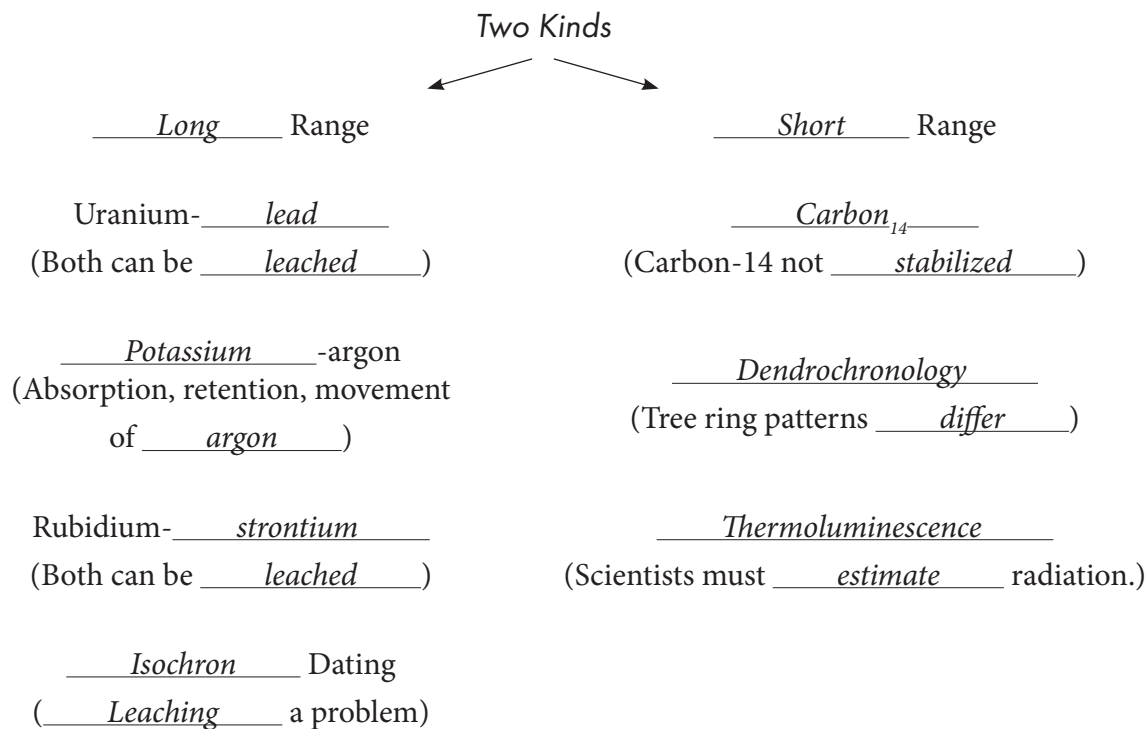
Radiometric Dating

Radiometric dating rests on three premises

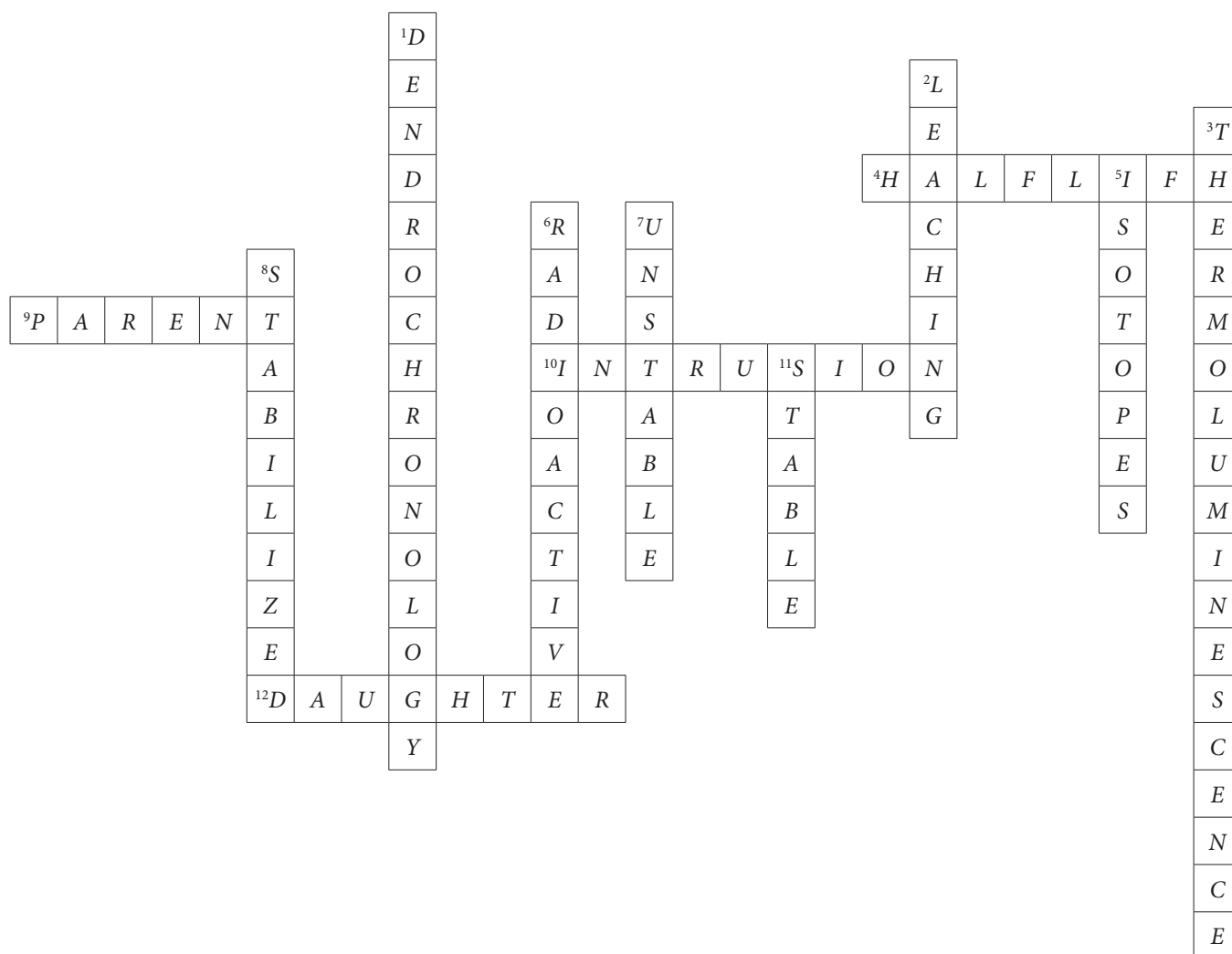


Concept Map Two

Radiometric Dating



Vocabulary Crossword Puzzle



Across

4. The time it takes for half the radioactive material in a rock to break down into a stable element.
9. In radiometric dating, the unstable, radioactive element is called the _____ element.
10. A section of igneous rock which pushes up into overlying rocks.
12. In radiometric dating the stable element which is the end product is called the _____ element.

Down

1. Tree ring dating.
2. Washing out of a rock.
3. Method which tests the amount of light released from a heated mineral.
5. Elements that have the same number of protons but a different number of neutrons.
6. Elements that break down into other elements are _____.
7. When atoms have too many neutrons they are _____.
8. Having the same amount of Carbon-14 available over a long period of time.
11. Elements that do not decay into other elements are _____.

Review

1. *What are three assumptions upon which all radiometric dating is based?*

- A. The rate of decay has always been constant.
- B. The original composition of the rock is known.
- C. There is no other way that radioactive material has gotten out of the rock.

2. *What is wrong with two of these assumptions?*

There is no way to know the original composition of the rock unless you were there when it was formed. Rubidium, strontium, uranium, and lead can all be leached out of rock.

3. *The third assumption has some credibility. State which one this is and tell why. Does this mean it is totally acceptable? Why or why not?*

The rate of decay has been constant for the past century. However, scientists project this rate back over billions of years, which stretches scientific credibility.

4. *What is half-life?*

Half life is the time it takes for half the radioactive material in a rock to decay to daughter element.

5. *Determine the amount of radioactive material that will be left in each of the following situations. Use fractions. Assume the material was all radioactive in the beginning.*

A. Element X has a half-life of 10 hours. How much will be left after 50 hours have passed?

Use fractions!

1/32 of the original radioactive material (element X) will be left.

B. Element Y has a half-life of 15 minutes. How much will be left after one hour?

1/16 of the original radioactive material (element y) will be left.

C. Element Z has a half-life of 3 days. How much will be left after 6 days?

1/4 of the radioactive material (element z) will be left.

6. Below are listed the different types of long-range dating that are used. We know the three assumptions affect their accuracy. Tell what each method measures and any additional problems each method has.

Method	Measures?	Problem(s)
Uranium-lead	<i>ratio of U to Pb</i>	<i>Both uranium and lead can be leach out of rocks</i>
Potassium-argon	<i>ratio of K to Ar</i>	<i>Argon can be absorbed from the air. Argon migrates from the lower to the upper parts of rock formations</i>
Rubidium-strontium	<i>ratio of Rb to Sr</i>	<i>Both Rb and Sr can be leached out of rock by groundwater.</i>
Isochron Dating	<i>ratio of various radioactive isotopes</i>	<i>The isotopes can be leached out of rocks</i>

7. In what type of rock are fossils found? What kind of rock is commonly tested radiometrically?

Fossils are found primarily in sedimentary rocks. Scientists radiometrically test primarily igneous rocks.

8. List three reasons why radioactive elements are unstable.

- A. The number of neutrons is much greater than the number of protons.
- B. The nuclei have too many protons.
- C. Their nuclei are too large for stability.

9. Give 2 examples of incorrect potassium-argon test results on rocks that were formed in historical times.

Scientists tested rocks formed in Hawaii in 1800 and 1801. These tests gave the rock ages of 160 million to 3 billion years. A dacite lava dome at Mt. St. Helens was also tested. In 1996, using the potassium-argon method, the dome was dated to be 350,000 to 500,000 years old even though scientists know it was formed in 1986!

10. Give an example of incorrect rubidium-strontium test results on rock formations in the Grand Canyon.

Rocks from the lower Cardenas Basalt formation tested to be 1.07 billion years old while the Western Grand Canyon flows were tested to be 1.34 billion years old. The obviously younger rock formation tested to be 270 million years older.

11. Short range methods:

A. Willard Libby, the developer of carbon14 dating, assumed that C14 was stabilized in the atmosphere. What does being stabilized mean?

This means that the amount of carbon14 remains constant in the atmosphere. Therefore, there would have been the same amount for plants to absorb as there is today.

B. Scientists now know that carbon-14 is not yet stabilized in the atmosphere. What effect would this have on artifacts that are tested?

If carbon14 is still not stabilized in the atmosphere, then there was less to be absorbed in the past. Therefore, the artifacts being tested would appear to be older because they had less carbon14 to begin with.

C. On what kind of materials is carbon14 dating used? What is its half-life, and how old can the materials be?

Carbon14 is used on organic material—artifacts. Its half-life is 5730 years. Materials generally must be younger than 50,000 years to be tested.

D. Can carbon14 dating ever be used with a relative degree of accuracy? How?

Carbon14 can give a general idea of whether an artifact is younger than 50,000 years.

12. List 2 other short-range methods and explain how each works.

- A. Dendrochronology—this is also known as tree ring dating. Scientists count the rings in trees to determine how old it is and also to gain some information about the climate at various periods in the past.
- B. Thermoluminescence—in this testing method, a researcher reheats materials such as flint or campfire stones. The amount of light released is supposed to reveal the material's age.

13. Explain in detail three evidences of a young Earth. What is significant about a young Earth?

- A. Using modern rates of accumulation, the salt in the ocean could have accumulated in only 62 million years.
- B. Helium atoms diffuse rapidly out of the crystals in rock. Yet, when these crystals were tested at the Oak Ridge National Laboratory in the early 1980s, it was found that they retained large amounts of helium. Later tests indicated that at the present rate, this diffusion from the rock crystals had only been taking place for 6,000–8,000 years.
- C. Short period comets lose of their mass each time they circle the sun. There is no known source of new ones. Therefore, if the solar system were older than 10,000 years, there should be no short period comets left, but there are—indicating that the solar system is younger than 10,000 years.
- D. With their short 5,700-year half-life, no carbon-14 atoms should exist in organic materials that evolutionists have dated to be millions of years old. Yet, independent laboratories have confirmed that carbon-14 existed in coal samples and even in a dozen diamonds that were tested. Carbon-14 has also been found in some fossils. Therefore, these things are not millions of years old, as assumed by evolutionists.

- E. The creationist Dynamic Decay Theory has accurately predicted which planets in our solar system have magnetic fields while the evolutionary Dynamo Theory has not. This accurate theory has assessed the earth's magnetic field at less than 100,000 years old and possibly at 6,000 years old, definitely a young earth.

These facts indicate the Earth is too young for evolution to have occurred.

Test

Multiple Choice

Place the letter in the space provided that best completes the sentence.

- C 1. Most radiometric dating relies on ____ assumptions.
- A. 1
B. 2
C. 3
D. 4
- A 2. We know that the rate of radioactive decay has been relatively constant for approximately:
- A. the last 100 years
B. billions of years
C. a few million years.
D. never
- B 3. The time it takes for 50% of the radioactive atoms in a sample rock to break down into its daughter element is called its:
- A. decay element
B. half-life
C. parent element
D. none of these choices
- C 4. The assumption about radiometric dating that has the most support is:
- A. the original composition of the rock is unimportant
B. there are several ways for radioactive material to get out of the rock
C. the rate of decay has always been constant
D. none of the assumptions has any support at all
- C 5. Scientists testing different samples of the same radioactive rock formation get:
- A. consistently the same results
B. fairly close results
C. widely varying results
D. None of the above
- D 6. Radioactive elements are unstable because:
- A. they have an excess of protons
B. their nuclei are too large for stability
C. they have more neutrons than protons
D. all of these are correct
- A 7. Element x has a half-life of 5 minutes. This means that at the end of 15 minutes _____ will be left.
- A. 1/8
B. 1/4
C. 1/3
D. 1/2

- E 8. In order to use long-range dating methods scientists
- A. must use carbon-14 only
 - B. can use uranium-lead,
 - C. can use potassium-argon
 - D. can use rubidium-strontium
 - E. B, C, and D are correct
- B 9. Uranium—lead dating is based on the ratio of uranium to lead in a(an) ____ rock.
- A. sedimentary
 - B. igneous
 - C. metamorphic
 - D. shale
- E 10. The following material(s) can be removed from a rock through leaching by ground water.
- A. Rubidium
 - B. Strontium
 - C. Lead
 - D. Uranium
 - E. All of these
- E 11. One of the reasons the Potassium—Argon method of dating is inaccurate is that:
- A. potassium and argon can be leached out of rocks
 - B. rocks can absorb argon from the air
 - C. argon can be forced up to the surface of the rock from the rock's interior
 - D. argon can be trapped in the rock
 - E. B, C, and D are correct
- D 12. Using potassium-argon dating, rock samples taken from Hualalai, Hawaii, and from Mt. St. Helens were tested. Although both rock samples were formed in historical times, the samples gave dates of:
- A. 10,000 to 20,000 years
 - B. 50,000 to 100,000 years
 - C. 1 to 2 million years
 - D. 350,000 to 3 billion years
- C 13. Rubidium-strontium dating:
- A. is very accurate
 - B. is not affected by the problems that other methods have
 - C. gives dates which are out of line with other methods of dating
 - D. is relatively accurate
- D 14. Isochron dating is an attempt to date the age of rocks by measuring the ratio of different ____ within the rocks.
- A. minerals
 - B. isochrons
 - C. electrons
 - D. isotopes

- D 15. Isochron dating has problems because:
- A. it is impossible to determine the original ratio of isotopes
 - B. different isotopes of both rubidium and strontium can be leached out of the rock
 - C. neither A nor B
 - D. both A and B
- B 16. Carbon-14 dating is generally used by evolutionists to date material up to ____ years old.
- A. 10 million
 - B. 50,000
 - C. 10,000
 - D. 1 million
- A 17. Libby, the developer of Carbon-14 dating, assumed:
- A. carbon-14 is stabilized in the atmosphere
 - B. carbon-14 is not stabilized in the atmosphere
 - C. it didn't matter if Carbon-14 is stabilized or not
 - D. none of the above
- A 18. Carbon-14 dating is used to date:
- A. artifacts (organic materials)
 - B. minerals
 - C. rocks
 - D. none of these
- A 19. Being stabilized means:
- A. the same amount of the substance is constantly present
 - B. the ^{14}C levels have fluctuated over time
 - C. the amount of carbon-14 in the upper atmosphere fluctuates, but the amount near the earth does not
 - D. the amount of carbon-14 is building up
- D 20. If ^{14}C has not yet stabilized in the atmosphere, this means:
- A. carbon-14 is still building up in the atmosphere
 - B. test samples will appear to be older than they actually are
 - C. the fluctuation of carbon-14 does not matter
 - D. both A and B

Modified True and False

If, according to the text, the statement is true, circle T. If it is false, circle F and then change the underlined word to correct the statement in the space provided. (One point for each correct true answer; two points for each corrected false answer)

- F 1. Some radiometric dating methods rest on premises (assumptions) which cannot be proved.

All

- T 2. Different samples of the same igneous rock will give different dates when dated radiometrically.

- F 3. Rubidium and strontium can be trapped in rocks.

leached from

- F 4. Rubidium is not in a steady state (stabilized) in the atmosphere.

Carbon-14

- T 5. Intermediate isotopes of radioactive elements can be leached from rocks.

- T 6. When magma is forming underground, mixing of different elements occurs.

Short Essay Questions

Answer the following questions in complete sentences.

1. Explain in detail *three* assumptions upon which all radiometric dating is based. (6 points)

The rate of decay has always been constant.

The original composition of the rock is known.

There is no other way for radioactive material to get out of the rock.

2. Explain why one of these assumptions has some credibility. (2 points)

The rate of decay has been constant for the past century that scientists have been checking it. However, it is a big step of faith to project this figure back over the past 4.5 billion years, as they do.

3. Explain in detail what is wrong with the other two assumptions. (4 points)

- A. There is no way to know the original composition of the rock unless someone was there when it was formed, took samples, and tested them.
- B. Radioactive materials such as uranium and rubidium can be leached out of the rock by ground water, as can their daughter materials and intermediate isotopes.
- C. Also, atmospheric argon can be absorbed by rocks. Regular argon can be trapped in the rock.

4. Explain in detail, three evidences indicating a young earth. If the Earth is young, what is significant about this fact? (6 points)

- A. The amount of salt in the oceans could have accumulated in only 32 million years, far too short a time for evolution to have occurred.
 - B. Helium atoms diffuse rapidly out of the crystals in rock. Yet, when these crystals were tested at the Oak Ridge National Laboratory in the early 1980s, it was found that they retained large amounts of helium. Later tests indicated that at the present rate, this diffusion from the rock crystals had only been taking place for 6,000–8,000 years.
 - C. Comets lose some of their mass each time they circle the sun. Short period comets last only about 10,000 years at most. There are still short period comets, indicating the solar system is less than 10,000 years old.
 - D. With their short 5,700-year half-life, no carbon-14 atoms should exist in organic materials that evolutionists have dated to be millions of years old. Yet, independent laboratories have confirmed that carbon-14 existed in coal samples and even in a dozen diamonds that were tested. Carbon-14 has also been found in some fossils.
 - E. The creationist Dynamic Decay Theory has accurately predicted which planets in our solar system have magnetic fields while the evolutionary Dynamo Theory has not. This accurate theory has assessed the earth's magnetic field at less than 100,000 years old and possibly at 6,000 years old, definitely a young earth.
- All of these facts indicate an Earth too young for evolution to have occurred.

Chapter 8

Suggestions for Beginning

Now is the time to bring out the group activity for Chapter 3 and review the characteristics that your student(s) believe a fossil should have in order to be considered a hominid. Discuss each characteristic along with the reasons for choosing that characteristic. Emphasize that it is important to have strict scientific standards for giving a fossil hominid status. Ask your pupil(s) to watch and see how many of the “hominids” in Chapter 8 actually meet the criteria they feel is scientifically necessary.

Sections Question Key

Section One: Paleontologists' Research Methods

1. *List three methods used by paleontologists in determining hominid status for a fossil and discuss why they would be unacceptable in any other branch of science.*

Scientists often take bones from different locations and rock strata and put them together to form one fossil. These locations are often over a mile apart laterally and in rock strata that by their own dating methods are hundreds of thousands of years apart in age. Scientists often “adjust” radiometric dates to fit dates they have already determined by the geologic time scale. Scientists often assign “link fossil status” to bones that are too small and too few to determine what they actually are.

2. *What problem does a lack of articulated skeletons create for paleontologists?*

The lack of these articulated skeletons in good shape make the results of studies of early man highly questionable. How can we know for sure that the bones are even of the same species, let alone of the same individual, if so little is found of the fossil that it is impossible to determine?

Section Two: Some Hominids Disproved by Evolutionists

1. *How much of the original fossil of Ramapithecus was found?*

The original fossil consisted of a few jaw fragments and teeth.

2. *What did paleoanthropologists later discover and how did this affect their opinion of Ramapithecus?*

When an entire skull with the same type of teeth was found, and scientists put all the pieces together, they discovered they had the head of an orangutan, a member of the ape family.

3. *How much of *P. boisei* was originally found?*

It consisted of a skull together with the upper teeth.

4. *Explain two other problems with determining if the fossil belonged in man's ancestry.*

Human remains have been found in almost all the sites where *P. boisei* was found, causing confusion about which bones belonged to *P. boisei*. Also there was a lack of body parts.

5. *What did the Leakeys finally decide about the status of *P. boisei*?*

They decided that “while it is possible that *Zinjanthropus* (*Paranthropus*) and *Homo habilis* both made stone tools, it is probable that the latter was the more advanced toolmaker and that the *Zinjanthropus* skull represents an intruder (or a victim) on a *Homo habilis* living site.”

Section Three: Very Early Hominids

1. How much of the original skeleton of Ar. ramidus was found?

Timothy White of UCLA-Berkley found pieces of a skull, and some teeth and arm bones in one location and a pelvis and some tibia bones in another.

2. How did Tim White and his colleagues put the fossil back together?

The fossil had to be painstakingly removed from the surrounding rock bit by bit. White, in an interview in *Science*, stated that the skull is “squished, and the bone is so chalky that when I clean an edge it erodes, so I have to mold every one of the broken pieces to reconstruct it.”

3. Why is the claim that A. ramidus walked upright so tenuous?

To determine if a creature walked upright requires careful measurements of several bones such as the femur, knee and foot bones, and pelvis. If these bones were crushed, how could even the most skillful scientists put them correctly back together with certainty? It also had a divergent big toe, associated with grasping forelimbs of trees, not walking on the ground.

4. How much of Ar. kadabba was found? Where were the fossil parts found?

Yohannes Haile-Selassie found in the Middle Awash of Ethiopia fragments of jaw, arm, hand, and foot bones, along with a collarbone and some teeth. The bone fragments were of at least five different specimens found in several different sites.

5. What are two major problems with including the toe bone with the other parts of the Ar. kadabba fossil?

The toe bone was found ten miles away and was dated by their methods to be at least 200,000 years younger.

6. What was the condition of the fossil?

The fossil parts were fragmentary and parts of several different individual fossils were found together. This makes it difficult to draw any scientific conclusions about the nature of the fossil.

Section Four: Later Hominids

1. Name the parts of the A. anamensis specimen and explain where they were found.

Meave Leakey discovered the upper and lower sections of a tibia (lower leg bone) in sediments at Kanapoi in Kenya, East Africa. In another location a member of the Leakey expedition found an almost complete set of lower teeth and a skull fragment. In still another spot, half of an upper jaw was found. The rock layer where the teeth were found was dated to be 4 million years old while the layer holding the tibia was “older than 3.5 million,” a difference of possibly 500,000 years.

2. Give three reasons why thinking persons might question its authenticity.

The parts were found in rock formations dated using the evolutionists' own dating methods, to be 500,000 years apart in age. The leg bone appears to be human, but the tooth and jaw fragments are apelike. The parts were found in three different locations. The parts are fragmentary. Some members of the ape family often walk upright.

3. Under what circumstances was A. afarensis found, and what important skeleton part was missing?

In Hadar, Ethiopia, in 1974, a paleoanthropologist named Donald Johanson discovered one of the most complete fossil skeletons classified as a hominid. Forty percent of the fossil was found, but the head parts were fragmentary.

4. How did Johanson get a skull for A. afarensis? Were there any skeletal bones with the skull? What problem does this pose?

When the Ethiopian government allowed work to resume, Johanson returned with his expedition workers to Hadar to search for a skull. They began to explore a different site than the earlier one where they had found Lucy. At the new site they found most of the bones of a skull. They did not find these skull bones along with skeletal bones that could be compared to their earlier specimens.

5. What is the Kanapoi hominid, and how does it affect the fossil status of A. afarensis?

The Kanapoi hominid, also known as KP 271.19, is the fossil of a human upper arm bone found in rock strata dated at over 4 million years old, to be older than all the Australopithecines! How could we be older than our ancestors?

6. How much of Kenyanthropus platyops was found, and what was the condition of the fossil?

A partial skull was found near Lake Turkana in Kenya. Expedition members also found a fragmentary upper jaw. These are the only parts that could be definitely assigned to this species.

7. Why was there a problem when the expedition members put the fossil skull together?

The skull pieces were distorted; they had large cracks that had been filled with material from the surrounding sediments. It was necessary to put these fragments together, and since the members of Dr. Leakey's expedition had no modern specimen to which to refer, it again became a matter of assembling this fossil without any reliable guide.

8. Were Dr. Leakey and her colleagues able to determine if K. platyops walked upright? Why or why not?

There are no known skeletal bones for this species. Therefore, there is no way to determine how it walked.

9. *What are two major problems with the Australopithecus africanus specimen?*

No one has made an intensive study of the fossil and published results. The cave in which it was found was dated to be not more than 870,000 years old, much too young to be a hominid.

10. *What has happened to the holotype specimen of A. africanus, the Taung skull?*

The age of Taung skull was at first believed to be approximately 2.5 to 3 million years old. Later, the deposits in which it was found were dated to be only 1 million years old. In fact, there have been so many problems with this particular fossil that it is often ignored as being representative of *A. africanus*, even though it appears to resemble some of the other specimens.

Section Five: "Final" Hominid

1. *Under what circumstances were the first Homo habilis specimens found?*

The fossils consisted of hand bones, foot bones, and cranial fragments; the skull fragments were not found in the same location as the other bones but all were put together anyhow.

2. *How much of the fossil was found?*

The fossils consisted of hand bones, foot bones, and cranial fragments belonging to both juveniles and adults.

3. *Give at least three problems with the bones of H. habilis that make it difficult to classify him as a human ancestor.*

The fossils consisted of hand bones, foot bones, and cranial fragments belonging to both juveniles and adults. The pieces of skull were not found in the same location as the skeletal bones. Also, the fossil fragments were mixed in with pieces of other species, including humans, so it was difficult to tell what parts went together.

4. *What is H. habilis more likely to be?*

It has been called a "wastebasket taxon" where a variety of hominid fossils have been put.

Section Six: Archaic Humans

1. *The term, holotype, refers to the original specimen from which the description of a new species is made. What is the main problem with the holotype specimen of H. ergaster?*

The first specimen (the holotype) assigned to *H. ergaster* was a lower jawbone that has also been assigned to *H. habilis*. The jaw does not have enough features to clearly distinguish it from either other *homo* species.

2. Describe specimen KNM-WT 15000. What does it appear to be?

The specimen, KNM-WT 15000, is the most complete skeleton assigned to this species. It appears to be the bones of an adolescent male. The authors of *The Last Human* point out, “In all respects, the skeleton is surprisingly human-like.”

3. What do the specimens of *H. ergaster* appear to be?

It appears that the fossil specimens classified as *Homo ergaster* are a mixture of ape-like and human remains, rather than examples of link fossils.

4. Under what conditions did Eugene DuBois discover the first specimen of *H. erectus*?

He assigned two army corporals and fifty forced laborers to dig in an area which looked as if it contained fossils. Although he claimed to have dated the fossil by the other fossils found in the area, Dubois gave very little information about these fossils and about the structure of the rock layers in which his specimen was found. Thus, other scientists were unsure whether either Dubois or his helpers had carefully determined the rock layer in which Java Man was found

5. How did Mr. DuBois date his specimen?

When he first dated the fossil, using the other fossils in the rock layer as a guide, he placed it in the Pleistocene epoch. However, when he realized that it had to be older in order to qualify as a link fossil, he ignored the evidence of the other fossils and described Java Man as belonging to the Pliocene epoch, in the Tertiary period, hundreds of thousands of years earlier. His reason: in his estimation, such a primitive form belonged to the Tertiary.

6. What other species did *H. erectus* resemble?

H. erectus resembled a smaller Neanderthal man.

7. List at least 3 characteristics of *H. erectus* that demonstrate his humanity.

Many of the later *H. erectus* fossils have been found with evidence of the use of tools and the mastery of fire. In addition, there is some evidence of Indonesian members of this species having seafaring abilities. Finally, the average brain capacity of *Homo erectus* specimens is 850–1100 cubic centimeters –within the range of *Homo sapiens*. In fact, the brain capacities of some of the *Homo erectus* specimens was greater than some modern humans.

8. What characteristics of *H. heidelbergensis* and *H. neanderthalensis* show them to be human?

Their brain capacity is the same as humans. Their body size is similar to modern humans. There is ample evidence that they used tools and fire, hunted, and buried their dead. There is evidence that Neanderthals also made war—an undesirable human trait.

Section Seven: The Lake Laetoli Footprints

1. According to Mary Leakey, what did the Lake Laetoli footprints closely resemble?

She states that the form of his foot was exactly the same as ours.

2. How were they dated and what age were they given?

They were dated radiometrically to be 3.6 million years old.

3. Why do evolutionists say they were made by *A. afarensis*?

They feel they were made by *A. afarensis* because the supposed age of the footprints agrees with the age ascribed to *A. afarensis*. Because of their preconception that man is not that old, they cannot accept the evidence as presented.

4. What did Richard Tuttle have to say about the footprints?

He said that they possibly could have been made by bears, but there were no signs of any in the area. He states that they are like the footprints of habitually unshod humans, and if they were not known to be so old, we would readily conclude they were made by *Homo sapiens*.

Section Eight: What does All This Mean?

1. If the Laetoli footprints are modern human footprints and the Kanapoi hominid is a human fossil, where does this put modern humans on the evolutionary time scale—especially in relation to the hominids?

It demonstrates that using the evolutionists' own dating methods, man has been living on the Earth along side all his supposed hominid ancestors.

2. What questions should you ask before accepting a link fossil as genuine?

How much of the fossil was found? Were all the fossil parts found together? If they were found in different locations, were they found in rocks of the same age? How were they dated? Were radiometric dates "adjusted" to fit geologic time scale dates?

Section 1

Paleontologists' Research Methods

Use the following words to fill in the appropriate blanks, after you read the first section of this chapter.

bipedal	link	different
unfamiliar	skull	evidence
found	aligned	hominid
few	articulated	together
Brontosaurus	incorrectly	fossil
<i>Apatosaurus</i>	man	assign
rock	methods	adjust
far	scientists	parts
lack	fragments	
debated	bones	

Perhaps no other area of evolution has been so widely debated as the evolution of man. There are several reasons for this debate. Many scientists question the methods used by scientists in gathering evidence. One of the problems is that relatively few fossil hominid remains have been found. Another is that scientists often find only fragments of a fossil. It is very rare to find articulated skeletons. They often gather bones from different locations and put them together to form one fossil. These locations may be far apart and in different rock strata. Scientists also adjust radiometric dates to fit their preconceptions about the fossil's age. Finally, there is a widespread lack of link fossils. So scientists often assign hominid status to fossil parts that are too few and too small.

One example of what can happen when scientists use fossil parts from different locations is Brontosaurus. This creature did not exist. However, scientists mistakenly put the wrong skull on the body of an Apatosaurus. Scientists often put together bones from creatures with which they are unfamiliar. As a result, they can put them together incorrectly. For example, if the parts of a foot are not properly aligned, the foot bones can be made to look as if the creature is bipedal, when it may not be.

Section 2

Some Early Men Disproved by Evolutionists

Decide whether each of the statements is true or false. If the statement is true, circle T. If the statement is false, circle F and then rewrite the statement so that it is true.

F 1. One early man disproved by evolutionists is *A. afarensis*.

*One early man disproved by evolutionists is **Ramapithecus** or **Paranthropus Boisei**.*

T 2. The original fossil of *Ramapithecus* was found in India.

T 3. The original fossil of *Ramapithecus* consisted of a few jaw fragments and teeth.

F 4. The later fossil of *Ramapithecus* consisted of a complete skeleton.

*The later fossil of **Ramapithecus** consisted of an entire skull with the same type of teeth.*

F 5. The fossil actually was actually that of a pig.

The fossil was actually that of an orangutan.

T 6. *Paranthropus Boisei* was also known as Nutcracker Man.

F 7. This fossil consisted of a complete skull and some skeletal bones.

This fossil consisted of a skull together with the upper teeth.

F 8. *Paranthropus boisei* was dated by its discoverers to be 2,000 years old .

***P. boisei** was dated by its discoverers to be 1.2 million years old.*

F 9. The fossil's brain case was large—about 1100 cubic centimeters.

The fossil's brain case was small—approximately 500 cubic centimeters.

T 10. The fossils of both *H. habilis* and humans have been found at *P.boisei* sites.

F 11. *P. boisei* is still generally considered in the line of man.

Many paleontologists believe the Paranthropus skull represents an intruder (or a victim) on a Homo habilis living site. Paranthropus boisei's classification is also being debated because of the lack of physical evidence (body parts).

Section 3

Very Early Hominids

I. On the page below, state the following facts about *Ar. ramidus* and *Ar. kadabba*.

A. *ramidus*

Amount of fossil found

Pieces of a skull, and some teeth and arm bones were found in one location and a pelvis and some tibia bones in another. Later, about 100 more fossil fragments were found, together with the original find making up about 45% of a skeleton.

Location of fossil parts

Parts were found in several locations.

Condition of fossil

The fossil had been trampled and its bones scattered; it had to be painstakingly removed from the surrounding rock bit by bit. White, in an interview in *Science*, stated that the skull is “squished, and the bone is ... chalky.”

Supporting facts for claims of bipedality

The evidence given—a divergent big toe that is associated with grasping tree branches rather than walking on the ground—is poor evidence for bipedality.

Opinions of other evolutionists

William Jungers of Stony Brook University also questions whether *Ar. Ramidus* could walk upright. “... The evidence for bipedality is limited at best. Divergent big toes are associated with grasping, and this has one of the most divergent big toes you can imagine. Why would an animal fully adapted to support its weight on its forelimbs in the trees elect to walk bipedally on the ground.”

A. *kadabba*

Amount of fossil found

The bone fragments of jaw, arm hand and feet together with a collarbone and some teeth. The fragments were of at least five different specimens.

Location of fossil parts

The fossil parts were found in several different sites. One of the specimens, a toe bone, was found ten miles away and in rock dated to be several hundred thousand years different in age from the rest of the bones.

Condition of fossil

The fossil parts were, for the most part fragmentary.

Supporting facts for claims of bipedality

One of the specimens, a toe bone, was found ten miles away. The toe bone was dated by their methods to be at least 200,000 years younger. This is their only “proof.”

Opinions of other evolutionists

Donald Johanson, discoverer of *A. afarensis*, is doubtful about *Ardipithecus kadabba*'s ability to walk upright. Johanson is "dubious about categorizing the 5.2 million-year-old toe bone with the rest of the fossils: not only is it separated in time by several hundred thousand years, but it was also found ten miles away from the rest."

II. Based on these facts, what is your opinion of the evidence supporting these fossils as true hominids, creatures in the ancestry of man?

Remarks will vary, but the general consensus of opinion should be that there is very little evidence to support either of these fossils as in the line of man.

Section 4

Later Hominids

I. On the page below, state the following facts about A. anamensis, A. afarensis, K. platyops, and A. africanus, based on the text. You may also look at any pictures of these hominids that are available in the book.

A. anamensis

Amount of fossil found

Meave Leakey found the upper and lower sections of a tibia, an almost complete set of lower teeth, a skull fragment, and half of an upper jaw.

Location of fossil parts

The fossil parts were found in 3 different locations. The rock layers holding the teeth and the tibia were dated, using evolutionist methods, to be 500,000 years apart.

Condition and nature of fossil

The tibia is very human in character. If it had been found in younger rock, it would have been classified as human. The tooth and jaw fragments are very apelike. The vertical placement of the canines is found in fossil apes as well as humans.

Supporting facts for claims of bipedality

The tibia is human in its character. If this is the case, it is logical to assume it walked upright. However, even if it is not human, the joint orientation is also found in baboons and old world monkeys.

Opinions of other evolutionists

None given in text.

A. afarensis

Amount of fossil found

About 40% of the skeleton was recovered. However, only a few fragments of the skull were found.

Location of fossil parts

The skeletal bones and fragments of a head were found together. Later the fragments of two skulls were found in a different location.

Condition and nature of fossil

The skeletal bones are in fairly good condition. The skulls were composed of fragments until the “reconstructed” them. The fossil showed the original creature had long, apelike arms which dangled by its body. Fossil parts of other individuals found nearby have been fragmentary.

Supporting facts for claims of bipedality

Based on the structure of the leg and pelvic bones, Johanson believed that the creature was bipedal. However, some members of the modern ape family also may be considered bipedal, but they are definitely still apes.

Opinions of other evolutionists

When he finally allowed others to examine the specimen, some specialists in anatomy disagreed as to whether it walked upright or not.

K. platyops***Amount of fossil found***

In 1999 Justus Erus, a team member of Meave Leakey's expedition, found a partial skull near Lake Turkana in Kenya. Expedition members also found a fragmentary upper jaw. These are the only parts that can be definitely assigned to this species. The find also consisted of about 30 skull and tooth fragments that cannot be definitely determined to be *K. platyops*. Sources other than the original article also mention a big toe bone.

Location of fossil parts

Text does not give this information.

Condition of fossil

The skull, as well as the palate is cracked and distorted. The additional skull and tooth fragments are also distorted.

Supporting facts for claims of bipedality

Although some articles have mentioned that *K. platyops* walked upright, based on one big toe bone, Dr. Leakey made no mention of finding such a bone when she described the original fossil. If such a bone was found later, it takes more than one toe bone to prove a fossil is bipedal.

Opinions of other evolutionists

None given in the text.

A. africanus***Amount of fossil found***

The holotype specimen consisted of a skull. Several specimens in a different location and labeled some of these *A. africanus*. One, a skull nicknamed "Mrs. Ples," together with a jaw from a different location, has become an example of an adult *A. africanus*. Other skeletal bones have been found and assigned to this species until evolutionists now believe that almost all the body parts are represented.

Location of fossil parts

The skull was found in one place. However, the other fossil parts have been found in several locations.

Condition of fossil

The condition of the skull was good enough to sit on the desk of a colleague for several years. However, the other fossil parts are often fragmentary and distorted from the fossilization process.

Supporting facts for claims of bipedality

These bones have not given evidence that *A. africanus* habitually walked on two legs. Instead, many paleoanthropologists believe that the body proportions and joint movement capabilities of *A. africanus* “are most in accord with a four-legged ground moving early hominid that still retained its ability to climb trees and spent considerable time standing on two legs... during feeding.”

Opinions of other evolutionists

The scientific community in London did not accept Dart’s opinion of the fossil Taung skull. Members noted that the skulls of young apes look much more like humans than do those of adult apes. At that time, most refused to accept that *A. africanus* was a link fossil between apes and man. Today there is still much speculation about this species.

II. What is the significance of the Kanapoi hominid?

The Kanapoi hominid is the fossil of a human upper arm bone found in rock strata dated, at over 4 million years old, to be older than all the Australopithecines! So how could we be older than our ancestors?

III. Based on these facts, what is your opinion of the evidence supporting these fossils as true hominids, creatures in the ancestry of man?

Remarks will vary, but the general consensus of opinion should be that there is very little evidence to support either of these fossils as in the line of man.

Section 5

“Final” Hominid

I. Below are listed questions that a thinking person asks himself on hearing of a new fossil find. In the blank spaces state the answers to these questions in reference to *H. habilis*.

1. How much of the fossil was found, and what was its condition?

The fossils consisted of hand bones, foot bones, and cranial fragments belonging to both juveniles and adults. The fossil fragments were mixed in with pieces of other species, including humans, so it was difficult to tell what parts went together.

2. Were all the fossil parts found together, or were they found in several locations?

The pieces of skull were not found in the same location as the skeletal bones. Additional fossil fragments were found in different locations in the general vicinity

3. If they were found in different locations, were they found in rocks of the same age?

The text does not mention rocks of different ages.

4. How were they dated? Were radiometric dates “adjusted” to support geologic time scale dates?

Homo habilis specimens were dated at 1.8 million years old, using the Geologic Time Scale. No mention was made to indicate radiometric dating changes.

5. Are there additional problems with the fossil?

The juvenile bones that were found were very difficult to evaluate. The hand, “differs from humans... in having relatively large fingers with chimpanzee-like curvatures and a thumb, which despite its human-like size, has a more rotated great-ape orientation relative to the other fingers.” In addition, the leg bones are more similar to living great apes than to humans. There is also no proof that *Homo habilis* walked upright.

6. How do some other evolutionists feel about *H. habilis*?

Dr. Ian Tattersall has said, “It is increasingly clear that *Homo habilis* has become a wastebasket taxon, little more than a convenient recipient for a motley assortment of hominid fossils from the latest Pliocene and earliest Pleistocene....”

II. How would you evaluate this fossil find, based on the answers to the questions?

Answers will vary somewhat but the answers to questions 1, 2, and 5 should cause them to question the authenticity of the fossil, as do many evolutionists.

Section 6

Archaic Humans

Until now you have been looking at the traits that a true hominid should possess. Now think in terms of what traits and characteristics are truly human. The list below is a beginning. Verify the status of each of the following fossils based on their exhibiting these human traits and characteristics. In some instances the text may not have included the information. If this is the case, write “information not given.”

1. Shows obvious evidence of walking upright

<i>Homo ergaster</i> (KNM-WT 1500)	Yes. (The bone size, length, and joint orientation indicate this.)
<i>Homo erectus</i>	Yes
<i>Homo heidelbergensis</i>	Yes. (Their bone structure is similar to modern humans.)
<i>Homo neanderthalensis</i>	This is assumed because of their other activities, although the text does not say so.

2. Has a brain capacity of 1100–1450 cubic centimeters

<i>Homo ergaster</i> (KNM-WT 1500)	Information not given
<i>Homo erectus</i>	Yes. (Brain capacity of 850–1100 cc's)
<i>Homo heidelbergensis</i>	Yes. (Brain capacity of 1200–1400 cc's)
<i>Homo neanderthalensis</i>	Yes. (Brain capacity 10% larger than modern man)

3. Bone structure and size is human in character

<i>Homo ergaster</i> (KNM-WT 1500)	Yes
<i>Homo erectus</i>	Information not given, although some may mention that the leg bone of the holotype specimen was human in character.
<i>Homo heidelbergensis</i>	Yes. (Body size similar to modern humans)
<i>Homo neanderthalensis</i>	Yes. (Overall size similar to modern humans)

4. Shows evidence of having used tools

<i>Homo ergaster</i> (KNM-WT 1500)	<i>Information not given</i>
<i>Homo erectus</i>	Yes
<i>Homo heidelbergensis</i>	Yes
<i>Homo neanderthalensis</i>	Yes

5. Shows evidence of the use of fire

<i>Homo ergaster</i> (KNM-WT 1500)	<i>Information not given</i>
<i>Homo erectus</i>	Yes
<i>Homo heidelbergensis</i>	Yes
<i>Homo neanderthalensis</i>	Yes

6. Shows evidence of having buried their dead

<i>Homo ergaster</i> (KNM-WT 1500)	<i>Information not given</i>
<i>Homo erectus</i>	<i>Information not given</i>
<i>Homo heidelbergensis</i>	Yes
<i>Homo neanderthalensis</i>	Yes

II. Based on this information, evaluate the status of each of these Archaic humans.

Are they human or not? WHY?

The consensus of opinion will probably be “yes” for *H. erectus*, *H. heidelbergensis*, and *H. neanderthalensis*. The class may be divided on *H. ergaster*. The problem with mixing of fossil parts, along with lack of information, may lead them to question *H. ergaster*. If so, that is good. It indicates they are using critical thinking in coming to their conclusions.

Sections 7 & 8

The Lake Laetoli Footprints & What Does All This Mean?

I. Place the following words in the blanks in which they belong.
One word will not be used.

volcanic ash	<i>Homo</i>	3.6 million
footprints	expedition	casts
barefoot	<i>A. afarensis</i>	disagree
foot	study	old
agree	bears	similar
ours	habitually unshod	form
Indians	important	humans

The Lake Laetoli Footprints are one of the most important finds of the past twenty years. Mary Leakey's expedition found footprints impressed in hardened volcanic ash. Dr. Leakey states that the footprints are remarkably similar to those of modern man. She also says that the form of the foot was exactly the same as ours. Almost all scientists agree with this description of the footprints.

Potassium-argon tests on the ash in which the footprints were found gave an age of 3.6 million years. Therefore the evolutionary scientific community stated the footprints must have been made by *A. afarensis*.

Richard Tuttle of the University of Chicago made a study of the footprints. At first he compared them to bears. He then made casts of the feet of some Indians of Peru who habitually go barefoot. He states that the footprints resemble habitually unshod humans. He concludes that if the footprints were not so old, we would readily conclude that they were made by a member of our genus, *Homo*. So, simply taking the evidence at face value, the Lake Laetoli footprints were made by humans.

II. What is the significance of the Lake Laetoli footprints?

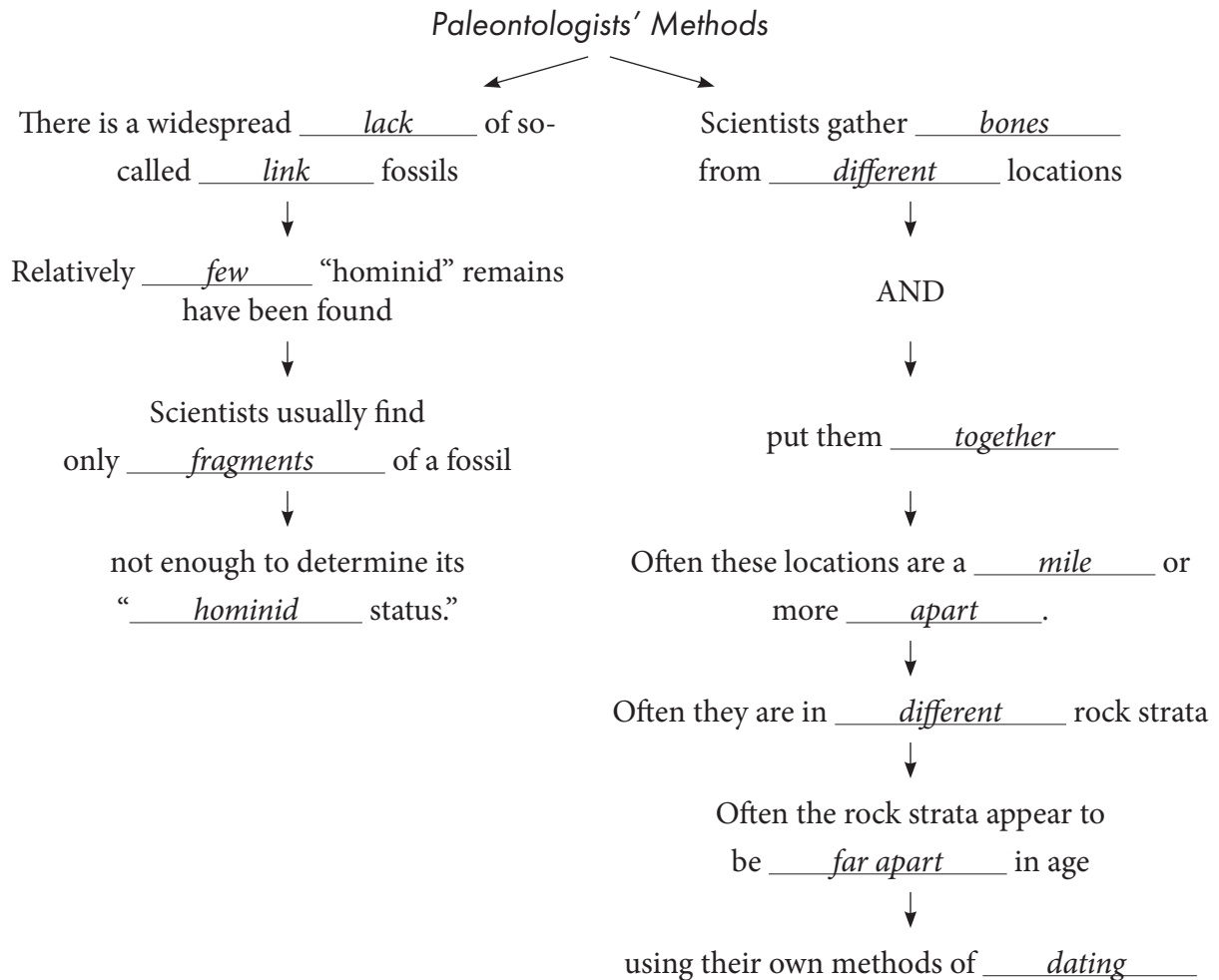
The Lake Laetoli footprints were dated by evolutionists' own methods to be 3.6 million years old. Like the Kanapoi hominid, this places humans before many of their so-called ancestors.

III. In the spaces below, list four questions an intelligent person asks himself when he hears of an important new fossil being discovered.

1. How much of the fossil was found?
2. Were all the fossil parts found together, or were they found in several locations?
3. If they were found in different locations, were they found in rocks of the same age?
4. What was the condition of the fossil parts?
5. How were they dated? Were radiometric dates “adjusted” to support geologic time scale dates?

Concept Map

Evolution of Man?



Vocabulary

In the blanks below write the word which fits the definition.

<u>articulated skeleton</u>	1. A skeleton with bones in place (in correct proximity to one another).
<u>bipedal</u>	2. Walking on two legs.
<u>sexual dimorphism</u>	3. The condition in which male members of the species differ from the females (in size, etc.)
<u>brontosaurus</u>	4. A dinosaur who “never was”.
<u>hominid</u>	5. Human-like species.
<u>extinct</u>	6. Referring to a species which has completely died out.
<u>Kanapoi hominid</u>	7. A fossil of a human upper arm bone dated to be over 4 m.y.o.
<u>Lake Laetoli footprints</u>	8. Impressions in volcanic ash; dated radiometrically to be older than the hominids.
<u>Ramapithecus</u>	9. At first believed to be an ancestor of both apes and man; later discovered to be an orangutan fossil.
<u>Paranthropus boisei</u>	10. At first thought to be a hominid; later believed to be an intruder (or a victim) on a <i>Homo habilis</i> living site. Lack of evidence to support hominid status.

Match the fossil with the correct description:

A. <i>A. afarensis</i>	D. <i>Homo habilis</i>	G. <i>Ar. kadabba</i>
B. <i>A. africanus</i>	E. <i>K. platyops</i>	
C. <i>A. anamensis</i>	F. <i>Ar. ramidus</i>	

<u>A</u>	1. Discovered by Johanson; nicknamed Lucy; no skull found; other scientists disagreed that the creature had been bipedal; older human bone found nearby.
<u>F</u>	2. Discovered by Tim White; fossil smashed and badly distorted; was in so bad a condition “digital reconstruction” and molds had to be used in putting the fossil together; fossil toe was divergent toe used for grasping, not walking.
<u>D</u>	3. Discovered by Lewis & Mary Leakey; very small skull capacity; called “handy human”; consisted of fossil parts from several locations and mixed with bones of other species.

- G 4. Found by Y. Haile-Selassie, a member of Tim White's team; consisted of bone fragments of 5 different individuals, a collarbone and some teeth, and a toe bone found 10 miles away and in rock dated to be at least 200,000 years different in age.
- B 5. Found by Raymond Dart: not extensively studied for many years; later fossils of species fragmentary and often distorted from the fossilization process.
- C 6. Discovered by Meave Leakey in three different locations; fossil consisted of skull fragment, ape-like tooth and jaw fragments, and human-like tibia; parts dated to be 500,000 year different in age.
- E 7. Partial skull and fragmentary upper jaw only parts that could be definitely assigned to this species; skull has been cracked and distorted; no skeletal bones.

Review

I. In the spaces below list some questionable methods used by paleontologists and physical anthropologists.

1. Scientists take fossil parts from two or more locations and put them together.
2. Scientists often assign fossil status to bone fragments and a few teeth.
3. Scientists often take fossil parts from rock layers that are by their own dating methods thousands of years apart in age and put them together to form one fossil.
4. Scientists often have trouble putting fossil parts together correctly because they are unfamiliar with the original animal.

II. In the spaces below name two “link fossils” in the line of man which were at first accepted and later disproved by evolutionists. Then tell what they really were.

1. **Ramapithecus.** The original fossil consisted of a few jaw fragments and teeth. Later, an entire skull with the same type of teeth was found. When scientists put all the pieces together, they discovered they had the head of an orangutan, a member of the ape family.

2. **Paranthropus boisei.** It consisted of a skull together with the upper teeth. The fossil brain was small—approximately 500 cubic centimeters. However, the jaw teeth were quite large. Human remains have been found in almost all the sites where *P. boisei* was found, confusing the issue. Later, scientists decided that “it is probable that the *Zinjanthropus* skull represents an intruder (or a victim) on a *Homo habilis* site.”

III. In the spaces below, give at least two reasons to explain why the seven listed hominids should not be listed as our ancestors.

1. *Ar. ramidus*

- A. The fossil consisted of some teeth and arm bones, a pelvis and some tibia bones. Later, more fossil fragments were found.
- B. The parts had been found in several locations and were in very bad shape. The skull was squished. The bones were in such bad shape Dr. White had to use “digital reconstruction” to help put the bones back together.
- C. The bones were so crushed it seems impossible to put them back together with certainty. The fossil had a divergent big toe which is associated with using forelimbs in trees. So the claim that the fossil had been bipedal has no scientific support.

2. *Ar. kadabba*

- A. Fragments of jaw, arm, hand, and foot bones, along with a collarbone and some teeth were found.
- B. The bone fragments were of at least five different specimens found in several different sites.
- C. One of the specimens, a toe bone, was found ten miles away.
- D. The toe bone was dated by their methods to be at least 200,000 years younger.

3. *A. anamensis*

- A. The bones were found in 3 different locations.
- B. Only sections of a leg bone, a set of lower teeth, and a skull fragment were found.
- C. The rock layers of two of the locations have been dated to be 500,000 years apart in age.
- D. The jaw and teeth fragments are very ape-like.
- E. The tibia bones appear to be human but are in older rock strata so are considered hominid bones.

4. *A. afarensis*

- A. Johanson took a skull and the skeletal bones from three very different locations and put them in the same species.
- B. Other scientists disagreed with Johanson's claim that the fossil had been bipedal.
- C. Some members of the ape family may be considered bipedal.
- B. The Kanapoi hominid, a decidedly human arm bone, was found in older rock strata than *A. afarensis*.

5. *K. platyops*

- A. Fossil consisted of only a partial skull and a fragmentary upper jaw.
- B. The skull, well as the palate, is cracked and distorted.
- C. There are no known skeletal bones for the species, so there is no way to tell how it walked.
- D. Although one article mentioned a toe bone, Dr. Leakey made no mention of it in her original article. However, even if such a bone exists, it takes more than one toe bone to determine how a creature walked.

6. *A. africanus*

- A. Its discoverer never made an intensive study of the fossil and published his results for the scientific community.
- B. The original fossil, the Taung skull, was discounted by other scientists, who mentioned that the skulls of young apes look much like humans.
- C. Mrs. Ples, a later specimen assigned to this species, consisted of a skull and a jaw from different locations.
- D. Skeletal bones later found and assigned to this species are from several locations and often "fragmentary and distorted from the fossilization process."
- E. These skeletal bones have not given evidence that *A. africanus* walked upright.
- F. Paleontologists are unsure of the age of this species.

7. *Homo habilis*

- A. The fossils consisted of hand bones, foot bones, and cranial fragments belonging to both juveniles and adults.
- B. The fossil was composed of bones from several locations.
- C. the fossil fragments were mixed in with pieces of other species, including humans, so it was difficult to tell what parts went together.
- D. The juvenile bones were very difficult to evaluate.
- E. There is no evidence that *H. habilis* walked upright.
- F. Other paleontologists consider *H. habilis* "a wastebasket taxon, little more than a convenient recipient for a motley assortment of hominid fossils from the latest Pliocene and earliest Pleistocene...."

IV. Explain what the following fossils are and discuss their significance.

A. Kanapoi Hominid

A human upper arm bone dated to be as old or older than the australopithecines.

B. Laetoli Footprints

The footprints of unshod humans in hardened, volcanic ash dated radiometrically to be 3.6 million years old, older than many of the proposed hominids.

So how can humans be older than their ancestors, as evolutionists' own dating methods prove them to be?

V. In the space below give five questions a thinking person should ask each time he hears of a new fossil find.

1. How much of the fossil was found?
2. Were all the fossil parts found together, or were they found in several locations?
3. If they were found in different locations, were they found in rocks of the same age?
4. What was the condition of the fossil parts?
5. How were they dated? Were radiometric dates adjusted to support geologic time scale dates?

VI. What is a more logical way to classify Archaic humans?

They are simply different varieties of human beings just like we have in the world today.

Test

Matching

Use the letters below to fill in the space provided. Each question is worth 1 point each

- | | |
|-------------------------|----------------------------|
| A. Articulated skeleton | F. hominid |
| B. bipedal | G. Kanapoi hominid |
| C. <i>Ramapithecus</i> | H. Lake Laetoli footprints |
| D. <i>Brontosaurus</i> | I. sexual dimorphism |
| E. Extinct | J. <i>P. boisei</i> |

- F 1. Human-like species
- A 2. A complete set of bones of one creature all in one place
- D 3. A dinosaur who never was.
- H 4. Impressions in volcanic ash; dated radiometrically to be older than the hominids
- E 5. Referring to a species that has died out
- C 6. A hominid that was really an orangutan
- I 7. A condition in which the male members of a species are veruy different in shape or size from the females
- B 8. Walking on two legs
- G 9. Also known as KP271; an upper human arm bone found in rock strata dated to be older than the australopithecines
- J 10. At first thought to be a hominid; later believed to be an intruder (or a victim) on a *Homo habilis* living site. Lack of evidence to support hominid status.

True and False

Circle T if the statement is true or F if the statement is false. Each question is worth one point.

- F 1. A great number of hominid fossil remains have been found.
- F 2. Scientists are careful to include only fossil parts found in the same rock strata.
- F 3. *Ar. ramidus* consisted of an articulated skeleton.
- T 4. Scientists often put bones from different locations together to form one fossil.

- F 5. Paleontologists can generally date their fossils fairly accurately.
- T 6. Brontosaurus is really an *Apatosaurus* with the wrong head.
- F 7. *A. kadabba* has more evidence to support its hominid status than *A. ramidus*.
- F 8. In addition to a skull, paleontologists also had several skeletal bones of *K. platyops*.
- T 9. Parts of the *A. anamensis* fossil were dated to be 500,000 years different in age.
- T 10. In determining the validity of a hominid, it is important to know how much of the fossil was found.
- T 11. The fossilization process often distorts fossils.
- T 12. Scientists often assign “hominid status” to human bones when they are considered too old to be human.

In the spaces below, give two reasons why each of the hominids listed are poor choices for our ancestors. Each answer is worth 2 points each.

Any of the following is acceptable.

1. *Ar. ramidus*

- A. The fossil consisted of some teeth and arm bones, a pelvis and some tibia bones. Later, more fossil fragments were found.
- B. The parts had been found in several locations and were in very bad shape. The skull was squished. The bones were in such bad shape Dr. White had to use “digital reconstruction” to help put the bones back together.
- C. The bones were so crushed it seems impossible to put them back together with certainty. The fossil had a divergent big toe which is associated with using forelimbs in trees. So the claim that the fossil had been bipedal has no scientific support.

2. *Ar. kadabba*

- A. Fragments of jaw, arm, hand, and foot bones, along with a collarbone and some teeth were found.
- B. The bone fragments were of at least five different specimens found in several different sites.
- C. One of the specimens, a toe bone, was found ten miles away.
- D. The toe bone was dated by their methods to be at least 200,000 years younger.

3. *A. anamensis*

- A. The bones were found in 3 different locations.
- B. Only sections of a leg bone, a set of lower teeth, and a skull fragment were found.
- C. The rock layers of two of the locations have been dated to be 500,000 years apart in age.
- D. The jaw and teeth fragments are very ape-like.
- E. The tibia bones appear to be human but are in older rock strata so are considered hominid bones.

4. *A. afarensis*

- A. Johanson took a skull and the skeletal bones from three very different locations and put them in the same species.
- B. Other scientists disagreed with Johanson's claim that the fossil had been bipedal.
- C. Some members of the ape family may be considered bipedal.
- D. The *Kanapoi hominid*, a decidedly human arm bone, was found in older rock strata than *A. afarensis*.

5. *K. platyops*

- A. Fossil consisted of only a partial skull and a fragmentary upper jaw.
- B. The skull, well as the palate, is cracked and distorted.
- C. There are no known skeletal bones for the species, so there is no way to tell how it walked.
- D. Although one article mentioned a toe bone, Ms. Leakey made no mention of it in her original article. However, even if such a bone exists, it takes more than one toe bone to determine how a creature walked.

6. *A. africanus*

- A. Its discoverer never made an intensive study of the fossil and published his results for the scientific community.
- B. The original fossil, the Taung skull, was discounted by other scientists, who mentioned that the skulls of young apes look much like humans.
- C. Mrs. Ples, a later specimen assigned to this species, consisted of a skull and a jaw from different locations.
- D. Skeletal bones later found and assigned to this species are from several locations and often "fragmentary and distorted from the fossilization process."
- E. These skeletal bones have not given evidence that *A. africanus* walked upright.
- F. Paleontologists are unsure of the age of this species.

7. *Homo habilis*

- A. The fossils consisted of hand bones, foot bones, and cranial fragments belonging to both juveniles and adults.
- B. The fossil was composed of bones from several locations.
- C. The fossil fragments were mixed in with pieces of other species, including humans, so it was difficult to tell what parts went together.
- D. The juvenile bones were very difficult to evaluate.
- E. There is no evidence that *H. habilis* walked upright.
- F. Other paleontologists consider *H. habilis* "a wastebasket taxon, little more than a convenient recipient for a motley assortment of hominid fossils from the latest Pliocene and earliest Pleistocene...."

In the space below write a paragraph explaining what the two following fossils are and discussing their significance: Kanapoi hominid, Laetoli footprints. (6 points)

The Kanapoi hominid is a human upper arm bone. The Lake Laetoli footprints were made by unshod humans and are dated radiometrically to be 3.6 million years old. Thus, using evolutionists'

own dating methods, modern humans have been shown to co-exist with or pre-exist the so-called hominids.

Name at least two questions a thinking person should ask before accepting a fossil as a hominid.

Any two of the following are correct:

1. How much of the fossil was found?
2. Were all the fossil parts found together?
3. Were they found in the same rock layer?
4. What was the condition of the fossil parts?
5. How were they dated? Were radiometric dates “adjusted” to support geologic column dates?

VI. What is a more logical way to classify Archaic humans?

They are simply different varieties of human beings just like we have in the world today.

Chapter 9

Suggestions for Beginning

Have available some sort of simple machine which is easily taken apart. A manual can opener might do. Even though the mousetrap is discussed in this chapter, it is also an excellent machine to use, and the repetition will not hurt your student(s). Discuss with your student(s) what the machine is and how it works. Point out that it has at least three necessary parts. One by one, suggest taking away or modifying various parts of the machine. Ask the following questions as you mention each part.

1. Would the machine still work without this part?
2. Could I damage this part without damaging the effectiveness of the machine?
3. Why not?
4. Would there be any reason for this machine to exist, if this part were missing?

The consensus of opinion generally is that there is no reason for the machine to exist unless it is complete and functional. Therefore, it is an irreducibly complex structure. Point out that machines in nature are constructed in the same way.

Sections Question Key

Section One: Perfection in the Microscopic World

1. Define irreducibly complex structure. Give an example.

An irreducibly complex structure is a “machine” that consists of at least three components, each of which must be present and working harmoniously with the others for the machine to function. A good example is a mousetrap.

2. What can the cell be compared to? Why? Give an example.

A cell can be compared to a fully automated factory because it contains a series of automated machines, each performing a task and working in perfect harmony with the others. For example, the “head office” would correspond to the DNA. The “foreman” would correspond to the messenger RNA. The “assembly line” would correspond to the Ribosomal RNA, etc.

3. Summarize transmembrane transport, using Dr. Behe’s analogy.

Transmembrane transport is the movement of a protein through a portal in the membrane of the organelle for which it was designed. In order for this to happen, there must be three essential parts. First of all, the clathrin vesicle carries the protein to an organelle such as a lysosome. The clathrin vesicle has a v-SNARE protein attached to it. When it reaches the lysosome, a t-SNARE protein on the lysosome “recognizes” the v-SNARE protein and allows the protein through the lysosome’s membrane. This process has been compared to an automated garage in which a scanner (the t-SNARE protein) “reads” the license plate (the v-SNARE protein) on a car (the clathrin vesicle) and then permits it to enter. It is considered irreducibly complex because it has three parts and each part must be in place and functioning, or the system will not work.

4. Why is the bacterial flagellum often called an irreducibly complex structure? Explain.

The bacterial flagellum consists of a filament that is turned by a motor at its base. The motor has rings which appear to function like bearings in a mechanical motor. The base is connected to the filament by a hook that resembles the universal joint in a manmade motor. The flagellum is run by electricity generated by the bacterium. . The flagellum has at least three essential parts, all of which must be present and functioning together, in order for it to work. Therefore, it is irreducibly complex.

Section Two: Perfection in Animals and Birds

1. What is unique about the bird's respiratory system? Why is it difficult to see how it could have evolved?

Birds have one-way lungs where air comes in through one passage, and after oxygen is absorbed, it is expelled through another. Other creatures have two-way lungs (man included) where air is taken in and released through the same passages. Without the front air sacs, the rear air sacs, and the one way air passages all in place and functioning, the system would not work, so it is irreducibly complex. There is no reason for any of the parts without all the parts in place and functioning.

2. What is unique about the bat microchiroptera's echolocation system which makes it an irreducibly complex structure?

Microchiroptera's system for locating insects is called biosonar. It consists of a complex, inter-dependent working relationship between the bat's specialized larynx, ears, and brain. The larynx sends out an ultra high frequency sound wave. These sounds are then reflected back to the bat's ears. (The bat's external ears are very large, while its internal ears are extremely sensitive.) In a split second, the bat's brain must then analyze the collected information, separating the sound of its own pulse from that of other bats and determining the size and nature of an object and its distance away. This system requires split second coordination between the bat's brain, ear, and larynx. If any part were missing, the system would not work and the bat would not survive. Therefore, it is an irreducibly complex structure.

3. Why would it be necessary for the giraffe's circulatory system to have been complete and in place in the first giraffe? Explain.

The giraffe's circulatory system consists of an unusually large heart, together with a unique set of arteries and veins. First of all, the heart of the average giraffe weighs about 11 kg (25 lb). Its size and strength are necessary to pump blood to the giraffe's long legs and neck. However, the arteries are also specially adapted. Blood travels to the giraffe's brain through the common and external carotid arteries. Before these arteries reach the brain, there is a connection between them and the vertebral artery. When the head is lowered, some of the blood is shunted off through this connection and also into smaller arteries which expand, lowering blood pressure to the head. Specialized valves also prevent backflow of blood to the brain at this time. When the giraffe raises its head, these same arteries adjust quickly to retain blood in the brain. In addition, the veins' specialized valves also prevent part of the blood from receding from the brain. These valves also prevent blood from backflowing when it is returning to the heart from the legs. All of these parts works in harmony with the others, and if any were missing, the giraffe would not survive.

Section Three: Perfection in Larger Systems

1. Explain how the oxygen and oxygen-weathering cycles work together to keep oxygen in balance on the Earth.

Oxygen balance is a complicated system of checks and balances which enables the oxygen level in the Earth's atmosphere to remain relatively stable. First of all, part of the balance is achieved through the plant-animal cycle. Animals take in oxygen and expel carbon dioxide. Plants take in carbon dioxide and give off oxygen. Chemical weathering takes oxygen from the atmosphere. However, it also adds phosphorus to the ocean water. This phosphorus stimulates the algae in the ocean to grow and produce more oxygen. If too much oxygen is produced, bacteria on the ocean's bottom take phosphorus out of the ocean water, slowing down the growth of algae and their production of oxygen. Ocean density currents are also needed to mix surface water with water from the ocean's floor.

Section Four: Ideal Characteristics of Water and Sunlight

1. List three of the special attributes of water and explain their significance.

Any three of the following:

- A. Water contracts when temperature is lowered until it reaches 40 centigrade. Then it expands. If this didn't happen, ice would sink to the bottoms of the lakes, rivers and oceans until all would eventually freeze up.
- B. When ice melts and water evaporates, heat is absorbed. When water freezes or condenses, heat is released. Both events cause a moderation of temperature change. Without this characteristic of water, the climate would be subject to far more rapid temperature changes. On a personal level, the evaporation of perspiration on the body helps to cool it on a hot day.
- C. The specific heat of water is very high. Because of this our climate is greatly moderated. Also, because of water's ability to hold heat, surface currents in the ocean can carry heat to areas in the north that ordinarily would be too cold to be inhabited. Other surface currents also bring cool water to the warmer latitudes, moderating their temperatures.
- D. The thermal conductivity of water is four times greater than that of most other liquids. This enables oceans to absorb sufficient radiant heat from sunlight to warm their surface waters in tropical and subtropical areas. Surface currents then carry the warm water to colder climates.
- E. The thermal conductivity of ice and snow is very low. This enables animals living in the polar areas to burrow into the snow and retain much of their body heat. Also, the ice on the surface of bodies of water provides insulation of sorts to the water beneath it, protecting marine creatures during the winter.

2. Explain why the sun's beneficial radiation reaches the Earth's surface, while most of the sun's harmful radiation does not.

First of all, the electromagnetic spectrum is composed of extremely short to very long waves. However, only a tiny part of the spectrum is beneficial to living things. The sun produces a wide range of frequencies of the electromagnetic spectrum. However, because its surface temperature

is approximately 6000o C, it produces the majority of its energy in this tiny, beneficial band. The Earth's atmosphere has a layer of ozone which blocks much of the harmful ultraviolet rays which do leave the sun. Nearer the Earth, oxygen and other atmospheric gases, as well as water, absorbs more harmful radiation. Yet the atmospheric gases and water both allow the beneficial radiation to pass through.

Section Five: Planet Earth's Perfect Position in the Solar System and the Universe

1. List four of special characteristics of a habitable planet mentioned by Dr. Brownlee and Dr. Ward, and explain why these characteristics are necessary.

Any of the following:

1. Right distance from a star
2. Right planetary mass
3. Plate tectonics
4. Jupiter-like neighbor
5. Ocean(s) of the right size
6. Stable planetary orbits
7. Large moon
8. The right tilt
9. The right atmosphere
10. The right galaxy
11. The right position in the galaxy
12. The right amount of carbon
13. Oxygen
14. Few impacts from large asteroids and meteoroids

Reasons:

Any four of the following:

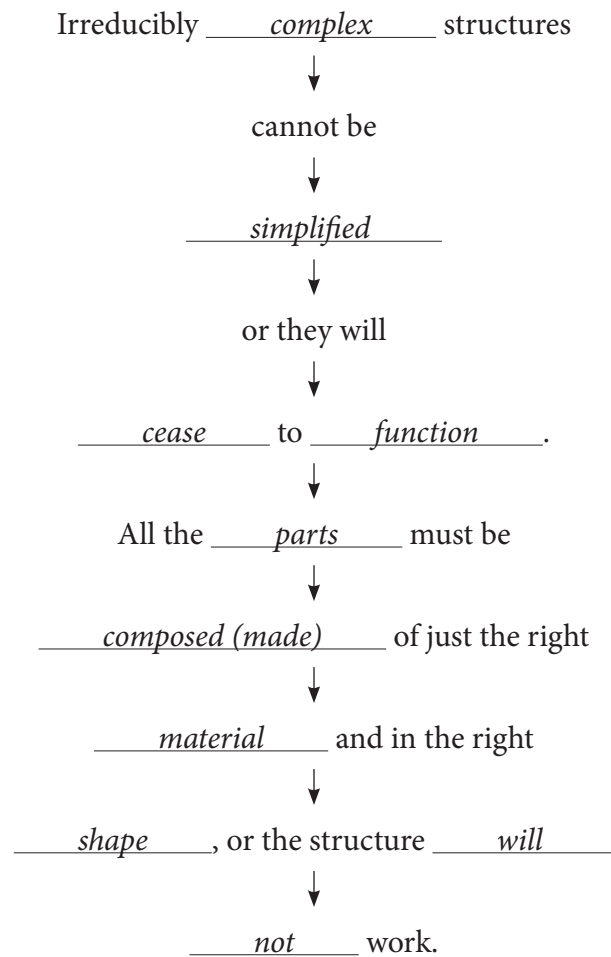
- A. Right distance from the sun: If the Earth were 5% nearer or 15% farther away, the Earth would be uninhabitable.
- B. The right tilt: The Earth tilted on its axis at 23½ degrees to the path of its orbit enables a much larger portion of the Earth to be inhabited.
- C. Large oceans filled with water: without it, carbon-based life could not exist.
- D. A large moon: This is necessary to stabilize the Earth's tilt as it circles the Sun.
- E. The Earth's position in the galaxy: Because we are in an area of relatively few stars, and far enough from the galaxy's center, we are not adversely affected by too many gamma rays, x-rays or other types of ionizing radiation.
- F. Students will no doubt come up with other ones.

2. Why does Dr. Denton's assessment seem far more logical than that of Dr. Brownlee and Dr. Ward?

In spite of the fact that they accurately present evidence that requires intelligent action on the part of a creator, Dr. Ward and Dr. Brownlee choose to ignore that evidence. They state instead that such a creator would be hard pressed, under natural law, to create such a universe and such a planet as earth. Isn't it far more logical to assume that such uniqueness requires a creator and that such a creator would have established the natural laws also. Dr. Denton does this. When he sees intelligent design all around him, he assumes intelligent action created it.

Concept Map

Irreducible Complexity



Review

Matching

Match the following terms with their definitions.

- | | |
|--------------------------------|--------------------------------------|
| A. Biosonar | G. Surface tension |
| B. Bacterial flagellum | H. Irreducibly complex structure |
| C. Oxygen balance | I. Water's essential characteristics |
| D. Pervasiveness of perfection | J. A cell |
| E. Electromagnetic spectrum | |
| F. Gated transport | |

- D 1. The idea that the Earth is filled with extremely complex systems much like computers, each system perfectly suited to perform its particular function and also to work together in harmony with other systems to achieve greater goals.
- H 2. A “machine” that consists of at least three components, each of which must be present and working harmoniously with the others for the machine to function.
- F 3. The movement of materials through the membranes of various organelles and through the cell membrane itself.
- A 4. The name of a bat's echolocation system.
- B 5. The extension on the body of a bacteria that looks something like a tail; its construction has been compared to that of an outboard motor.
- C 6. The maintenance of a steady level of oxygen in the Earth's atmosphere.
- G 7. This causes water to rise up through the soil into the roots of plants and up their stems to their tops.
- E 8. The radiation emitted by the sun and other stars, characterized by waves of widely varying wavelengths and frequencies.
- J 9. A good example of a fully automated, self-replicating factory.
- I 10. Its special thermal and chemical properties and its surface tension.

Short answer

Answer the following in short but complete sentences:

1. What did Darwin expect that scientists would find as they were able to study smaller units? What did scientists actually find?

Darwin thought things would become simpler. Actually, scientists found layer upon layer of complexity.

2. Why is the bat's brain extraordinary?

The bat's brain must separate the reflected sound of its own pulse from that of other bats and determine the nature and size of the object and its distance away, all in a split second.

3. What do most compounds do as they get colder and freeze—expand or contract? What does water do? Why is this important?

Most compounds contract. As water nears freezing temperature, it begins to contract so that ice is 10% less dense than water. As a result ice floats on water, it insulates the water so that creatures in the water can survive. In addition, in the spring the ice melts, allowing for the water to support life around it, instead of slowly building up as ice year after year and preventing life from surviving around it.

4. Why is oxygen balance important?

The oxygen in the Earth's atmosphere must be maintained at a relatively steady level or living things would not survive. We would either suffocate or be destroyed by fire storms.

5. How has the cell been described?

The cell has been described as a fully automated, self-replicating factory with a complexity that man has not come close to achieving.

Essay questions

Answer the following questions in detail, using complete sentences:

1. Explain how the cell resembles a man-made factory.

Like a man-made factory, the cell has a head office (DNA), foremen (messenger RNA), an assembly line (ribosomal RNA, along with the endoplasmic reticulum and the Golgi apparatus), a power plant (mitochondria), warehouses (cell vacuoles), and a garbage disposal unit (lysosome), to name a few.

2. What is gated transport? Describe the process. Why is it considered irreducibly complex?

Gated transport is the movement of a protein through a portal in the membrane of the organelle for which it was designed. In order for this to happen, there must be three essential parts. First of all, the clathrin vesicle carries the protein to an organelle such as a lysosome. The clathrin vesicle has a v-SNARE protein attached to it. When it reaches the lysosome, a t-SNARE protein on the lysosome "recognizes" the v-SNARE protein and allows the protein through the lysosome's membrane. This process has been compared to an automated garage in which a scanner (the t-SNARE

protein) “reads” the license plate (the v-SNARE protein) on a car (the clathrin vesicle) and then permits it to enter. It is considered irreducibly complex because it has three parts and each part must be in place and functioning, or the system will not work.

3. Describe the parts of the bacterial flagellum and explain how each part works with the others to form an irreducibly complex structure.

The bacterial flagellum consists of a filament that is turned by a motor at its base. The motor has rings that appear to function like bearings in a mechanical motor. The base is connected to the filament by a hook that resembles the universal joint in a manmade motor. The flagellum is run by electricity generated by the bacterium. When energy is applied, the shaft rotates counterclockwise inside the rings, moving the bacteria in a straight line. If it rotates clockwise, the bacterium halts and changes direction slightly. The flagellum has at least three essential parts, all of which must be present and functioning together, in order for it to work. Therefore, it is irreducibly complex.

4. How are birds’ lungs different from ours? Why would they be considered irreducibly complex?

Birds have one-way lungs where air comes in through one passage, and after oxygen is absorbed, it is expelled through another. Other creatures have two-way lungs (man included) where air is taken in and released through the same passages. Without the front air sacs, the rear air sacs, and the one way air passages all in place and functioning, the system would not work, so it is irreducibly complex.

5. Give the name of the bat microchiroptera’s system for locating insects, list each part of the system, and explain how they all work together to enable the bat to find food.

Microchiroptera’s system for locating insects is called biosonar. It consists of a complex, interdependent working relationship between the bat’s specialized larynx, ears, and brain. The larynx sends out an ultra high frequency sound wave. These sounds are then reflected back to the bat’s ears. (The bat’s external ears are very large, while its internal ears are extremely sensitive.) In a split second, the bat’s brain must then analyze the collected information, separating the sound of its own pulse from that of other bats and determining the size and nature of an object and its distance away.

6. Describe the giraffe’s unique circulatory system and explain how each part works together with the others to enable the giraffe to survive, in spite of its long neck and legs.

The giraffe’s circulatory system consists of an unusually large heart, together with a unique set of arteries and veins. First of all, the heart of the average giraffe weighs about twenty-five pounds. Its size and strength are necessary to pump blood to the giraffe’s long legs and neck. However, the arteries are also specially adapted. Blood travels to the giraffe’s brain through the common and external carotid arteries. Before these arteries reach the brain, there is a connection between them and the vertebral artery. When the head is lowered, some of the blood is shunted off through this connection and also into smaller arteries which expand, lowering blood pressure to the head. Specialized valves also prevent backflow of blood to the brain at this time. When the giraffe raises its head, these same arteries adjust quickly to retain blood in the brain. In addition, the veins’ specialized valves also prevent part of the blood from receding from the brain. These valves also prevent blood from backflowing when it is returning to the heart from the legs.

7. Describe in detail the different elements of oxygen balance. Include an explanation of the plant-animal cycle, chemical weathering, the action of algae and bacteria, and density currents.

Oxygen balance is a complicated system of checks and balances which enables the oxygen level in the Earth's atmosphere to remain relatively stable. First of all, part of the balance is achieved through the plant-animal cycle. Animals take in oxygen and expel carbon dioxide. Plants take in carbon dioxide and give off oxygen. Chemical weathering takes oxygen from the atmosphere. However, it also adds phosphorus to the ocean water. This phosphorus stimulates the algae in the ocean to grow and produce more oxygen. If too much oxygen is produced, bacteria on the ocean's bottom take phosphorus out of the ocean water, slowing down the growth of algae and their production of oxygen. Ocean density currents are also needed to mix surface water with water from the ocean's floor.

8. Select two of the thermal properties of water and explain how these characteristics help to make life possible on Earth.

Any two of the following:

- A. Water contracts when temperature is lowered until it reaches 40 centigrade. Then it expands. If this didn't happen, ice would sink to the bottoms of the lakes, rivers and oceans until all would eventually freeze up.
- B. When ice melts and water evaporates, heat is absorbed. When water freezes or condenses, heat is released. Both events cause a moderation of temperature change. Without this characteristic of water, the climate would be subject to far more rapid temperature changes. On a personal level, the evaporation of perspiration on the body helps to cool it on a hot day.
- C. The specific heat of water is very high. Because of this our climate is greatly moderated. Also, because of water's ability to hold heat, surface currents in the ocean can carry heat to areas in the north that ordinarily would be too cold to be inhabited. Other surface currents also bring cool water to the warmer latitudes, moderating their temperatures.
- D. The thermal conductivity of water is four times greater than that of any other liquid. This enables oceans to absorb sufficient radiant heat from sunlight to warm their surface waters in tropical and subtropical areas. Surface currents then carry the warm water to colder climates.
- E. The thermal conductivity of ice and snow is very low. This enables animals living in the polar areas to burrow into the snow and retain much of their body heat. Also, the ice on the surface of bodies of water provides insulation of sorts to the water beneath it, protecting marine creatures during the winter.

9. Explain how the energy of the electromagnetic spectrum is uniquely suited to favor life on earth. Include an explanation of how the sun produces it and also how the Earth's atmosphere affects what energy reaches the Earth's surface.

First of all, the electromagnetic spectrum is composed of extremely short to very long waves. However, only a tiny part of the spectrum is beneficial to living things. The sun produces all of the waves of the electromagnetic spectrum. However, because its surface temperature is approximately 6000°C, it produces the majority of its energy in this tiny, beneficial band. The Earth's atmosphere has a layer of ozone that blocks much of the harmful ultraviolet rays which do leave the sun. Nearer the Earth, oxygen and other atmospheric gases, as well as water, absorbs more harmful radiation. Yet the atmospheric gases and water both allow the beneficial radiation to pass through.

10. Pick out three of the characteristics mentioned by Drs. Ward and Brownlee as being necessary for the Earth to sustain life and explain why they are important.

Any three of the following:

- A. Right distance from the sun: If the Earth were 5% nearer or 15% farther away, the Earth would be uninhabitable.
- B. Jupiter-like neighbor: A large planet nearby acts as a “vacuum cleaner” attracting the asteroids and meteors that might otherwise hit the Earth.
- C. The right tilt: The Earth tilted on its axis at $23\frac{1}{2}$ degrees to the path of its orbit enables a much larger portion of the Earth to be inhabited.
- D. Large oceans filled with water: without it, carbon-based life could not exist.
- E. A large moon: This is necessary to stabilize the Earth’s tilt as it circles the Sun.
- F. The Earth’s position in the galaxy: Because we are in an area of relatively few stars, and far enough from the galaxy’s center, we are not adversely affected by too many gamma rays, x-rays or other types of ionizing radiation.

Test

Multiple Choice

Circle the letter of the correct answer below. Be sure you read every answer before you decide!

- B 1. The “pervasiveness of perfection” means:
- A. perfection is uncommon in nature
 - B. everywhere there are machines and systems carefully built and suited for the tasks they perform
 - C. there are some machines in nature that are well suited for their tasks
 - D. perfection is common only in the microscopic world
- D 2. In an irreducibly complex structure:
- A. the parts work well together
 - B. there are no moving parts
 - C. the machine will not work unless all the parts are present and functioning together
 - D. both A and C
- A 3. When Darwin formulated his theory, he believed that as scientists studied smaller and smaller units, they would find that:
- A. things became increasingly less complicated
 - B. things became more complex
 - C. the same degree of complexity
 - D. none of the above
- D 4. As scientists have studied smaller and smaller units, they have found:
- A. that things become less complicated
 - B. layer upon layer of complexity
 - C. microscopic machines
 - D. both B and C
- D 5. A cell is a good example of:
- A. an automated factory
 - B. a complex system of machines working together
 - C. an irreducibly complex structure
 - D. all of these

- D 6. Gated transport is:
- A. carrying of proteins through the cell's cytoplasm to the ribosomes
 - B. movement through the membrane of the organelle for which the protein was produced
 - C. a good illustration of the complexity of cellular activities
 - D. both B and C
- C 7. The bacterial flagellum is considered an irreducibly complex structure because:
- A. it has more than one part
 - B. it is small
 - C. it has at least three essential parts
 - D. none of these
- A 8. A bacterial flagellum has been compared to:
- A. an outboard motor
 - B. a boat
 - C. a cell
 - D. a tail
- D 9. Birds' lungs:
- A. have one-way passages
 - B. have two-way passages
 - C. are irreducibly complex
 - D. both A and C
- C 10. Bats navigate by a complex system which may be called:
- A. biosonar
 - B. an irreducibly complex structure
 - C. both A and B
 - D. neither A nor B
- A 11. Biosonar:
- A. is an echolocation system
 - B. is a relatively simple system
 - C. could easily have evolved
 - D. involves only the ears and larynx of the bat
- D 12. The bat's brain is extraordinary because:
- A. it must be able to separate the reflected sound of its own pulse from that of other bats
 - B. it must determine the size of an object and its distance away
 - C. it requires split-second cooperation of larynx, ears and brain
 - D. A, B, and C are correct
 - E. none are correct
- B 13. The giraffe's circulatory system:
- A. could have evolved rather easily
 - B. is uniquely suited to its specialized body
 - C. is relatively uncomplicated
 - D. none of the above

- C 14. The feature of the giraffe's body that presents the greatest challenge from an evolutionary standpoint is:
- A. the heart
 - B. the long neck
 - C. the system of blood vessels
 - D. the liver
- D 15. The giraffe has a unique situation because:
- A. it must have a large, strong heart to pump enough blood to its long neck and legs
 - B. it must be able to bend its head to the ground to drink water
 - C. its body cannot stand a great fluctuation in blood pressure
 - D. all of the above
- A 16. The giraffe's body:
- A. has a unique system of arteries and veins
 - B. has a unique system of arteries but a very ordinary system of veins
 - C. has a unique system of veins but a very ordinary system of arteries
 - D. none of the above
- E 17. The giraffe's veins:
- A. are much like those of other mammals
 - B. have valves to counteract the effects of gravity on the giraffe's long legs
 - C. have valves to prevent part of the blood from receding from the brain
 - D. have specialized valves only near the aorta
 - E. both B and C
- D 18. In the giraffe's arteries:
- A. some of the blood is shunted off to the vertebral artery when the head is lowered
 - B. blood travels the same way it does in other mammals
 - C. some of the arteries expand and contract to hold different amounts of blood
 - D. both A and C
- B 19. Oxygen balance is:
- A. relatively unimportant
 - B. is very important, since too much or too little oxygen can lead to disastrous effects
 - C. is achieved only by the balance between animal and plant life
 - D. none of the above

- D 20. Part of oxygen balance is achieved by:
- A. animals giving off carbon dioxide that plants use and, in turn, give off oxygen
 - B. chemical weathering removing oxygen from the atmosphere
 - C. algae in the ocean producing oxygen
 - D. all of the above
- C 21. Oxygen balance is also aided by:
- A. bacteria on the ocean's bottom
 - B. density currents in the oceans
 - C. both A and B
 - D. neither A nor B
- F 22. The Earth is uniquely suited for life because it has:
- A. the right tilt
 - B. ocean(s) of the right size
 - C. the right atmosphere
 - D. the right amount of carbon
 - E. both A and B
 - F. A, B, C, and D
- A 23. Most compounds:
- A. contract as they get colder
 - B. expand as they get colder
 - C. remain the same as they get colder
 - D. none of the above
- B 24. Water:
- A. contracts as it gets colder and freezes
 - B. contracts as it gets colder until it reaches 40 centigrade
 - C. remains the same as it gets colder
 - D. contracts as it gets warmer
- D 25. The following characteristic(s) of water is (are) absolutely necessary for life on Earth:
- A. water's thermal characteristics
 - B. water's surface tension
 - C. water's chemical properties
 - D. A, B, and C are correct
 - E. only A and B are correct
- C 26. The electromagnetic spectrum:
- A. is composed of waves that reach the Earth in equal amounts
 - B. is composed of waves, most of which are beneficial to living things
 - C. is composed of waves, most of which are harmful to living things
 - D. is composed of waves with a narrow band of wavelengths

- B 27. The sun produces the majority of its radiation in:
- A. the ultraviolet band
 - B. the near ultraviolet, visible light, and near infrared bands
 - C. radio waves
 - D. gamma rays
- C 28. Very little harmful radiation reaches the Earth because:
- A. the sun produces very little harmful radiation
 - B. the Earth's atmosphere acts to block harmful radiation
 - C. both A and B
 - D. the harmful radiation is unable to travel so far through space

Essay Questions

Below are nine essay questions dealing with what you have learned in this chapter. Select four of these and answer them as clearly and fully as possible. Each question is worth five points.

1. Explain how the cell resembles a man-made factory.

Like a man-made factory, the cell has a head office (DNA), foremen (messenger RNA), an assembly line (ribosomal RNA, along with the endoplasmic reticulum and the Golgi apparatus), a power plant (mitochondria), warehouses (cell vacuoles), and a garbage disposal unit (lysosome), to name a few.

2. What is gated transport? Describe the process. Why is it considered irreducibly complex?

Gated transport is the movement of a protein through a portal in the membrane of the organelle for which it was designed. In order for this to happen, there must be three essential parts. First of all, the clathrin vesicle carries the protein to an organelle such as a lysosome. The clathrin vesicle has a v-SNARE protein attached to it. When it reaches the lysosome, a t-SNARE protein on the lysosome "recognizes" the v-SNARE protein and allows the protein through the lysosome's membrane. This process has been compared to an automated garage in which a scanner (the t-SNARE protein) "reads" the license plate (the v-SNARE protein) on a car (the clathrin vesicle) and then permits it to enter. It is considered irreducibly complex because it has three parts and each part must be in place and functioning, or the system will not work.

3. Describe the parts of the bacterial flagellum and explain how each part works with the others to form an irreducibly complex structure.

The bacterial flagellum consists of a filament that is turned by a motor at its base. The motor has rings which appear to function like bearings in a mechanical motor. The base is connected to the filament by a hook that resembles the universal joint in a manmade motor. The flagellum is run by electricity generated by the bacterium. When energy is applied, the shaft rotates counterclockwise inside the rings, moving the bacteria in a straight line. If it rotates clockwise, the bacterium halts and changes direction slightly. The flagellum has at least three essential parts, all of which must be present and functioning together, in order for it to work. Therefore, it is irreducibly complex.

4. How are birds' lungs different from ours? Why would they be considered irreducibly complex?

Birds have one-way lungs where air comes in through one passage, and after oxygen is absorbed, it is expelled through another. Other creatures have two-way lungs (man included) where air is taken in and released through the same passages. Without the front air sacs, the rear air sacs, and the one way air passages all in place and functioning, the system would not work, so it is irreducibly complex.

5. Give the name of the bat microchiroptera's system for locating insects, list each part of the system, and explain how they all work together to enable the bat to find food.

Microchiroptera's system for locating insects is called biosonar. It consists of a complex, interdependent working relationship between the bat's specialized larynx, ears, and brain. The larynx sends out an ultra high frequency sound wave. These sounds are then reflected back to the bat's ears. (The bat's external ears are very large, while its internal ears are extremely sensitive.) In a split second, the bat's brain must then analyze the collected information, separating the sound of its own pulse from that of other bats and determining the size and nature of an object and its distance away.

6. Describe the giraffe's unique circulatory system and explain how each part works together with the others to enable the giraffe to survive, in spite of its long neck and legs.

The giraffe's circulatory system consists of an unusually large heart, together with a unique set of arteries and veins. First of all, the heart of the average giraffe weighs about twenty-five pounds. Its size and strength are necessary to pump blood to the giraffe's long legs and neck. However, the arteries are also specially adapted. Blood travels to the giraffe's brain through the common and external carotid arteries. Before these arteries reach the brain, there is a connection between them and the vertebral artery. When the head is lowered, some of the blood is shunted off through this connection and also into smaller arteries which expand, lowering blood pressure to the head. Specialized valves also prevent backflow of blood to the brain at this time. When the giraffe raises its head, these same arteries adjust quickly to retain blood in the brain. In addition, the veins' specialized valves also prevent part of the blood from receding from the brain. These valves also prevent blood from backflowing when it is returning to the heart from the legs.

7. Describe in detail the different elements of oxygen balance. Include an explanation of the plant-animal cycle, chemical weathering, the action of algae and bacteria, and density currents.

Oxygen balance is a complicated system of checks and balances which enables the oxygen level in the Earth's atmosphere to remain relatively stable. First of all, part of the balance is achieved through the plant-animal cycle. Animals take in oxygen and expel carbon dioxide. Plants take in carbon dioxide and give off oxygen. Chemical weathering takes oxygen from the atmosphere. However, it also adds phosphorus to the ocean water. This phosphorus stimulates the algae in the ocean to grow and produce more oxygen. If too much oxygen is produced, bacteria on the ocean's bottom take phosphorus out of the ocean water, slowing down the growth of algae and their production of oxygen. Ocean density currents are also needed to mix surface water with water from the ocean's floor.

8. Select two of the thermal properties of water and explain how these characteristics help to make life possible on Earth.

Any two of the following:

- A. Water contracts when temperature is lowered until it reaches 4°C. Then it expands. If this didn't happen, ice would sink to the bottoms of the lakes, rivers and oceans until all would eventually freeze up.
- B. When ice melts and water evaporates, heat is absorbed. When water freezes or condenses, heat is released. Both events cause a moderation of temperature change. Without this characteristic of water, the climate would be subject to far more rapid temperature changes. On a personal level, the evaporation of perspiration on the body helps to cool it on a hot day.
- C. The specific heat of water is very high. Because of this our climate is greatly moderated. Also, because of water's ability to hold heat, surface currents in the ocean can carry heat to areas in the north that ordinarily would be too cold to be inhabited. Other surface currents also bring cool water to the warmer latitudes, moderating their temperatures.
- D. The thermal conductivity of water is four times greater than that of any other liquid. This enables oceans to absorb sufficient radiant heat from sunlight to warm their surface waters in tropical and subtropical areas. Surface currents then carry the warm water to colder climates.
- E. The thermal conductivity of ice and snow is very low. This enables animals living in the polar areas to burrow into the snow and retain much of their body heat. Also, the ice on the surface of bodies of water provides insulation of sorts to the water beneath it, protecting marine creatures during the winter.

9. Explain how the energy of the electromagnetic spectrum is uniquely suited to favor life on earth. Include an explanation of how the sun produces it and also how the Earth's atmosphere affects what energy reaches the Earth's surface.

First of all, the electromagnetic spectrum is composed of extremely short to very long waves. However, only a tiny part of the spectrum is beneficial to living things. The sun produces all of the waves of the electromagnetic spectrum. However, because its surface temperature is approximately 6000°C, it produces the majority of its energy in this tiny, beneficial band. The Earth's atmosphere has a layer of ozone which blocks much of the harmful ultraviolet rays which do leave the sun. Nearer the Earth, oxygen and other atmospheric gases, as well as water, absorb more harmful radiation. Yet the atmospheric gases and water both allow the beneficial radiation to pass through.

Pick out three of the characteristics mentioned by Drs. Ward and Brownlee as being necessary for the Earth to sustain life and explain why they are important.

Any three of the following:

- A. Right distance from the sun: If the Earth were 5% nearer or 15% farther away, the Earth would be uninhabitable.
- B. The right tilt: The Earth tilted on its axis at 23½ degrees to the path of its orbit enables a much larger portion of the Earth to be inhabited.
- C. Large oceans filled with water: without it, carbon-based life could not exist.
- D. A large moon: This is necessary to stabilize the Earth's tilt as it circles the Sun.
- E. The Earth's position in the galaxy: Because we are in an area of relatively few stars, and far enough from the galaxy's center, we are not adversely affected by too many gamma rays, x-rays or other types of ionizing radiation.

Short Research Paper Topics

There are essay questions at the end of each section of Chapter 9. However, only a review sheet and an exam have been provided as separate exercises for this chapter. This chapter is better suited to research projects. For example, your student(s) might make posters or displays that illustrate in detail the parts and operations of one of nature's machines and explain why it is irreducibly complex. If you insist that your pupil(s) provide greater detail, any of the machines mentioned in this chapter might do. In addition, several other possible machines are listed below.

Note: since Chapter 11 has research papers as projects, it might be advantageous to study Chapters 9 and 11 consecutively and broaden the scope of your student's research. Some students might also want to do research on some creationist theories. Excellent research sources for this chapter are *Darwin's Black Box*, *Evolution: a Theory in Crisis*, and *Nature's Destiny*. *Rare Earth* is also helpful; although its authors maintain their evolutionary stance, they give the facts clearly and correctly.

The publication information for each of these books is in the end notes at the back of this book. Also, high school biology and physics books should be of help, since they often give details about the functioning of different machines in nature that show them to be irreducibly complex.

Natures Irreducibly Complex Structures, etc. :

1. A bird's feather
2. A cilium
3. The woodpecker's unique head
4. The human eye
5. Photosynthesis
6. Defense mechanism, bombardier beetle
7. The blood clotting mechanism
8. The body's immune system
9. Synthesis of protein in the cell
10. DNA replication
11. Penguins
12. Attini ants
13. Human lung
14. Human kidney
15. *Rehobatrachus silus* frog
16. Lobster's eye
17. Humpback whale flippers
18. Nitrogen cycle
19. Bioluminescence
20. Structure of a leaf

Some more complicated ones for a brighter student who is interested in science:

21. The synthesis of AMP (adenosine monophosphate)

22. The regulatory mechanism of AMP biosynthesis

A little research or a discussion with a local Christian school's biology and physics teachers should also increase your list of topics. However, looking at any organ of the human body or any of God's creatures will show their uniqueness and irreducible complexity to a student who does the research.

Chapter 10

Suggestions for Beginning

Since you are probably teaching Christian student(s), they may have some predetermined theory of how and when God created the Earth and the fossil record. Now is a good time to find out where they are on this subject. Begin by asking them the questions below. List some of your students' opinions on a sheet of paper. Try not to be judgmental about their opinions but rather let the scientific facts speak for themselves as they read the chapter.

1. What explanations have you heard about the creation of the Earth?
2. Do you believe Noah's Flood occurred? If so, how do you think it occurred?
3. What geologic events could have precipitated it?
4. Do you think there was an ice age?
5. How do you think all that oil got far beneath the ocean floor in so many places? After all, oil is made from organic material like trees and plants. And it takes massive amounts of them.

This last question is to spark their thinking about the present structure of the earth and how it got that way. After a short period of discussion, direct your student(s) to the first section(s) of Chapter 10 by pointing out to them that there is disagreement among creationists about some things. Chapter 10 discusses this and attempts to give the best known explanation of origins, both scripturally and scientifically.

Sections Question Key

Section One: Philosophical Theories of Non-evolutionist Groups

1. Describe the gap theory and the day-age theory.

The gap theory proposes that there was an earlier creation which was destroyed when Satan was driven from Heaven. Gap theorists believe that the fossil record was formed by the remains of this earlier creation. The day-age theory proposes that the days mentioned in Genesis were actually ages, and thus God took millions of years to create the world.

2. Contrast the beliefs of the old-Earth and young-Earth creationists. Which groups fall into each category?

The old-Earth creationists (gap theorists and day-age theorists) believe the Earth is millions of years old, while the young-Earth creationists believe the creation days were 24 hour days and the Earth is only thousands of years old.

3. Describe the attitude of the intelligent design group.

They feel that the production of all the Earth's living things is beyond the reach of chance, so somebody had to do it.

4. Please read the article on Genesis and poetry below and then answer the following question. Does it appear that the Genesis account of creation was meant to be taken poetically? Why or why not?

The Hebrew language uses a different subject/verb/object order for poetry and for narrative. The order used in Genesis (verb/subject/object) is the order for narrative. Therefore, it is meant to be treated as narrative, not poetry—in other words as fact.

Section Two: The Runaway Subduction Theory

1. What is subduction?

Subduction refers to a denser ocean plate diving under a less dense continental plate at a convergent plate boundary.

2. Describe the Runaway Subduction Theory.

The Runaway Subduction Theory proposes that in the past the ocean plates were denser than both the continental plates and the mantle beneath them. Under these circumstances, as the ocean plates continued to cool and get denser, they would begin to descend rapidly under the continents. Friction would further increase this acceleration, and rapid subduction would cause earthquakes,

intense volcanic activity, rising ocean beds, and tsunamis which would lead to continental flooding and the destruction of Noah's flood.

3. What would cause the ocean to subside to its present level, according to this theory?

According to this theory, the oceans would start to subside as the ocean crusts cooled and increased in density.

4. What happened to the super continent that once existed? When did this occur?

Scientists believe that the super continent broke up into the seven continents we have today as a result of the intense geologic activity in the crust and mantle. This would have occurred during and shortly after the flood.

5. What were the results of the scientists' computer simulations?

Computer simulations on the theory showed that under the postulated conditions, the events would occur exactly as the scientists hypothesized.

Section Three: Noah's Flood

1. Give three detailed examples of supporting evidence for Noah's flood.

Polystrate fossils are fossils which extend through several layers of rock. Since rapid burial and sedimentation are necessary for fossilization to occur, these rocks which hold the polystrate fossils must have been laid down rapidly under catastrophic conditions, not over millions of years.

The structure of the fossil beds also supports a catastrophic cause, since thousands of the fossils are found together, often showing signs of distortion, as if caught in some violent current. Often these fossils were caught instantaneously in the very act of living—one fish eating another, for example.

The structure of the sedimentary rock itself gives evidence of its rapid deposition. In Carbon Canyon, a ravine leading into the Grand Canyon, a portion of rock called the Tapeats Sandstone is exposed. The Tapeats Sandstone is bent at a 90° angle, but the rock is not fractured or broken at the fold. This could only have happened if all the rock layers were laid down rapidly and then folded while they were still wet.

2. After reading the above article on the formation of coal and petrified fossil trees, explain briefly Dr. Steve Austin's theory of how petrified forests can be formed.

After the eruption of Mt. St. Helens and the destruction of a forest nearby, many of the trees in Spirit Lake still had their heavier roots attached; these trees have been floating upright in the water, with the root-end hanging down beneath the surface. Some of these trees have now sunk, still in upright position, creating a "forest" on the bottom of the lake. These trees are being buried at different levels. Therefore, if they were to be buried quickly enough to be fossilized, they would appear to be "multiple forests which grew on different levels over periods of thousands of years."

Section Four: The Ice Age

1. What two conditions are necessary for an ice age to occur?

In order for an ice age to occur, there must be abnormally cool summers together with abnormally warm oceans, especially near the poles..

2. What events may have created the conditions necessary for an ice age immediately after Noah's flood?

If the runaway subduction theory is correct, the release of all the magma at the divergent plate boundaries in the oceans would have warmed the ocean waters. Also the intense volcanic activity, which both theories predict, would have reflected much sunlight and thus cooled the average yearly temperature. Thus, the two conditions necessary for an ice age would have been met.

3. What exists off the coast of Norway today which gives evidence for a warmer, shallower ocean? Why?

An ancient coral reef exists off the coast of Norway at a depth of 457 m (1500 feet). Yet coral today does not live that far north nor below a depth of 45.72 m (150 feet). Thus, the ocean must have at one time been warmer and shallower.

Section 1

Non-Evolutionists

Below are statements that describe groups which have different beliefs about the origin of life on Earth. If the statement is true of the intelligent design group, put "ID" in the space in front. If it is true of the Gap theorists, put "GT" in the space. If it is true of Day-age theorists, use "DA". If it is true of Young Earth creationists, use "YE". Some statements may require more than one answer.

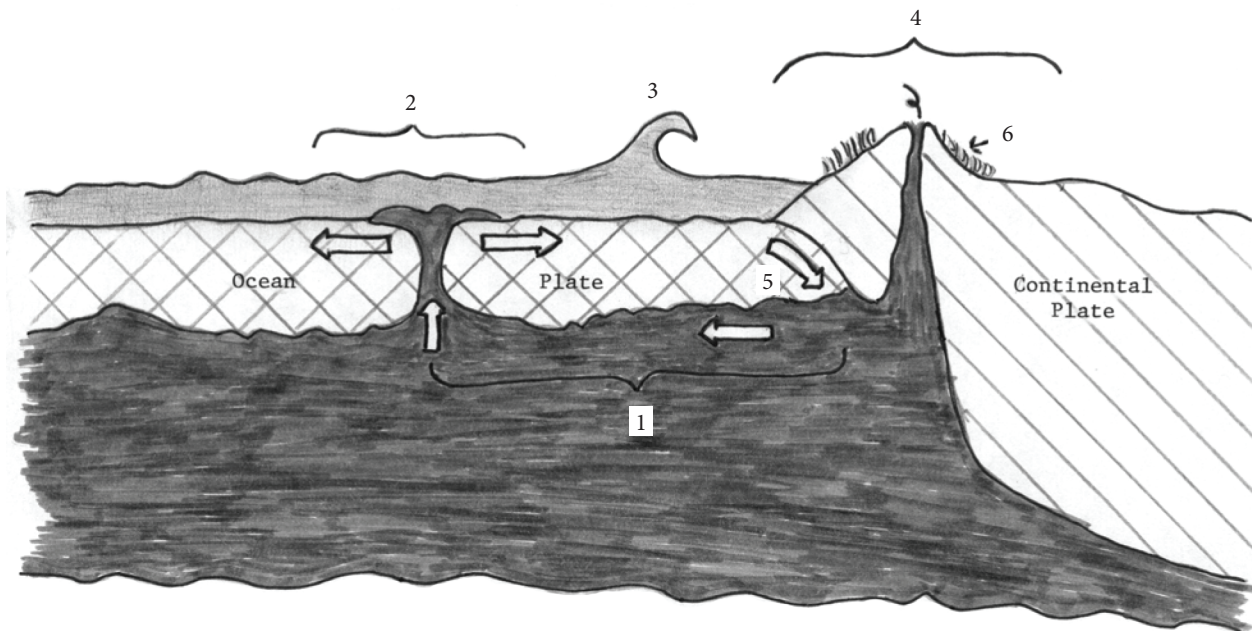
- | | |
|-----------------------|--|
| <u>YE</u> | 1. They believe all of creation took place in six twenty-four hour days. |
| <u>DA</u> | 2. They believe the days mentioned in Genesis were actually long periods of time. |
| <u>YE</u> | 3. They take the first chapter of Genesis literally and believe the gap and day-age theorists misinterpret scripture. |
| <u>ID</u> | 4. They have determined scientifically that spontaneous generation is not possible. |
| <u>DA, GT</u> | 5. They are old Earth creationists. |
| <u>GT</u> | 6. They use Isaiah 14:12–16 and Ezekial 28:12–16 as support for their theory. |
| <u>ID</u> | 7. They have a great deal of scientific proof that evolution did not occur, and they deal only with scientific proof, not Scripture. |
| <u>DA</u> | 8. They use 2 Peter 3:8 as support for their theory. |
| <u>DA, GT, YE, IA</u> | 9. They believe the Earth and its inhabitants were created instead of evolving. |
| <u>GT</u> | 10. They believe there was an earlier creation which was destroyed when Satan was put out of Heaven. |
| <u>DA</u> | 11. They believe that God created the earth's inhabitants over a long period of time. |
| <u>YE</u> | 12. They believe the Earth is thousands rather than billions of years old. |
| <u>ID</u> | 13. They believe "somebody" had to do it. |
| <u>YE, GT, DA</u> | 14. They believe the God of the Bible is the creator of the world. |

Section 3

Runaway Subduction Theory

On the illustration below, several locations have been numbered. Write down the events that are taking place at these locations, according to your text. Use the following terms within your explanation. Then write a short paragraph explaining the theory of runaway subduction in your own words. You will need to add some information from the text as well as mention the activities below.

Divergent plate boundary allows magma to come to the surface
 Convergent plate boundary with subduction and volcanic activity
 Subduction is occurring here.
 A convection current has formed
 A volcano has formed
 Undersea activity has caused tsunamis



Give the proper terms for the numbers on the illustration:

1. *A convection current has formed* _____
2. *Divergent boundary allows magma to the surface* _____
3. *Undersea activity causes large tsunamis* _____
4. *Convergent boundary with subduction & volcanoes* _____
5. *Subduction is occurring* _____
6. *A volcano has formed* _____

Briefly explain what runaway subduction is, according to the theory.

If the ocean plates were slightly denser in the past than they are today, the ocean plates would dive or subduct under the continental plates much more rapidly than now, creating widespread volcanic activity, earthquakes, and tsunamis, and the destruction of Noah's flood.

Section 3

Noah's Flood

Evidences for the flood: complete the sentences below:

1. Creationists generally agree that there was a world-wide flood as recorded in Genesis.
2. There are several phenomena that can be explained by such a catastrophe.
3. Polystrate fossils are fossils that extend through several layers of strata.
4. Since rapid burial and sedimentation are necessary for fossilization, this indicates the strata were laid down rapidly.
5. In the fossil record, thousands of fossils are usually found together.
6. This is what we would expect if the fossils were buried together in a world-wide catastrophic event.
7. These fossils are sometime caught in the very act of living—as in a big fish eating a little fish.
8. Often these fossils are distorted as if caught in some violent current.
9. The construction of sedimentary rock often gives evidence of its rapid deposition.
10. Sedimentary rock will not bend once it has hardened.
11. The Tapeats Sandstone is a large sedimentary rock formation in the Grand Canyon.
12. Evolutionary geologists believe the Tapeats Sandstone was laid down over millions of years and folded millions of years later.
13. Yet, even though the Tapeats Sandstone is bent at a 90o angle the rock is not fractured or broken at the hinge of the fold.
14. This indicates the sediments had to have been laid down rapidly and then folded soon after, as in a catastrophic flood.

Section 4

The Ice Age

Complete the following sentences:

1. There is abundant geological evidence to support an _____ *ice age.*
2. Today, conditions on Earth _____ *are not right for another ice age.*
3. Cold winters are not enough; abnormally _____ *cool summers are also needed.*
4. The oceans must also be abnormally _____ *warm, to cause evaporation.*
5. Today in Siberia and the polar areas the temperature is so cold _____ *there is not enough moisture in the air to produce the great amounts of snow needed to create continental glaciers.*
6. After Noah's flood _____ *conditions would have been right for such an ice age.*
7. The cracking of the crust and runaway subduction _____ *would have caused intense volcanic activity.*
8. This would have released _____ *volcanic ash into the atmosphere.*
9. Volcanic ash reflects _____ *sunlight.*
10. This reflection of the sun's energy would lead to _____ *cooler summers.*
11. Also, the post-flood ocean would have been warmer due to _____ *the underwater volcanic activity.*
12. Thus, the unusual conditions of warm _____ *oceans and abnormally cool summers would have been ideal for the creation of an ice age.*
13. The catastrophic events of Noah's flood _____ *provide an excellent explanation for the cause of the ice age.*

Group Activity

Runaway Subduction

Note: This activity works well with just two people or with a group of four. Read all background material before you begin.

Purpose

To acquaint you with runaway subduction by demonstrating the four types of plate boundaries and the geologic activity that occurs at each type of boundary. This lab should enable you to better understand the effects of plate tectonics on the earth's surface and the landforms generated by such activity.

Materials:

- ▶ One entire graham cracker (an oblong section or two squares). More as needed
- ▶ One sheet of wax paper on which there are 1—2 heaping tablespoons of cake frosting
- ▶ One half of a small styrofoam plate, with pencil holes near the straight edge
- ▶ A paper towel and a small beaker with water for cleanup

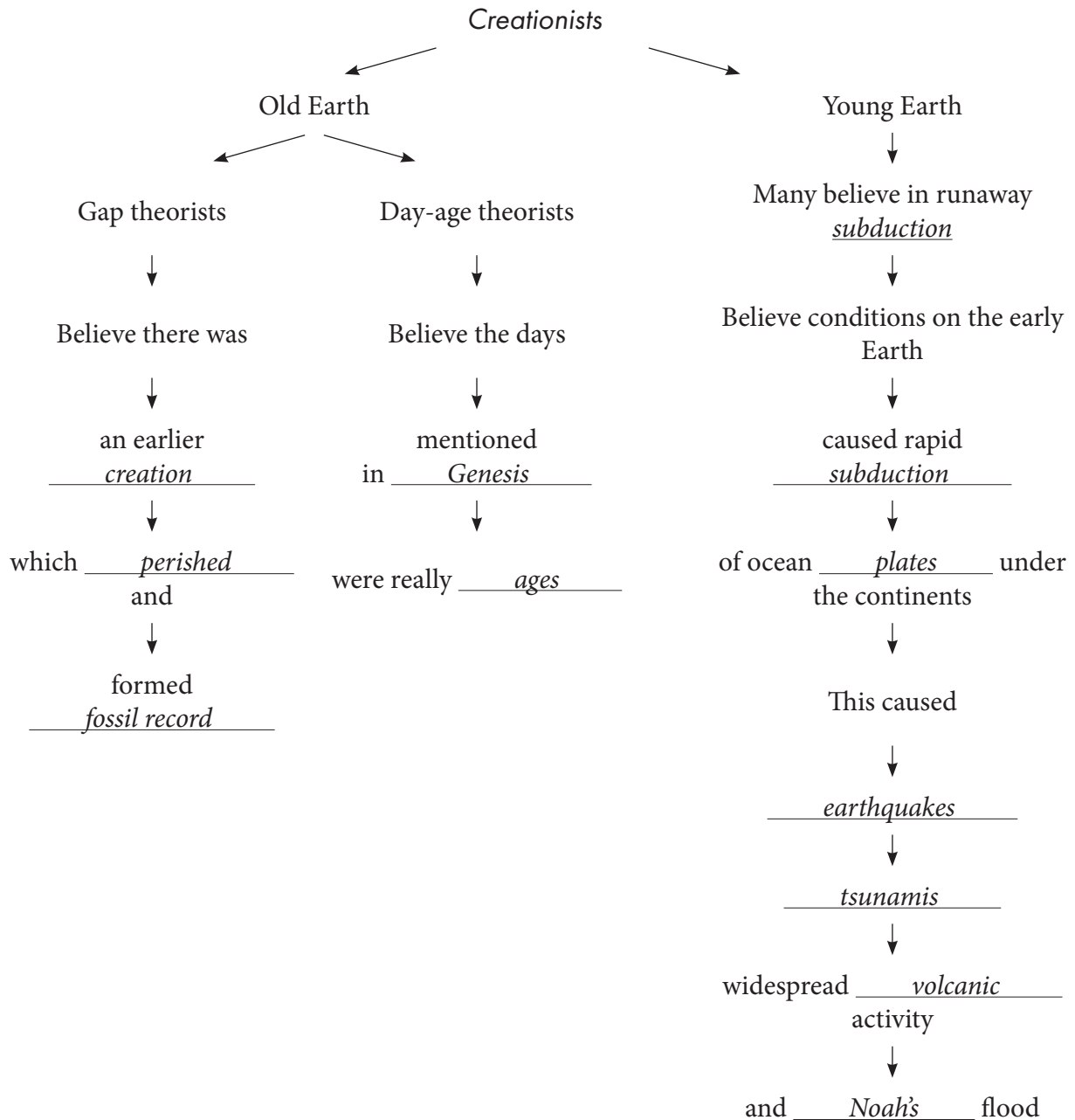
Background:

The theory of plate tectonics states that the crust of the earth is composed of individual pieces which “float” on the hot, plastic-like lower mantle. At plate boundaries, the crustal plates may collide (convergent boundary), come apart (divergent boundary), or grind past one another (strike-slip fault). At a convergent boundary between an ocean plate and a continental plate, subduction zones occur and volcanoes are formed. At a convergent boundary between two continental plates, the crust buckles and mountains form. According to the Runaway Subduction Theory, in the past these geologic activities also occurred, but at a much more rapid rate.

In this group activity, you will investigate the interactions that occur between plates at their boundaries. Using the graham crackers as your “plates” and the cake frosting as the “mantle,” you will study plate collision, subduction, earthquakes, volcanoes, and divergence. Using the paper, you will study mountain building.

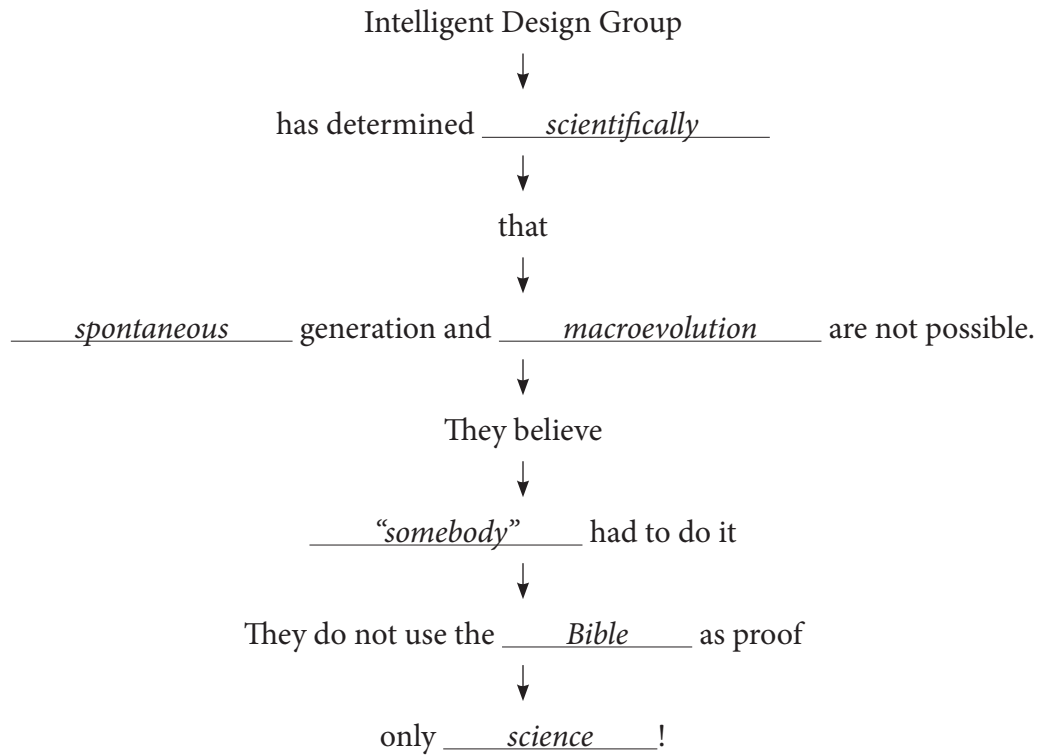
Concept Map One

Different View of Creation



Concept Map Two

Intelligent Design



Vocabulary

Match the following words with their definitions:

- | | | |
|-----------------------------|---------------------------|-----------------------------|
| A. circumstantial evidence | G. Long Day Theory | L. Runaway Subduction |
| B. convergent boundary | H. Old Earth Creationists | Theory |
| C. Day-age Theorists | I. pangaea | M. Short Day Theory |
| D. divergent boundary | J. polystrate fossils | N. subduction zone |
| E. Gap Theorists | K. ring of fire | O. Young Earth Creationists |
| F. Intelligent design group | | |

- C 1. This group of old Earth creationists believes that the days referred to in Genesis are actually long periods of time.
- H 2. They are creationists who believe that the Earth is millions of years old.
- J 3. A tree or other plant or an animal which extends through several layers of rock.
- A 4. Facts that lead to a conclusion that is hard to explain in any other way.
- F 5. They believe that science proves “somebody” had to do it.
- O 6. They believe the days mentioned in Genesis refer to 24 hour days.
- E 7. They believe that there was a long period of time between Genesis 1:1 and Genesis 1:2 during which an earlier creation existed, but was destroyed when Satan fell from Heaven.
- N 8. An area on the Earth where a denser plate “dives” beneath a less dense one.
- K 9. A string of volcanoes that have formed all around the Pacific plate.
- L 10. This theory states that in the past the Earth’s ocean floor was denser than both the continental crust and mantle, causing rapid descending of the ocean plate into the mantle.
- B 11. A spot on the Earth where two plates come together.
- I 12. The name of the supercontinent believed to have existed at one time on the Earth.
- D 13. A spot on the Earth where two plates pull apart.
- G 14. Another term for the Day-age theory.
- M 15. The theory that the days mentioned in Genesis were 24 hours.

Review

1. There are two major groups of old Earth creationists. They use some scripture to support their theories. Name these two groups and explain a weakness in their interpretations of these scriptures.

The gap theorists believe that there was an earlier creation which was destroyed before Adam and Eve were created. They believe this creation was destroyed when Satan fell. However, Romans 5:12 states that sin and death entered the world through Adam. If this is true, how could there be millions of dead things in the fossil record? The day age theorists believe the days mentioned in Genesis are really long periods of time. Yet the Hebrew word for days indicates a 24 hour period.

2. What does the intelligent design group believe and on what do its members base their belief?

Members of the intelligent design group believe that scientifically there is only one reasonable answer: some intelligent force had to create life on Earth. The world is not a product of chance. They base their beliefs solely on scientific evidence.

3. Name the major group of young Earth creationists and explain why they believe that the days mentioned in Genesis should be interpreted as ordinary days.

The runaway subduction theorists are young Earth creationists. They believe that the days of creation were 24 hour days because the Hebrew word given in Genesis refers to a 24 hour day.

4. Briefly explain the runaway subduction theory.

The runaway subduction theory is based on plate tectonics. Scientists today believe the Earth's crust is broken into plates. At a subduction zone the ocean plate subducts under the continental plate. Most scientists also believe there is a convection current in the Earth's mantle. Thus material moves from the subduction zone toward the center of the ocean where magma comes up at a divergent boundary. With runaway subduction this would happen much faster, creating intense volcanic activity, widespread earthquakes, and giant tsunamis.

5. What is circumstantial evidence? Does it have any basis in fact?

Circumstantial evidence is information left behind which points to a logical conclusion. Yes, it does have a basis in fact, as in the case of fingerprints or DNA left behind.

6. List three examples of circumstantial evidence which support Noah's flood.

- A. polystrate fossils, which extend through several rock layers, indicate catastrophic events which laid down thick layers of rock very quickly.
- B. The structure of the fossil beds, with thousands of fossils found together in one place, indicates a catastrophe which destroyed them all at the same time.

- C. The presence of distorted fossils, or of a fossil fish caught in the very act of swallowing another indicates these organisms were caught unexpectedly by a sudden, catastrophic occurrence.
- D. The structure of the sedimentary rock itself gives evidence of its rapid deposition. In Carbon Canyon, a ravine leading into the Grand Canyon, a portion of rock called the Tapeats Sandstone is exposed. The Tapeats Sandstone is bent at a 90° angle, but the rock is not fractured or broken at the fold. This could only have happened if all the rock layers were laid down rapidly and then folded while they were still wet.

7. Why is it highly unlikely that we could have a new ice age today?

In order for an ice age to occur, the Earth's oceans, especially in the northern latitudes, must be abnormally warm, while the Earth's climate, especially the summers, must be abnormally cool. Today, the oceans are too cool to provide the moisture needed; the summers are warm enough that the glaciers do not advance.

8. How might conditions following the flood have contributed to the ice age?

If the runaway subduction theory is correct, the oceans would have been abnormally warm due to the intense volcanic activity underwater. Also the widespread volcanic activity would have put enough dust in the air to block sunlight and thus cool the Earth.

9. Explain briefly Dr. Steve Austin's theory of how petrified forests can be formed.

After the eruption of Mt. St. Helens and the destruction of a forest nearby, many of the trees in Spirit Lake still had their heavier roots attached; these trees have been floating upright in the water, with the roots hanging down beneath the surface. Some of these trees have now sunk, still in upright position, creating a "forest" on the bottom of the lake. These trees are being buried at different levels. Therefore, if they were to be buried quickly enough to be fossilized, they would appear to be "multiple forests which grew on different levels over periods of thousands of years."

10. Does it appear that the Genesis account of creation was meant to be taken poetically? Why or why not?

The Hebrew language uses a different subject/verb/object order for poetry and for narrative. The order used in Genesis (verb/subject/object) is the order for narrative. Therefore, it is meant to be treated as narrative, not poetry—in other words as fact.

Test

Multiple Choice

Place the letter in the space provided that best completes the sentence.

- B 1. The belief that there was an earlier creation which was destroyed when Satan fell is known as:
- | | |
|-----------------------|-------------------------|
| A. The Day-age Theory | D. The Old Earth Theory |
| B. The Gap Theory | E. None of these. |
| C. The Canopy Theory | |
- D 2. Scientists who believe that the Earth and its inhabitants are too complicated to have happened by chance, and therefore someone had to create them are known as the:
- | | |
|----------------------|-----------------------------|
| A. Gap theorists | C. Young Earth creationists |
| B. Day-age theorists | D. Intelligent Design Group |
- D 3. Those who believe that all of creation was accomplished in six literal 24-hour days are known as:
- | | |
|---------------------------|-----------------------------|
| A. Old Earth creationists | C. Day-age theorists |
| B. Gap theorists | D. Young Earth creationists |
- A 4. Those who believe that the days mentioned in Genesis were really long periods of time are known as :
- | | |
|----------------------|-----------------------------|
| A. Day-age theorists | C. Young Earth creationists |
| B. Gap theorists | D. Canopy theorists |
- B 5. An area where one crustal plate goes beneath another is known as a:
- | | |
|-----------------------|------------------|
| A. divergent boundary | C. hydroplate |
| B. subduction zone | D. none of these |
- D 6. Which of the following would be considered circumstantial evidence?
- | | |
|---|-------------------------|
| A. A fingerprint left at the scene of a crime | C. DNA at a crime scene |
| B. An eyewitness report | D. Both A and C |

- C 7. The Genesis account of creation:
- A. is meant to be taken poetically
 - B. in the original Hebrew structured like poetry
 - C. in the original Hebrew is structured like narrative
 - D. is not clear on the subject
- D 8. Petrified fossil forests, like the one in Yellowstone National Park, logically could have come about as:
- A. the result of a long slow process involving millions of years
 - B. the result of trees being uprooted violently
 - C. the result of trees settling to the bottom of a body of water while in a vertical position
 - D. both B and C

Modified True and False:

If, according to the text, the statement is true, circle T. If it is false, circle F and then change the underlined word to correct the statement in the space provided. (One or two points each)

- F 1. Circumstantial evidence has no basis in fact.
a basis
- T 2. Polystrate fossils are circumstantial evidence for the flood.
- T 3. Young Earth Creationists believe that the Noah's flood was a worldwide cataclysm.
- F 4. The ring of fire is a string of volcanoes that extend around the Atlantic Ocean.
Pacific
- T 5. Tsunamis would be one possible effect of runaway subduction of the ocean's plates.
- F 6. Few fossils are generally found together.
thousands of
- T 7. Rapid burial and sedimentation are necessary in order for organisms to be fossilized.

T 8. Fossil bones are often found in distorted positions.

F 9. Neither the Gap nor the Day-age theorists attempt to use any scriptural support.

both

F 10. The gap theory provides a good explanation for polystrate fossils.

flood

T 11. There are only two possibilities: both the universe and all its inhabitants are the result of random mechanistic processes or they are the result of intelligent action.

F 12. In order to have an ice age, short, cool winters are needed.

summers

Essay Questions:

1. *Why is it highly unlikely that another ice age could happen today? Also, explain how conditions following the flood may have contributed to the first ice age. (6 points)*

If the runaway subduction theory is true, during the time of the flood, the widespread, underwater volcanic activity would have heated the oceans. The volcanic activity would also have released a great deal of ash that would filter the sunlight and cool down the Earth. This combination of abnormally cool weather (especially summers) and warm oceans would have created the ideal conditions for an ice age. These conditions no longer exist today, so it is unlikely that an ice age would occur.

2. *List two examples of circumstantial evidence which support the idea that Noah's flood caused the fossil record and explain their significance. (4 points)*

- A. polystrate fossils, which extend through several rock layers indicate catastrophic events which laid down thick layers of rock very quickly.
- B. The structure of the fossil beds, with thousands of fossils found together in one place indicates a catastrophe which destroyed them all at the same time.
- C. The presence of distorted fossils, or of a fossil fish caught in the very act of swallowing another indicates these organisms were caught unexpectedly by a sudden, catastrophic occurrence.
- D. The structure of the sedimentary rock itself gives evidence of its rapid deposition. In Carbon Canyon, a ravine leading into the Grand Canyon, a portion of rock called the Tapeats Sandstone is exposed. The Tapeats Sandstone is bent at a 90° angle, but the rock is not fractured or broken at the fold. This could only have happened if all the rock layers were laid down rapidly and then folded while they were still wet. This indicates a rapid, catastrophic occurrence.

3. *Briefly explain the Runaway Subduction Theory. (5 points)*

The runaway subduction theory proposes that the subduction which scientists believe occurs today, at some time in the past occurred at a much faster rate; so rapidly, in fact, that widespread volcanic activity would occur at the subduction zones as well as at divergent boundaries in mid-ocean. There would also have been widespread earthquakes and tsunamis, which would have caused continental flooding. Scientists believe this created much of the destruction of Noah's flood.

4. *Does it appear that the Genesis account of creation was meant to be taken poetically? Why or why not?*

The Hebrew language uses a different subject/verb/object order for poetry and for narrative. The order used in Genesis (verb/subject/object) is the order for narrative. Therefore, it is meant to be treated as narrative, not poetry—in other words as fact.

Chapter 11

Suggestions for Beginning

Start by putting the word IDEAS on a sheet of paper in big, bold print. Then spark a discussion with your student(s) by asking:

1. Do ideas have power?
Put words such as test, freedom, happiness, love, special creation, and accident of nature on the paper in successive order and ask the following about each one:
2. What effect does this word have on you?
3. What things do you connect with it?
4. Which of these two terms would you prefer to describe you?
5. What is the effect on humans of thinking that they are special creations?
Your student(s) may reply that it makes them feel important, valuable, or loved. They may also bring out that this implies an obligation on their part to their creator.
6. What is the effect on humans of thinking that they are accidents of nature? How would it affect you?
Your student(s) may point to the increase in mental illness (especially depression), suicide, and murder, along with other escalating problems of modern society.

Finish by telling them that Chapter Eleven deals with the effects of this idea (#8) on the social, moral, and political climate of the world over the past 150 years.

Sections Question Key

Section One: The Political Ramifications of Darwinism

1. *Why was Karl Marx so pleased with Darwin's theory of evolution? What did he offer to do?*

He was pleased because it appeared to scientifically explain away the need for a creator God. He offered to dedicate his book *Das Kapital* to Darwin.

2. *What effect did a belief in evolution have on Lenin?*

Lenin actively practiced social Darwinism. His belief in survival of the fittest led him to destroy every actual and potential political opponent that he could.

3. *What effect did a belief in "survival of the fittest" have on Stalin?*

Stalin's belief in social Darwinism led him to institute programs as dictator of the Soviet Union that caused the deaths of millions of people. To him it was the survival of the race as a whole that counted, not the individual.

4. *How did Hitler justify Germany's conquering and enslaving nearby countries?*

He felt it was an "iron principle" that "the weaker one falls so that the strong one gains life." Even when Russia won the war, he clung to his evolutionary beliefs, claiming that Russia had a right to conquer Germany since she had proven to be stronger.

5. *How did Mussolini justify his treatment of other countries and peoples?*

A belief in evolution led to Mussolini's abusive treatment of races and peoples whom he thought inferior—less evolved. Like Lenin, Stalin, and Hitler, he considered it right and natural for the strong to use force to subjugate the weak—survival of the fittest.

Section Two: The Social Effects of Darwinism

1. *According to Darwin, what effect do vaccination and caring for society's weak have on the human race?*

He thought that because they allow some of the physically weak to survive, they have a weakening effect on the human race as a whole.

2. How did Herbert Spencer's belief in evolution affect his view of human society?

It was Spencer who coined the term “survival of the fittest.” He was primarily responsible for applying Darwinian principles to human society. He felt that it was perfectly natural for individuals to suffer or to be exterminated if they were “useless.”

3. Describe two instances of evolution's effect on literature.

A belief in evolution has had a great deal of effect on both 19th and 20th century literatures. Jack London, for example, wrote short stories such as “The Law of Life” in which he treats an Indian tribe's leaving of an old, blind Indian to die as natural and reasonable. In Jonathon Kellerman's book, *Survival of the Fittest*, the serial killer justifies his murdering of the handicapped as purifying the race. He points out that his justification comes from Darwin's theory and explains his position with flawless logic. Other writers such as Stephen Crane and George Bernard Shaw also were influenced by Darwinism.

Section Three: Darwinism's Effects on Ethics

1. Who is Peter Singer?

Peter Singer is an Australian philosopher and a professor at Princeton University. He has also authored several books.

2. How does his belief in evolution affect his ethical beliefs concerning the old and the ill?

He points out that his belief in Darwinism is the basis for his worldview. As a result, he regards the old and the ill who are helpless to be “non-persons” and advocates euthanasia for them.

3. Who does Singer consider to be a person?

In Singer's eyes a person is “a being with certain characteristics such as rationality and self-awareness.” Thus, he classifies some people along with apes and possibly whales, dolphins, elephants, monkeys, dogs, and pigs as persons

4. What does Singer consider a fetus or a newborn baby to be? How does he feel about abortion and infanticide?

Singer does not consider a fetus or a newborn baby to be a person. He puts them in the same category as a fish. Therefore, abortion and infanticide are perfectly acceptable to him.

*5. How is euthanasia being practiced in the Netherlands today?
Who is being affected by it?*

Euthanasia is being practiced not only on the terminally ill who request it but also often on the terminally ill without their consent. It is also being performed on the chronically ill and the emotionally distraught.

6. How and where is assisted suicide being practiced in the United States today?

Advocates of assisted suicide have been successful in passing laws to allow it in three states—Oregon, Washington, and Montana. Oregon’s assisted suicide law, called the Death with Dignity Act (DWDA), allows terminally ill adults 18 years of age or older to obtain lethal doses of medication. There are certain guidelines in place.

Thought Questions:

1. Is any such law in accordance with a Christian world view based on God’s Word?

Since Scripture clearly states that God is in charge of our lives, and it is His right to determine our years on this planet, this is not in accordance with His word.

2. What is the significance of the Oregon law stating that assisted suicide is not suicide?

Many answers are possible here. Through discussion, perhaps try to bring out the idea that this is said to break down our culture’s Christian attitude toward suicide and thus to make it more “palatable”.

Section Four: The Moral Consequences of a Belief in Darwinism

1. What is the “God is Dead” philosophy, and what is the reasoning behind it?

The “God is Dead” philosophy arose in the nineteenth century out of a belief in evolution. Since the theory of evolution seemingly explained away the need for a creator God, there was no longer any reason to believe in one.

2. According to Paul A. Carter, in what sense is God dead?

He says that God can be considered dead in a social sense because the “political, economic, and educational institutions which used to convey and confirm the presence of God no longer do so.” He also feels God may be theologically dead since “Christian...theology has become only a somewhat novel mode of atheist humanism.”

3. Explain the pattern of reasoning that develops from a belief that evolution is true.

If the theory of evolution is true, the Genesis account of creation must be false. If Genesis is false, the rest of the Bible is unreliable. If the Bible is unreliable, there are no moral absolutes. Man is free to make up his own rules and “survival of the fittest” becomes common practice.

Section 1

Political Ramifications of Darwinism

Match the following persons with the statements which describe them. If the description fits Marx, put MA in the blank. If it fits Lenin, put L. If it fits Stalin, put S. If it fits Hitler, put H. If it fits Mussolini, put MU. Some descriptions may fit more than one person.

- | | |
|---------------------|---|
| <u>MA</u> | 1. He offered to dedicate his book to Darwin. |
| <u>MU</u> | 2. He used evolution as an excuse for his enslaving other races. |
| <u>S</u> | 3. He regarded animals of more value than humans. |
| <u>L</u> | 4. He established the communist dictatorship which ruled Russia for more than 70 years. |
| <u>S, H, L</u> | 5. He used evolution as an excuse for violently disposing of any potential enemies. |
| <u>S</u> | 6. During his time in power, he forcibly removed millions of people from their land and was responsible for the deaths of over 17 million people. |
| <u>H, MU</u> | 7. He felt Aryan people were the “fittest,” and that this justified the conquering, enslaving, and annihilating of other “less fit” people. |
| <u>H, MU</u> | 8. He developed racial laws prohibiting marriage between his “racially superior” people and those he considered “less fit”. |
| <u>MU</u> | 9. He regarded Darwin as “one of the two greatest thinkers of the 19 th century”. |
| <u>H, MU</u> | 10. He glorified war because he considered it right and natural for the strong to use force to subjugate the weak. |
| <u>MA</u> | 11. He felt Darwin’s <i>Origin of Species</i> made atheism scientifically acceptable. |
| <u>L, S, MA, MU</u> | 12. He was an atheist. |
| <u>L, S, H, MU</u> | 13. He believed in the right of the strong to conquer and kill or enslave the weak. |
| <u>S</u> | 14. His biographers claim that he first read Darwin in his teens and became an atheist. |

- S, H 15. He persecuted the Christian church in his country.
- H 16. He stated, "It is an iron principle that the weaker one falls so that the stronger one gains life".
- H, MU 17. He used the evolutionary theory to justify genocide.
- H 18. He believed in struggle as a Darwinian principle that "forced every people to try to dominate all others".
- L, S, H, MU 19. He was a vicious tyrant.
- MA 20. He was the "father" of communism.

Section 2

The Social Effects of Darwinism

Darwin's theory was at first applied only to biology. However, he was aware that it could also be applied to social issues. In fact, he felt that helping the weak and sick did not allow natural selection to operate and thus weakened the human race.

One of the individuals who applied Darwin's theory to society was Herbert Spencer. He developed a theory that became known as social Darwinism. It was Herbert Spencer who coined the phrase, survival of the fittest. He felt that victory of the strong over the weak was not only logical but also acceptable.

Darwinism also affected the literature of the time. It influenced the works of such well-known American writers as Jack London and Stephen Crane, as well as British writers such as George Bernard Shaw. For example, Jack London wrote a short story entitled "The Law of Life." In it, an old Alaskan Indian is left to die by his tribe because he is too old and blind to care for himself. He finally accepts his fate with resignation. He thinks, "Was it not the law of life?"

In Modern literature such as Jonathon Kellerman's *Survival of the Fittest*, the author describes a serial killer who uses evolution as an excuse to kill people with handicaps. The killer regards humans as just organic material, of no particular value. He considers himself to be helping the human race by getting rid of its unfit ones. Unfortunately, his reasoning, though warped and distorted, is a logical outcome of the application of natural selection to human society.

Section 3

Darwinism's Effects on Ethics

From your text, locate the word or phrase that best completes the following sentences and write them in the blanks.

1. A belief in evolution has led to destructive social behavior in the twentieth century.
2. Hitler's belief in evolution led to the forced sterilization of thousands of mentally and physically handicapped people.
3. Stalin looked upon the loss of farm animals as more important than the loss of people.
4. Peter Singer, an Australian philosopher and professor at Princeton, is considered reputable and moderate.
5. Mr. Singer's belief system comes directly from his evolutionary world view.
6. Singer says—if we are an animal, rather than a specially created being made in the image of God – how can this not reduce the gulf between us and them (animals)?
7. Singer's new “commandments” are based on moral relativism and a belief in evolution.
8. He considers a “person” to be a being with certain characteristics such as rationality and self awareness.”
9. Singer advocates the abortion of all defective fetuses.
10. In addition, he advocates the infanticide of defective and unwanted newborn babies.
11. He states, “Since neither a newborn human infant nor a fish is a person, the wrongness of killing such beings is not as great as the wrongness of killing a person.
12. Derek Humphry founded the Hemlock Society, an organization dedicated to making assisted suicide and euthanasia legal.
13. Dr Jack Kevorkian was a Michigan pathologist who advocated assisted suicide and euthanasia.
14. Supporting Dr. Kevorkian's position requires a belief in Singer's first and third commandments based on evolutionary humanism.

15. In the Netherlands, where euthanasia is practiced, they have moved from assisted suicide to voluntary euthanasia, and from voluntary euthanasia to involuntary euthanasia.

16. Many people attribute this loss of value for the human life in the Netherlands to moral relativism. Others point to the influence of humanism.

17. Dr. Herbert Hendin points out that many in the U.S. also advocate euthanasia.

18. He states, "In a culture in which life has no continuity, in which life lacks significance beyond itself, death becomes more threatening and intolerable.

19. Assisted suicide is now being practiced in four states—Oregon, Washington, Montana, and California.

Below are listed 5 "new commandments" by Dr. Peter Singer. In the space provided, explain the basic meaning of each "commandment" (as Dr. Singer means it) in your own words. Hint: look at the Christian commandment he puts opposite it.

1. Recognize the worth of human life varies.

You are a person only if you are physically and mentally healthy.

2. Take responsibility for the consequences of your decisions.

Go ahead and kill if you can live with it.

3. Respect a person's desire to live or die.

Help with suicide or allow it.

4. Bring children into the world only if they are wanted.

Kill fetuses and newborn babies if you don't want them.

5. Do not discriminate on the basis of species.

Treat animal life as of equal value to human life. There is no soul that separates us.

Section 4

The Moral Effects of a Belief in Evolution

Answer the following in complete sentences:

1. Why is the “personhood” of all humans being questioned?

It is being questioned because a new set of “commandments” has been drawn up to replace those of the Bible—the commandments of evolutionary humanism.

2. What is the “God is Dead” philosophy, and how has it come into being?

The God is dead philosophy came about in the later 19th century in response to a rising belief in evolution. Essentially it states that God is dead because “the political, economic, and educational institutions which used to convey and confirm the presence of God no longer do so.

3. How does Mr. Carter describe much of Christian theology today?

He says that God may be considered dead theologically also because “Christian theology has become only a somewhat novel mode of atheist humanism”.

4. It has been rightly stated that many belief systems have fostered evil acts by some of their advocates. For example, all manner of evil has been justified in the name of Christianity. How is this different from the acts of evolutionists?

Evil acts committed in the name of Christ are in direct opposition to the teachings of Christ, and those who commit them should not be considered Christians. Such people are obviously not living according to Christian principles. However, with a belief in evolution, this is not the case. If a secular humanist practices moral relativism or Social Darwinism, it is a logical outcome of his belief in evolution.

Describe the logical progression of thought which arises from a belief in evolution. Start each sentence with “If” and the conclusion with “then.” The first sentence has been done as an example for you.

*1. If all organisms evolved from a spontaneously generated single-celled creature, **then** the Genesis account of creation is false.*

2. If Genesis is false, the truth of the rest of the Bible is brought into question

3. If the Bible is unreliable, people may feel they have no moral absolutes.

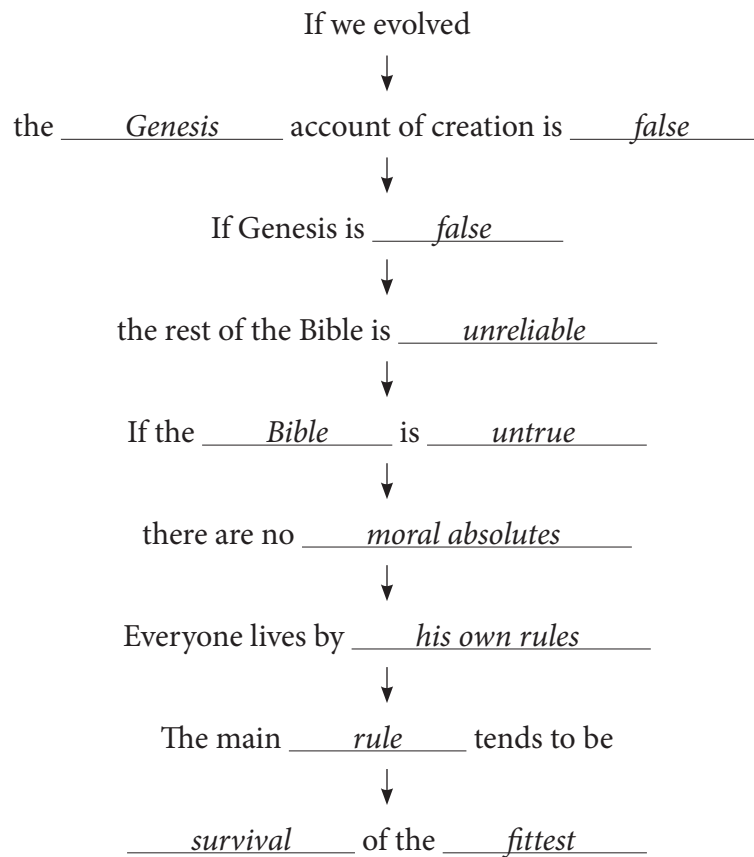
4. If there are no moral absolutes, man is free to make up his own rules to live by rather than adhering to God’s.

5. What is the final result?

The final result is often moral relativism or a “survival of the fittest” attitude, both of which have contributed to the widespread political, social and moral decline which we have witnessed in America in the twentieth century.

Concept Map

The Moral Effects of a Belief in Evolution



Vocabulary

Match the following words with their definitions.

- | | | |
|---------------------------|--------------------|-----------------------------------|
| A. animal rights movement | G. euthanasia | L. Manifesto of Racist Scientists |
| B. anti-Semitism | H. fascism | M. medicide |
| C. assisted suicide | I. Hemlock Society | N. moral relativism |
| D. atheism | J. humanism | O. social Darwinism |
| E. communism | K. infanticide | P. worldview |
| F. ethics | | |

- I 1. An organization dedicated to the legalization of assisted suicide and euthanasia in the U.S.
- N 2. Situational ethics; right and wrong depend on the circumstances.
- D 3. A belief that no god exists.
- O 4. The theory of natural selection applied to human society; “survival of the fittest”.
- K 5. The killing of newborn babies.
- A 6. An organization dedicated to giving “higher” animals a status equal to man.
- B 7. Hatred of Jews.
- L 8. A paper in which Italian scientists stated that the Aryan race was superior to others, especially Jews.
- C 9. Having help in killing oneself.
- J 10. A philosophy that centers on humans and their abilities and capacities, and whose value system depends on human rather than spiritual standards.
- E 11. A system of government characterized by state ownership of property. The state controls the economy, and all goods are supposed to be equally shared among all people.
- M 12. Using medical knowledge to perform assisted suicide and euthanasia.
- F 13. Rules or standards governing the conduct of people.
- P 14. The perspective from which one sees and interprets the world around him.
- G 15. The practice of putting to death an individual suffering from an incurable disease or condition.
- H 17. A system of government, usually headed by a dictator, that controls all political, economic, and cultural activities; it allows industry to remain in private hands, but under strict government control.

Review

Match the following people with the correct description. Some of the descriptions will fit more than one man.

A. Charles Darwin
B. Adolf Hitler
C. Derek Humphry
D. Jack Kevorkian

E. Vladimir Lenin
F. Karl Marx
G. Benito Mussolini
H. Peter Singer

I. Herbert Spencer
J. Joseph Stalin

- C 1. He founded the Hemlock Society.
- F 2. He is the father of communism.
- B 3. He was the fascist leader of Germany during World War II.
- E 4. He led the communist revolution in Russia.
- H 5. He considers neither a fish nor a baby to be a person.
- J 6. During his reign as dictator of Russia, he caused the deaths of more people than died in World War I.
- F 7. He offered to dedicate a book to Darwin.
- A 8. He recognized the effect his theory could have on several areas.
- J 9. He supposedly read Darwin in his early teens and became an atheist.
- D 10. He advocated a new medical specialty called medicide which will prepare doctors to assist in suicides.
- G 11. He regarded Darwin as one of the two great thinkers of the 19th century.
- B, G 12. He felt the Aryan race was superior to all others.
- I 13. He coined the term “survival of the fittest”.
- H 14. He is a philosopher who is considered moderate.
- I 15. He felt London’s poor should not receive charity but instead be allowed to die.
- H 16. He considers infanticide, abortion, assisted suicide, and euthanasia all to be acceptable.
- H 17. He created some new commandments based on evolutionary humanism.
- H 18. He wants to elevate the moral status of animals to that of humans.
- B, E G, J 19. His belief in survival of the fittest led to the killing and/or enslaving of many people.

- F 20. He viewed religion as “the opiate of the people”.
- B, G 21. His belief in the racial superiority of his people led to the passing of laws prohibiting marriage to “lesser” races.
- B 22. He believed in “survival of the fittest” to the end—even when he realized he would lose the war.
- B, E, J, G 23. He felt that victory of the strong over the weak was totally acceptable.

Answer the following in complete sentences, often more than one sentence.

1. Explain briefly how a belief in evolution influenced the actions of the following dictators.

A. Lenin

His belief in evolution helped to shape a worldview which permitted the remorseless destruction of his real and also his potential opponents.

B. Stalin

Like Lenin, his belief in “survival of the fittest” led him mercilessly to persecute and destroy millions of helpless people.

C. Hitler

Because of his evolutionary beliefs, he felt that it was natural and “right” for the strong to destroy the weak “to gain life.”

D. Mussolini

His evolutionary beliefs led him to persecute those he felt were racially “inferior.”

2. In what way can belief in evolution lead to moral relativism? List each step in this logical process.

If evolution is true, Genesis is false. If Genesis is false, the accuracy of the whole Bible is in question. If the Bible is unreliable, there are no moral absolutes. Man is free to make up his own rules.

3. State three of Peter Singer’s “commandments” and explain in your own words what they mean.

Any 3 of the following:

- A. Recognize the worth of human life varies. You are a person only if you are physically and mentally healthy.
- B. Take responsibility for the consequences of your decisions. Go ahead and kill if you can live with it.
- C. Respect a person’s desire to live or die. Help with suicide or allow it.
- D. Bring children into the world only if they are wanted. Kill fetuses and newborn babies if you don’t want them.
- E. Do not discriminate on the basis of species. Treat animal life as of equal value to human life. There is no soul that separates us.

KNOW THE VOCABULARY RELATED TO THIS CHAPTER ALSO!

Test

Multiple Choice

Place the letter in the space provided that best completes the sentence.

- D 1. Although many law-abiding, moral citizens accept evolution as true, it can logically lead to _____ in many lives.
- A. moral relativism
B. social darwinism
C. agnosticism
D. all of these
- C 2. Karl Marx viewed religion as:
- A. a benefit to people
B. unimportant to people
C. the opiate of the people
D. none of these
- B 3. Marx was very excited when he read Darwin's work because:
- A. it showed how God created the world
B. it made atheism scientifically acceptable
C. it was easy for a layman to read
D. it showed how God used evolution instead of the Biblical method to create the world
- B 4. Marx was so impressed and grateful to Darwin that he:
- A. invited him to speak at a Communist rally
B. offered to dedicate a book to him
C. asked him to write a book especially for Communists to read
D. became a Christian
- D 5. Lenin was deeply influenced by Darwin's theory; he went on to:
- A. become an atheist
B. lead the communist revolution in Russia
C. use a belief in social Darwinism as an excuse for violence and killing
D. all of these
- B 6. Joseph Stalin, according to his biographers,
- A. was not particularly influenced by Darwin
B. read Darwin in his early teens and became an atheist
C. was only mildly influenced by Darwin
D. at first accepted Darwin but later changed his views

- D 7. During his time in power, Stalin:
- A. introduced several 5-year plans which caused the death of millions
 - B. began enforcing grain quotas which didn't leave enough for the farmers to eat
 - C. forcibly removed millions of people from their land
 - D. all of these
- A 8. The number dying in Stalin's "war against the peasants" was:
- A. greater than the number of lives lost in World War I
 - B. sizable but less than a million
 - C. less than a thousand
 - D. two million
- C 9. Hitler's entire justification for enslaving and annihilating non-Germanic peoples was:
- A. they posed a threat to German people
 - B. the Germanic people were trying to help other countries
 - C. the German people were the most fit and therefore had a right to take what they wanted
 - D. both B and C
- A 10. In 1945, when Hitler realized the Russians would win, he:
- A. still believed in survival of the fittest
 - B. declared the Germans were still the best
 - C. abandoned his belief in evolution
 - D. gave up his atheism
- B 11. Benito Mussolini:
- A. read Darwin and only partially accepted his theory
 - B. regarded Darwin as one of the two greatest thinkers of the 19th century
 - C. was a faithful Christian
 - D. none of these
- D 12. Mussolini:
- A. also believed in the superiority of the Aryan race
 - B. used social Darwinism as an excuse to enslave other races
 - C. passed laws preventing Italians from intermarrying with other races
 - D. all of these
- E 13. "Survival of the fittest" was world view which was held by:
- A. Lenin
 - B. Stalin
 - C. Hitler
 - D. Mussolini
 - E. all of these

B 14. Euthanasia is:

- | | |
|--|-----------------------|
| A. assisted suicide | C. a type of abortion |
| B. killing of the ill, with or without their consent | D. none of these |

C 15. In moral relativism:

- | | |
|---|---|
| A. right and wrong depend on Biblical absolutes | C. right and wrong depend on the circumstances of the situation |
| B. right and wrong depend on the absolutes of a given culture | D. right and wrong are not considered |

Modified True and False

If, according to the text, the statement is true, circle T. If it is false, circle F and then change the underlined word to correct the statement in the space provided.

T 1. Peter Singer is considered a moderate by some sections of our society.

T 2. Mr. Singer considers infanticide as acceptable under certain circumstances.

F 3. Mr. Singer considers humans to be special creations.

animals

F 4. Mr. Singer has created some new commandments based on Christian ethics.

evolutionary ethics

T 5. Mr. Singer wants to elevate the moral status of animals to that of humans.

F 6. Singer is the only prominent individual to promote euthanasia in the United States.

not the only

F 7. Karl Marx, in his book *Man Versus the State*, felt that London's poor should not receive charity but be allowed to die.

Herbert Spencer

T 8. The evolutionary worldview also had a profound effect on literature.

T 9. Herbert Spencer felt that the victory of the strong over the weak was unacceptable.

T 10. In the Netherlands, involuntary euthanasia is at times practiced.

F 11. In the Netherlands, guidelines to prevent abuse of assisted dying are strictly enforced.
not strictly enforced

T 12. The “God is Dead” philosophy came about as a result of a belief in evolution.

Short Answers

Answer the following in complete sentences.

1. How does a belief in evolution lead to moral relativism? List each step in this logical process.

If Genesis is false, the rest of the Bible is unreliable also. If the rest of the Bible is unreliable, then many may feel they have no absolute standard of right and wrong. If we have no absolute standard of right and wrong, situational ethics or moral relativism becomes our standard. Everyone does “what is right in his own eyes.”

2. It has been rightly stated that many belief systems have fostered evil acts by some of their advocates. For example, all manner of evil has been justified in the name of Christianity. How is this different from the acts of evolutionists?

Evil acts committed in the name of Christ are in direct opposition to the teachings of Christ, and those who commit them should not be considered Christians. Such people are obviously not living according to Christian principles. However, with a belief in evolution, this is not the case. If a secular humanist practices moral relativism or Social Darwinism, it is a logical outcome of his belief in evolution.

3. Explain how a belief in evolution contributed to the actions of the dictators we discussed. Use the actions of at least 2 dictators as examples.

Answers will vary.

4. Choose two of Singer’s “commandments” listed in your text and explain what they mean in your own words.

Answers will vary.

Research Paper

If you have time left at the end of the semester, this is an excellent opportunity to allow your student(s) to become “experts” in one area of creation research. It would help to have a library stocked with some books on creation, since many of these are not available at the public library or a secular bookstore. The website creation.com is an excellent source of information. Many secular magazines, especially National Geographic, are available at used book sales or you can get them at your local library. You can also request copies of the individual articles from your public library and create your own files.

The paper need not be long in order to be successful. Five hundred to a thousand words are sufficient. Three to four days of library research, followed by three or four days of work to write and “polish” the papers should be enough time.

Emphasize that your student(s) needs to “digest” the information and write the paper in their own words. Of course, giving credit to sources is equally important. If you teach in a Christian school, perhaps you can work together with a fellow teacher such as an English teacher to coordinate work on a term paper that is graded by both of you. This can work very well.

Possible Topics

1. Do an “in depth” study of spontaneous generation. Is it possible for it to have happened? Explain why or why not.
2. Does comparative embryology provide any true evidence for evolution having occurred? Why or why not? Give examples.
3. Do a study of the geologic time scale. How was it originally set up? Is there a legitimate way it can be used? What is wrong with using it to date fossils and rocks?
4. Study in detail the evolution of the whale. Are there any problems with considering this a true evolutionary series? Explain.
5. How is long range radiometric dating supposed to work? Does it give accurate dates for the rocks tested? Why or why not?
6. How is carbon dating supposed to work? Does it give totally accurate dates for the artifacts tested? Why or why not? Is there any way it can be used with accuracy?
7. Pick one “hominid” and do an in-depth study of it. How was it found? Who found it? How much of it was found? What research methods were used? Why does it make a poor ancestor? Make sure the student goes back to the original article written by the finder of the hominid.
8. Explain in detail the runaway subduction theory. How does it explain many of the features of the Earth we see today? What are its weak points, if any?
9. What are polystrate fossils? Where are they found? Why are they an evolutionist’s nightmare? How do they support the theory of a world-wide flood? What is one creationist theory of their origin? Explain in detail.
10. There are several other theories of spontaneous generation besides Oparin’s. Discuss these and point out the basic problems with any theory of this kind.
11. What was Miller’s experiment? Did it truly provide evidence for spontaneous generation? Why or why not?

12. Does comparative homology provide any true evidence for evolution? Why or why not?
13. What is the history of comparative embryology? Why has it persisted as proof for evolution, in spite of its incorrectness?
14. Trace the political effects of a belief in evolution in the twentieth century.
15. Trace the social effects of a belief in evolution in the twentieth century.
16. Trace the effects of a belief in evolution on the Christian church in the late nineteenth and twentieth centuries.
17. Do a study of the "Eugenics Movement" started by Francis Galton, Darwin's cousin, and directly attributable to a belief in evolution.
18. Do a study of euthanasia. Who are its strongest supporters? Who argue against it? Why? Where is it presently being practiced? Are the rules always being followed?
19. Any other related topic you may choose related to this subject. As has been mentioned before, what can be especially fascinating is having a student pick any organ in the body or any one of several creatures and research how it is unique and irreducibly complex and therefore impossible to have evolved.

Final exam question sheet

Many of the questions in this section are from an Evolutionist's Perspective.

- A 1. Most fossils are found in ____ rock.
- A. sedimentary
 - B. metamorphic
 - C. basalt
 - D. igneous
- C 2. According to Lamarck's theory
- A. evolution was a quick, punctuated process
 - B. traits acquired in one generation would be passed on only if they were in the sex cells
 - C. traits acquired in one generation were passed on to the next generation
 - D. only the fittest survive
- B 3. Natural selection is a process by which
- A. acquired traits are passed on to the next generation
 - B. organisms well adapted to the environment will survive and reproduce more often than other organisms
 - C. mutations change organisms
 - D. all answers are correct
- D 4. Hugo de Vries
- A. wrote a book on populations
 - B. proved the theory of use and disuse
 - C. discovered genes
 - D. proposed that evolution proceeded by mutations
- B 5. Lyell proposed
- A. the theory of use and disuse
 - B. the principle of uniformity
 - C. the theory of populations
 - D. the mutation theory
- A 6. Meiosis
- A. provides the variety for devolution to occur
 - B. produces cells exactly like parent cells
 - C. does not affect devolution
 - D. none of these

- A 7. Organs which appear to be reduced in size and to have no function are said to be
- A. vestigial
B. adaptations
C. acquired traits
D. recessive
- D 8. Rocks which are formed from fragments of plants, animals and other rocks are
- A. metamorphic
B. granite
C. igneous
D. sedimentary
- B 9. Recessive genes
- A. are often expressed in an organism's phenotype
B. are not expressed if the corresponding dominant genes are present
C. gradually disappear from an organism
D. none of these
- B 10. The process by which a parent's genes are divided and passed on to the offspring is
- A. an acquired trait
B. meiosis
C. mutation
D. adaptation
- A 11. Dominant genes
- A. are expressed in an organism's phenotype
B. are not expressed
C. gradually disappear
D. none of these
- C 12. "The present is the key to the past" is
- A. the mutation theory
B. the theory of acquired traits
C. the principle of uniformity
D. the principle of segregation
- D 13. Which of the following is a proposed ancestor of the whales?
- A. *Pakicetus*
B. *Ambulocetus*
C. *Basilosaurus*
D. all of these
- B 14. Hardened tree sap which traps and preserves insects is
- A. mold
B. amber
C. cast
D. original remains
- A 15. Body parts of different organisms that have the same basic structure but are used for different functions are called
- A. homologous
B. evolutionary
C. analogous
D. none of these

- C 16. This is created when minerals fill in a cavity after the organism that formed the cavity decays.
- A. Mold
B. Amber
C. Cast
D. Imprint
- C 17. Change within a genus or species due primarily to meiosis, along with genetic isolation, genetic drift, and natural selection is:
- A. evolution
B. geographic isolation
C. devolution
D. mutation
- D 18. Movement into or out of a population is:
- A. mutation
B. genetic isolation
C. genetic drift
D. migration
- D 19. This occurs when members of the same species cannot interbreed.
- A. Migration
B. Mutation
C. Meiosis
D. genetic isolation
- C 20. He proposed a theory as to how the first cell on Earth could have arisen spontaneously.
- A. Miller
B. Redi
C. Oparin
D. Pasteur
- A 21. He performed an experiment to test a theory of how the first cell was formed.
- A. Miller
B. Oparin
C. Darwin
D. De Vries
- B 22. An evolutionary theory which states that in the past there were rapid changes in species, followed by long periods of stability and little change:
- A. gradualism
B. punctuated equilibrium
C. genetic drift
D. both A and B
- D 23. Cytochrome C is:
- A. a mutant gene
B. a protein used in aerobic respiration
C. present in a wide variety of species
D. both B and C
- B 24. This is a hollow cavity in rock formed by the body of a dead organism.
- A. Cast
B. Mold
C. Imprint
D. Amber

- C 25. This occurs when plants or plant leaves are buried and decay partially, leaving carbon from their bodies.
- A. Amber
B. Mold
C. Carbon film fossil
D. cast
- A 26. The type of nuclear division in which the final chromosome count is half the normal number is known as:
- A. meiosis
B. mitosis
C. natural selection
D. both A and B
- C 27. It is believed to be brought about primarily by mutation and natural selection working together.
- A. Genetic drift
B. Devolution
C. Evolution
D. None of these
- D 28. An impression left in a rock by a leaf or a foot before the rock hardens is:
- A. a carbon film fossil
B. a cast
C. a mold
D. an imprint
- B 29. Bacteria which do not require oxygen; believed to have been the first cells on Earth:
- A. aerobic
B. anaerobic
C. mutational
D. nucleic
- C 30. A random change in a gene or chromosome is:
- A. meiosis
B. mitosis
C. mutation
D. natural selection
- D 31. Fossils can be trapped and preserved in:
- A. tar
B. ice
C. tree sap
D. all of these
- B 32. The name *Homo habilis* means:
- A. human-like
B. handy human
C. ape-like
D. none of these
- D 33. Neanderthals are noted for:
- A. using simple tools
B. walking upright
C. a large brain capacity
D. all of these

- A 34. A scientist who studies fossils to learn about the Earth's history is a:
- A. geologist
 - B. paleontologist
 - C. physical anthropologist
 - D. paleoanthropologist
- C 35. A scientist who studies primarily human fossils is a(n):
- A. paleontologist
 - B. geologist
 - C. physical anthropologist
 - D. archaeologist
- A 36. *Homo erectus* appears to be much like modern man because:
- A. he had a brain capacity close to that of modern humans
 - B. he was as large as modern humans
 - C. he had a much smaller brain capacity
 - D. none of these
- D 37. *Homo erectus* also shows intelligence because:
- A. he used fire
 - B. he made and used simple tools
 - C. he used agriculture
 - D. both A and B
- B 38. The hominids are believed to have been bipedal. This means:
- A. they were able to do two things at once
 - B. they walked on two legs
 - C. they walked on four legs
 - D. none of these
- A 39. Humans, along with apes and several other creatures are placed in the order:
- A. Primates
 - B. Animalia
 - C. Diptera
 - D. Isoptera
- D 40. *A. africanus* is different from *A. afarensis* because:
- A. he is believed to have had a thumb like humans
 - B. he wore animal skins
 - C. he had larger, more rounded skull
 - D. both A and C
- B 41. *A. anamensis* is considered a hominid by its discoverer because:
- A. she found a complete skeleton
 - B. the mandible she found appeared ape-like, but the tibia she found demonstrated bipedalism
 - C. both the mandible and the tibia appeared to be similar to humans
 - D. she found forty per cent of the fossil
- D 42. *Ar. ramidus* is considered by its discoverer to be:
- A. 4.4 million years old
 - B. an ancestor of man
 - C. bipedal
 - D. all of these are correct

- D 43. The original fossil of *A. afarensis*
- A. was nicknamed Lucy
 - B. was made up of 40% of the original skeleton
 - C. did not have a complete skull
 - D. all answers are correct
- A 44. In general hominids:
- A. are considered bipedal but retain some ape-like characteristics
 - B. are very easy to find
 - C. are considered neither ape-like nor human-like
 - D. none of these
- B 45. Evolutionists generally believe:
- A. an increase in brain capacity came before bipedalism
 - B. bipedalism came before an increase in brain capacity
 - C. brain capacity and bipedalism evolved at the same time
 - D. none of these

From a Creationists' Perspective

- B 46. Louis Pasteur helped to disprove spontaneous generation by:
- A. showing that maggots could not arise spontaneously from rotten meat
 - B. demonstrating that microorganisms could not arise spontaneously
 - C. testing Oparin's theory
 - D. none of these
- C 47. Francisco Redi helped to disprove spontaneous generation by:
- A. boiling beef broth in a jar
 - B. performing an experiment on amino acids
 - C. showing that maggots could not arise spontaneously from rotten meat
 - D. helping Stanley Miller test Oparin's theory
- D 48. In the experiment on rotten meat, maggots formed
- A. in all the jars
 - B. in none of the jars
 - C. in the covered jars only
 - D. in the uncovered jars only
- A 49. In the experiment on beef broth, microorganisms formed
- A. only in the flasks contaminated by dust
 - B. in all the flasks
 - C. in none of the flasks
 - D. only in the flasks uncontaminated by dust

- A 50. "Living things can come only from other living things" is
- A. the principle of biogenesis
 - B. the second law of thermodynamics
 - C. a description of spontaneous generation
 - D. none of these
- D 51. Oparin's theory:
- A. attempted to explain the principle of biogenesis
 - B. attempted to explain Stanley Miller's experiment
 - C. took into account all the chemical processes of life
 - D. attempted to explain how spontaneous generation of the first cell could take place
- C 52. Stanley Miller attempted to test Oparin's theory, but the experimental apparatus contained one thing not present in nature. This was:
- A. a condenser
 - B. an energy source
 - C. a trap
 - D. lightning
- A 53. The ocean could not protect amino acids because
- A. the sun's ultraviolet rays could still destroy them
 - B. the water would dissolve them
 - C. neither of these
 - D. both A and B
- B 54. In order to form proteins from amino acids _____ are absolutely necessary.
- A. lactic acids
 - B. enzymes
 - C. UV rays
 - D. none of these
- A 55. Enzymes are:
- A. proteins
 - B. sugars
 - C. inorganic molecules
 - D. proteinoids
- B 56. Another major difficulty with Miller's experiment is that it
- A. had no available heat source
 - B. produced a great deal of other compounds besides amino acids
 - C. had no way to turn the gases back into liquids
 - D. produced only left-handed amino acids
- B 57. In an organic soup the amino acids would be more likely to combine with
- A. other amino acids
 - B. other substances
 - C. proteins
 - D. none of these

- D 58. Nature uses exclusively:
- A. right-handed sugars
 - B. left-handed amino acids
 - C. left- and right-handed amino acids
 - D. both A and B
- D 59. Photosynthesis could not evolve because:
- A. it has one phase that is very complicated
 - B. it has two phases which are mutually dependent on one another
 - C. both its phases are very complicated
 - D. both B and C
- C 60. Without a trap, amino acids that were produced in Miller's experiment would:
- A. combine to form proteins
 - B. combine with other substances
 - C. be destroyed by the energy that formed them
 - D. be unaffected
- A 61. Oparin's theory stated that the early Earth had a reducing atmosphere. This was absolutely necessary because:
- A. organic molecules will not combine in the presence of free oxygen
 - B. DNA requires free oxygen in order to combine
 - C. the organic soup had to be protected from the sun's UV rays
 - D. water vapor was not important to his theory
- A 62. These form the "punctuation" of DNA.
- A. Start & stop codons
 - B. Proteins
 - C. Nucleotides
 - D. Genes
- C 63. DNA has often been compared to:
- A. a factory
 - B. a gene
 - C. a language
 - D. none of these
- B 64. It has been said that the probability of five favorable mutations occurring within a single life cycle of an organism is:
- A. very likely
 - B. effectively zero
 - C. not likely but possible
 - D. moderately likely
- D 65. Michael Richardson has shown that the same parts of embryos of different species:
- A. do not look alike
 - B. look very much alike
 - C. vary widely in size
 - D. both A and C

- A 66. The same parts of the embryos of different species often:
- A. do not develop into similar body parts in adults
 - B. always develop into similar body parts in adults
 - C. look very similar
 - D. both A and C
- C 67. What evolutionists call “gill slits” in humans are more accurately called:
- A. the throat
 - B. the coccyx
 - C. pharyngeal pouches
 - D. all of these
- B 68. The yolk sac was once thought to be vestigial. This means:
- A. it is too large
 - B. it is reduced in size and has no function
 - C. it is too small to be useful
 - D. it has a use only in adults
- D 69. Mankind’s embryonic yolk sac:
- A. is truly vestigial
 - B. is marginally useful
 - C. is useful late in the pregnancy
 - D. performs an important function early in the pregnancy
- D 70. These are not mentioned as homologous structures by evolutionists.
- A. The fingers
 - B. The legs of humans
 - C. The hind legs of most vertebrates
 - D. Both B and C
- A 71. So-called homologous structures in adult organisms:
- A. often develop from different parts of their respective embryos
 - B. always develop from the same parts of their respective embryos
 - C. are really analogous structures
 - D. never develop from the same parts of their respective embryos.
- B 72. The genes that control so-called homologous structures:
- A. are always homologous
 - B. are frequently found in different locations and on different chromosomes
 - C. are always found on the same chromosomes
 - D. none of these
- C 73. Pleiotropy is :
- A. the phenomenon of a gene influencing more than one trait
 - B. a strong argument against comparative homology
 - C. both A and B
 - D. neither A nor B

- D 74. Scientists are trying to use a protein which is present in many organisms to determine which are intermediate or link species. This protein is:
- A. leucine
 - B. praline
 - C. glutamine
 - D. cytochrome C
- A 75. When evolutionists tested different organisms using this protein (see # 74), they found that:
- A. all species tested appeared to be equidistant from bacteria
 - B. there were several species which could be considered intermediate
 - C. there were one or two species that could be considered intermediate
 - D. most of the species could not be considered intermediate
- E 76. Which of the following provides evidence that supports evolution?
- A. Genetics
 - B. Comparative embryology
 - C. Comparative homology
 - D. Comparative biochemistry
 - E. None of these
- A 77. Devolution occurs primarily due to:
- A. the loss of genetic information
 - B. the gain of genetic information
 - C. neither of these
 - D. both of these
- B 78. Geologists originally used _____ to determine the relative ages of rocks.
- A. the principle of biogenesis
 - B. the principle of uniformity
 - C. carbon-14 dating
 - D. none of these
- D 79. Creationists have used another dating method to disprove geologic column dating. This is:
- A. uranium-lead
 - B. rubidium-strontium
 - C. isochron dating
 - D. carbon-14
- C 80. Representatives of what percentage of the known phyla show up in Cambrian rock?
- A. 15%
 - B. 50%
 - C. 95%
 - D. 75%
- A 81. The species that died in the Cambrian period are essentially the same as those we have today. This means the fossil record exhibits:
- A. stasis
 - B. meiosis
 - C. gradual change
 - D. none of these

- B 82. If birds evolved from reptiles, there should be _____ intermediate fossils in the fossil record.
- A. ten or twenty
B. thousands of
C. 1 or 2
D. thirty or forty
- C 83. Because of the transitional forms, Stephen Gould and Niles Eldredge proposed another theory of evolution. This is called:
- A. mutation
B. circular reasoning
C. punctuated equilibrium
D. both A and C
- D 84. One of the major problems with fossil study is:
- A. too many fossils to choose from
B. too little of the fossil to give it link fossil status
C. a lack of soft tissue
D. both B and C
- D 85. Creationists consider *Archaeopteryx* to be simply a bird because:
- A. some modern birds have claws on their wings
B. some modern birds have flat breast-bones
C. it has no halfway features between scales and feathers
D. all choices are correct
- A 86. One problem with the whale series is:
- A. the specimens' only similarity to a whale is some bones in the ear
B. the specimens are too small for study
C. there are too many specimens to work with
D. none of these
- C 87. Using the rocks to date the fossils and the fossils to date the rocks is an example of
- A. logical progression of thought
B. begging the question
C. circular reasoning
D. none of these
- A 88. Correlating the rocks is:
- A. the process of examining the rocks in different locations to determine if they are the same age
B. examining the processes that help to form rocks
C. an example of circular reasoning
D. all of the answers are correct
- D 89. Organisms which have no living examples are said to be
- A. transitional
B. homologous
C. analogous
D. extinct

- C 90. Another term for link fossil is
- A. intermediate form
B. transitional form
C. both A and B.
D. neither A nor B
- C 91. Most radiometric dating relies on ____ assumptions.
- A. 1
B. 2
C. 3
D. 4
- A 92. We know that the rate of radioactive decay has been relatively constant for approximately:
- A. the last 100 years
B. billions of years
C. a few million years
D. never
- B 93. The time it takes for 50% of the radioactive atoms in a sample rock to break down into its daughter element is called its:
- A. decay element
B. half-life
C. parent element
D. None of these choices
- C 94. The assumption about radiometric dating that has the most support is:
- A. the original composition of the rock is unimportant
B. there are several ways for radioactive material to get out of the rock
C. the rate of decay has always been constant
D. none of the assumptions has any support at all
- C 95. Scientists testing samples of radioactive rock get:
- A. consistently the same results
B. fairly close results
C. widely varying results
D. none of the above
- D 96. Radioactive elements are unstable because:
- A. they have an excess of protons
B. their nuclei are too large for stability
C. they have more neutrons than protons
D. all of these can cause instability
- A 97. Element x has a half-life of 5 minutes. This means that at the end of 15 minutes _____ will be left.
- A. 1/8
B. 1/4
C. 1/3
D. 1/2

- E 98. In order to use long-range dating methods scientists
- A. must use carbon-14 only
 - B. can use uranium-lead
 - C. can use potassium-argon
 - D. can use rubidium-strontium
 - E. B, C, D, are correct
- B 99. Uranium—lead dating is based on the ratio of uranium to lead in a(an) ____ rock.
- A. sedimentary
 - B. igneous
 - C. metamorphic
 - D. shale
- E 100. The following material(s) can be removed from a given rock through leaching by ground water.
- A. Rubidium
 - B. Strontium
 - C. Lead
 - D. Uranium
 - E. All of these
- E 101. One of the reasons the Potassium—Argon method of dating is inaccurate is that:
- A. potassium and argon can be leached out of rocks
 - B. rocks can absorb argon from the air
 - C. argon can be forced up to the surface of the rock from the rock's interior
 - D. argon can be trapped in the rock
 - E. B, C, and D are correct
- C 102. Rubidium-strontium dating:
- A. is very accurate
 - B. is not affected by the problems that other methods have
 - C. gives dates which are out of line with other methods of dating
 - D. is relatively accurate
- D 103. Isochron dating is an attempt to date the age of rocks by measuring the ratio of different ____ within the rocks.
- A. minerals
 - B. isochrons
 - C. electrons
 - D. isotopes
- D 104. Isochron dating has problems because:
- A. it is impossible to determine the original ratio of isotopes
 - B. different isotopes of both rubidium and strontium can be leached out of the rock
 - C. neither A nor B
 - D. both A and B

- B 105. Carbon-14 dating as used by evolutionists is used to date material up to _____ years old.
- A. 10 million
B. 50,000
C. 10,000
D. 1 million
- A 106. Libby, the developer of Carbon-14 dating, assumed:
- A. carbon-14 is stabilized in the atmosphere
B. carbon-14 is not stabilized in the atmosphere
C. it didn't matter if Carbon-14 is stabilized or not
D. none of the above
- A 107. Carbon-14 dating is used to date:
- A. artifacts (organic materials)
B. minerals
C. rocks
D. none of these
- A 108. Being stabilized means:
- A. the same amount of the substance is constantly present
B. the ^{14}C levels have fluctuated over time
C. the amount of carbon-14 in the upper atmosphere fluctuates, but the amount near the earth does not
D. the amount of carbon-14 is building up
- D 109. If ^{14}C has not yet stabilized in the atmosphere, this means:
- A. carbon-14 is still building up in the atmosphere
B. test samples will appear to be older than they actually are
C. test samples will appear to be younger than they actually are
D. both A and B
- B 110. Brontosaurus is really
- A. a dinosaur
B. an *Apatosaurus* with the wrong head
C. the largest sauropod ever to live
D. an example of how easy it is to put fossils together
- D 111. A problem with the species, *Homo habilis* is
- A. parts of the fossil were found with other creatures scattered over an acre of ground
B. many scientists believe the genus has become a "taxonomic wastebasket"
C. neither of these is a problem.
D. both A and B are problems

- D 112. The Lake Laetoli footprints are an important find for creationists because:
- A. they are of unshod humans
 - B. they are obviously ape-like
 - C. they are dated to be older than many hominids
 - D. both A and C are correct
- D 113. *A. anamensis* is questionable as a true hominid because:
- A. its finder took it from three different locations
 - B. the bones appeared to be from both a human and another primate
 - C. parts of the fossil were found in rock strata dated to be of very different ages
 - D. all of the above
- A 114. *Ar. kadabba* is questionable as our ancestor because
- A. parts of the fossil were found 10 miles and 200,000 years apart
 - B. parts were squashed
 - C. the fossil consisted of an arm bone
 - D. none of these
- B 115. More recent examples of *H. erectus* appear to be
- A. orangutans
 - B. humans
 - C. apes
 - D. gibbons
- B 116. *K. platyops* is questionable as our ancestor because
- A. its parts were scattered
 - B. its parts were distorted
 - C. it had been dated to be too young
 - D. finders couldn't assemble a skull
- D 117. *Homo heidelbergensis* and *Homo neanderthalensis* are obviously both
- A. hominids
 - B. poor examples of humans
 - C. not really human
 - D. human
- E 118. Parts of the different specimens of *A. Africanus*
- A. come from several locations
 - B. are often fragmentary
 - C. give no evidence that it was bipedal
 - D. A and C are correct
 - E. A,B,C are correct
- E 119. Evidence for *Ar. ramidus* being our ancestor is debatable because
- A. its evidence for being bipedal is a divergent big toe
 - B. its bones disintegrated at a touch
 - C. its parts had been trampled and scattered
 - D. A and B are correct
 - E. all answers are correct

- B 120. The “pervasiveness of perfection” means:
- A. perfection is uncommon in nature
 - B. everywhere there are machines and systems carefully built and suited for the tasks they perform
 - C. there are some machines in nature that are well suited for their tasks
 - D. perfection is common only in the microscopic world
- D 121. In an irreducibly complex structure:
- A. the parts work well together
 - B. there are no moving parts
 - C. the machine will not work unless all the parts are present and functioning together
 - D. both A and C
- B 122. As scientists have studied smaller and smaller units, they have found:
- A. that things become simpler
 - B. layer upon layer of complexity
 - C. microscopic machines
 - D. both B and C
- D 123. Gated transport is:
- A. carrying of proteins through the cell’s cytoplasm to the ribosomes
 - B. movement through the membrane of the organelle for which the protein was produced
 - C. a good illustration of the complexity of cellular activities
 - D. both B and C
- C 124. The bacterial flagellum is considered an irreducibly complex structure because:
- A. it has more than one part
 - B. it is small
 - C. it has at least three essential parts
 - D. none of these
- D 125. The bat’s brain is extraordinary because:
- A. it must be able to separate the reflected sound of its own pulse from that of other bats
 - B. it must determine the size of an object and its distance away
 - C. it must work in split-second cooperation with the bat’s larynx and ears
 - D. A, B, and C are correct
 - E. none are correct
- E 126. The giraffe’s veins:
- A. are much like those of other mammals
 - B. have valves to counteract the effects of gravity on the giraffe’s long legs
 - C. have valves to prevent part of the blood from receding from the brain
 - D. have specialized valves only near the aorta
 - E. both B and C

- D 127. In the giraffe's arteries:
- A. some of the blood is shunted off to the vertebral artery when the head is lowered
 - B. blood travels the same way it does in other mammals
 - C. some of the arteries expand and contract to hold different amounts of blood
 - D. both A and C
- D 128. Part of oxygen balance is achieved by:
- A. animals giving off carbon dioxide which plants use and, in turn, give off oxygen
 - B. chemical weathering removing oxygen from the atmosphere
 - C. algae in the ocean producing oxygen
 - D. all of the above
- C 129. Oxygen balance is also aided by:
- A. bacteria on the ocean's bottom
 - B. density currents in the oceans
 - C. both A and B
 - D. neither A nor B
- E 130. The Earth is uniquely suited for life because it has:
- A. the right tilt
 - B. ocean(s) of the right size
 - C. the right atmosphere
 - D. the right amount of carbon
 - E. A, B, C, and D
 - F. only A and B are correct
- D 131. The following characteristic(s) of water is (are) absolutely necessary for life on Earth:
- A. water's thermal characteristics
 - B. water's surface tension
 - C. water's chemical properties
 - D. A, B, and C are correct
 - E. only A and B are correct
- B 132. The sun produces the majority of its radiation in:
- A. the ultraviolet band
 - B. the near ultraviolet, visible light, and near infrared bands
 - C. radio waves
 - D. gamma rays
- C 133. Very little harmful radiation reaches the Earth because:
- A. the sun produces very little harmful radiation
 - B. the Earth's atmosphere acts to block harmful radiation
 - C. both A and B
 - D. the harmful radiation is unable to travel so far through space

- B 134. The belief that there was an earlier creation which was destroyed when Satan fell is known as the:
- A. Day-age Theory
B. Gap Theory
C. Canopy Theory
D. Old Earth Theory
- C 135. Scientists who believe that the Earth and its inhabitants are too complicated to have happened by chance, and therefore someone had to create them are known as the:
- A. Gap theorists
B. Day-age theorists
C. Intelligent Design Group
D. Young Earth Creationists
- C 136. Those who believe that the days mentioned in Genesis were 24 hours in length are known as:
- A. Old Earth Creationists
B. Gap theorists
C. Young Earth Creationists
D. Day-age theorists
- A 137. Those who believe that the days mentioned in Genesis were really long periods of time are known as:
- A. Day-age theorists
B. Gap theorists
C. Young Earth Creationists
D. Canopy theorists
- B 138. An area where one crustal plate goes beneath another is known as a:
- A. divergent boundary
B. subduction zone
C. hydroplate
D. none of these
- D 139. The Runaway Subduction theory proposes that:
- A. the Earth once had ocean plates which were denser than they are today
B. the ocean plates once moved very rapidly under the continental plates
C. the rapid movement of crustal plates caused the catastrophe of Noah's flood
D. all choices are correct
- A 140. Which of the following would be considered circumstantial evidence?
- A. A fingerprint left at the scene of a crime
B. An eyewitness report
C. Laboratory repetition of experiments
D. None of these
- A 141. In order for an ice age to occur, there must be a combination of:
- A. abnormally cool summers and abnormally warm arctic oceans
B. Abnormally warm summers and abnormally warm arctic oceans
C. abnormally cool summers and abnormally cool arctic oceans
D. abnormally warm summers and abnormally cool arctic oceans

- D 142. These offer good circumstantial evidence for a catastrophic flood.
- A. Radioactive elements
 - B. Structure of the fossil beds
 - C. Polystrate fossils
 - D. Both B and C
- D 143. This (these) would be a possible consequence of runaway subduction.
- A. Rapid continental drift
 - B. Tsunamis
 - C. Frozen, preserved mammoths
 - D. Both A & B
- E 144. These theorists attempt to use scripture for support.
- A. Canopy theorists
 - B. Hydroplate theorists
 - C. Gap theorists
 - D. Day-age theorists
 - E. All of these
- C 145. These theorists believe in rapid continental drift.
- A. Day-age theorists
 - B. Gap theorists
 - C. Runaway Subduction theorists
 - D. None of these
- C 146. Circumstantial evidence:
- A. has no basis in fact
 - B. has very little basis in fact
 - C. has a definite basis in fact
 - D. is not acceptable in a court of law
- D 147. Although many law-abiding, moral citizens accept evolution as true, it can logically lead to _____ in their lives.
- A. moral relativism
 - B. social darwinism
 - C. agnosticism
 - D. all of these
- C 148. Karl Marx viewed religion as:
- A. a benefit to people
 - B. unimportant to people
 - C. the opiate of the people
 - D. none of these
- B 149. Marx was very excited when he read Darwin's work because:
- A. it showed how God created the world
 - B. it made atheism scientifically acceptable
 - C. it was easy for a layman to read
 - D. it showed how God used evolution instead of the Biblical method to create the world
- B 150. Marx was so impressed and grateful to Darwin that he:
- A. invited him to speak at a Communist rally
 - B. offered to dedicate a book to him
 - C. asked him to write a book especially for Communists to read
 - D. became a Christian

- D 151. Lenin was deeply influenced by Darwin's theory; he went on to
- A. become an atheist
 - B. lead the communist revolution in Russia
 - C. use a belief in Social Darwinism as an excuse for violence and killing
 - D. all of these
- B 152. Joseph Stalin, according to his biographers,
- A. was not particularly influenced by Darwin
 - B. read Darwin in his early teens and became an atheist
 - C. was only mildly influenced by Darwin
 - D. at first accepted Darwin but later changed his views
- D 153. During his time in power, Stalin:
- A. introduced several 5-year plans which caused the death of millions
 - B. began enforcing grain quotas which didn't leave enough for the farmers to eat
 - C. forcibly removed millions of people from their land
 - D. all of these
- A 154. The number dying in Stalin's "war against the peasants" was:
- A. greater than the number of lives lost in World War I
 - B. sizable but less than a million
 - C. less than a thousand
 - D. two million
- C 155. Hitler's entire justification for enslaving and annihilating non-Germanic peoples was:
- A. they posed a threat to German people
 - B. the Germanic people were trying to help other countries
 - C. the German people were the most fit and therefore had a right to take what they wanted
 - D. both B and C
- A 156. In 1945, when Hitler realized the Russians would win, he:
- A. still believed in survival of the fittest
 - B. declared the Germans were still the best
 - C. abandoned his belief in evolution
 - D. gave up his atheism
- B 157. Benito Mussolini:
- A. read Darwin and only partially accepted his theory
 - B. regarded Darwin as one of the two greatest thinkers of the 19th century
 - C. was a faithful Christian
 - D. none of these

- D 158. Mussolini:
- A. also believed in the superiority of the Aryan race
 - B. used social Darwinism as an excuse to enslave other races
 - C. passed laws preventing Italians from intermarrying with other races
 - D. all of these
- E 159. "Survival of the fittest" was the world view which was held by:
- A. Lenin
 - B. Stalin
 - C. Hitler
 - D. Mussolini
 - E. all of these
- E 160. Peter Singer is:
- A. a Christian philosopher
 - B. a college professor
 - C. considered a moderate by many
 - D. a believer in moral absolutes
 - E. both B and C
- D 161. Prof. Singer believes:
- A. abortion is okay but infanticide is wrong
 - B. both abortion and infanticide are acceptable
 - C. euthanasia is acceptable
 - D. both B and C
- B 162. Euthanasia is:
- A. assisted suicide
 - B. killing of the ill, with or without their consent
 - C. a type of abortion
 - D. none of these
- C 163. In the Netherlands, guidelines to prevent abuse of assisted dying are:
- A. strictly enforced
 - B. never enforced
 - C. left to the judgment of the attending doctor
 - D. none of these
- C 164. In moral relativism:
- A. right and wrong depend on Biblical absolutes
 - B. right and wrong depend on the absolutes of a given culture
 - C. right and wrong depend on the circumstances of the situation
 - D. right and wrong are not considered

- D 165. If evolution were true, which of the following series of statements is a logical progression of thought?
- A. Genesis is a myth that God gave us. The rest of the Bible is okay. There are still moral absolutes.
 - B. Most of Genesis is still true. The Bible is fairly accurate. We have some basic moral absolutes.
 - C. God used evolution to create the world. He gave us the Bible to guide us. He is still the creator God.
 - D. Genesis is false. The rest of the Bible is therefore unreliable. There are no moral absolutes. Right and wrong depend on circumstances. Survival of the strongest and fittest is “right” and logical.

Vocabulary (Chapters 1–5)

Chapter 1

<u>igneous</u>	1. Rock formed from melted rock.
<u>Metamorphic</u>	2. Rock formed from heat and pressure.
<u>sedimentary</u>	3. Rock formed from the remains of plants, animals, and rock fragments.
<u>sedimentary</u>	4. Rock in which most fossils are found.
<u>Lamarck</u>	5. He proposed the Theory of Acquired Traits and the Theory of Use and Disuse.
<u>Inheritance of Acquired Traits</u>	6. This states that traits acquired in one generation are passed on to the next generation.
<u>Vestigial organs</u>	7. These appear to be reduced in size and to have no apparent function.
<u>Lyell</u>	8. He proposed the Principle of Uniformity. He said the slow processes we see today indicate an old earth. “The present is the key to the past”.
<u>de Vries</u>	9. He proposed the Mutation Theory, which states that mutations provide the genetic variety on which natural selection can work.
<u>Darwin</u>	10. He popularized natural selection.
<u>Natural Selection</u>	11. The process by which organisms well adapted to the environment will survive and reproduce more often than those that are not.
<u>Mendel</u>	12. He is the “father” of genetics. He discovered dominant (expressed) genes and recessive (unexpressed) genes.
<u>Meiosis</u>	13. The process by which a parent’s genes are divided, and one half passed on to the next generation; provides the genetic variety for devolution to occur.

Chapter 2

<u>Devolution</u>	14. Change primarily within genus or species, and extending in some cases to the family level: occurs primarily because of a loss of genetic information.
<u>Evolution</u>	15. Change that goes beyond the genus, species, or family level; requires the influx of a massive amount of genetic information.
<u>Migration</u>	16. Movement into or out of a population.

<u>Genetic isolation</u>	17. This occurs when organisms are unable to interbreed.
<u>Cast</u>	18. A mold is a cavity in rock formed by the body of a buried organism which then decays. This is created when minerals fill in the cavity.
<u>Amber</u>	19. Carbon film fossils occur when plants are buried and decay partially, leaving carbon from their bodies; what is hardened tree sap called?
<u>Homologous structures</u>	20. Analogous structures are body parts which have a different structure but the same function; what are body parts of different organisms that have the same basic structure but a different function called?
<u>Miller</u>	21. Oparin proposed a theory as to how the first cell formed: this man tested it.
<u>Punctuated Equilibrium</u>	22. Evolutionary theory that proposes that in the past there were rapid changes followed by long periods of stability and little change. It was formulated primarily to explain the lack of link (transitional or intermediate) fossils.
<u>Evolution</u>	23. Devolution is brought about primarily by the interaction of meiosis and natural selection; what is supposed to be brought about by mutation and natural selection?
<u>Mutation</u>	24. A random change in a gene or chromosome. Scientists have estimated that the probability of 5 beneficial ones occurring in the same organism during its lifespan is effectively zero.
<u>Sedimentary rock</u>	25. Fossils can be found in ice, tar, tree sap and this.
<u>Cytochrome C</u>	26. A protein used in respiration in a wide variety of organisms.
<u>Anaerobic bacterium</u>	27. The first cell is supposed to have resembled this, a bacterium that does not require free oxygen.
<u>Imprint</u>	28. An impression left in a rock by a leaf or a foot, etc. before the rock hardens.

Chapter 3

<u>Physical anthropologist, Or paleoanthropologist</u>	29. A geologist is a scientist who studies fossils to learn about the earth's history. What is a scientist who studies primarily human fossils called?
<u>Bipedalism</u>	30. Hominids are human-like species which were supposed to have retained some ape-like characteristics. They supposedly walked on two legs. What is walking on two legs called?
<u>Primates</u>	31. Humans, along with several other creatures, are placed in this order.

- Ramapithecus 32. It was a small monkey-like primate that is supposed to have lived between 8 and 17 million years ago and was considered for a time to have been the ancestor of both apes and man. It was really an orangutan.
- Ar. ramidus 33. The fossil consisted of a mandible, some arm bones, and pieces of skull in one location. Together with bones found in another location, they had about 45% of a skeleton. Believed to have lived 4.4 million years ago.
- Ar. kadabba 34. Believed to have walked upright and to have been an ancestor of *Ar. ramidus*.
- K. platyops 35. It consists of a badly abraded skull and a partial upper jaw; found in 1999 near Lake Turkana, Kenya by Justus Erus, a member of Meave Leakey's team.
- A. anamensis 36. Meave Leakey found this fossil; she considered it to be a hominid because the mandible she found was ape-like, but the tibia she found demonstrated bipedalism.
- A. africanus 37. *A. afarensis* was discovered by Donald Johanson and nicknamed Lucy. Forty per cent of the skeleton was found (although no head). What is the name of the claimed fossil descendent which is different from *A. afarensis* because he is supposed to have had a larger, more rounded skull and a thumb like humans?
- Brain capacity 38. Evolutionists believe an increase in this came after hominids began to walk upright.
- Homo erectus 39. An archaic human whose holotype specimen consisted of a human femur and a skull plate resembling a neanderthal's. Now considered an archaic human.
- H. neanderthalensis,
Homo heidelbergensis,
Homo ergaster,
Homo erectus 40. These are considered Archaic humans by evolutionists.
- Cro Magnon 41. This human is identical in appearance to modern man.
- Out of Africa Model 42. States that modern humans evolved in Africa and then came out of the continent and replaced other, less-evolved hominids that had left Africa at an earlier time. Also known as Single Origin Model.
- Regional –continuity Model 43. States that groups of *Homo erectus* left Africa and dispersed into many areas of the old world; then each group fathered a line that gave rise to modern humans. Also known as Multi-regional Model.

From a creationist's perspective

Chapter 4

<u>Pasteur</u>	44. Francisco Redi was an Italian scientist who disproved spontaneous generation of larger organisms by showing that maggots did not arise spontaneously from rotten meat. Who is the French scientist who proved that microorganisms could not arise spontaneously. Note: you are responsible to know what happened in these experiments.
<u>Principle of Biogenesis</u>	45. This states, "living things can come only from other living things".
<u>Oparin</u>	46. He attempted to explain how the first cell could have spontaneously generated, but he failed to take into account all the chemical processes of life.
<u>Trap</u>	47. Stanley Miller's experimental apparatus contained one thing not present in nature. What is it? Because it is missing, the amino acids would have been destroyed by the energy that formed them. On Oparin's Earth, oceans could not have protected the amino acids because the water would have dissolved them and the UV rays of the sun could still have reached them.
<u>Enzymes</u>	48. These proteins are absolutely necessary to form other proteins from amino acids.
<u>Miller's experiment</u>	49. This produced a great deal of other compounds besides amino acids with which the amino acids would be much more likely to combine.
<u>Right handed</u> <u>Left handed</u>	50. 51. Nature uses exclusively _____ sugars and _____ amino acids.
<u>Photosynthesis</u>	52. This could not have evolved because it has two very complicated processes that are mutually dependent.
<u>Reducing atmosphere</u>	53. This is an atmosphere with no free oxygen. It is absolutely necessary for any theory of spontaneous generation because organic molecules will not combine in the presence of free oxygen.
<u>Oxidized iron in</u> <u>Pre-cambrian rock</u>	54. This proves there was O ₂ in the early atmosphere.

Chapter 5

<u>DNA</u>	55. This has often been compared to a language. It has "letters", (nucleotides) "words", (triplets) "sentences", (genes) and "punctuation", (start and stop codons).
<u>Information</u>	56. DNA carries this. This never arises by accident.

- Richardson 57. His research showed that embryos of different organisms at the same stage of development do not look alike. It has also been shown by other scientists that homologous parts of embryos of different species often do not develop into homologous parts in the adult organisms. The reverse is also true. For example, the so-called “gill slits” (more accurately called pharyngeal pouches) of human embryos do not develop into the respiratory system as in fish; instead, they grow into various glands.
- Yolk sac 58. This performs an important function early in embryonic development; it provides the red blood cells to the baby until the bone marrow can take over the job.
- Legs of man and hind legs of quadrupeds 59. Evolutionists do not mention these as homologous structures.
- Pleiotropy 60. The genes that control so-called homologous structures are frequently found on different locations and on different chromosomes. _____ is the phenomenon of a gene influencing more than one trait. It is also a strong argument against comparative homology. Both situations indicate non-homologous genes are controlling so-called homologous structures.
- Cytochrome C 61. Scientists comparing this protein in different species, looking for evidence for evolution, found that all species appeared to be equidistant from bacteria. There were no intermediate species.
- None 62. This science offers some good support for evolution.

Vocabulary (Chapters 6–11)

Chapter 6

<u>Correlating rock</u>	1. The process of examining the rocks in different locations to determine if they are the same age.
<u>Principle of uniformity</u>	2. Geologists originally used this to determine the relatively old ages of rocks.
<u>Circular Reasoning</u>	3. Using the rocks to date the fossils and the fossils to date the rocks is an example of this.
<u>Carbon-14</u>	4. Creationists have used this dating method to disprove geologic column dating.
<u>Ninety-five% (95%)</u>	5. Representatives of this percentage of the known phyla show up in Cambrian rock. Once they show up, the different species remain essentially the same. This is known as stasis.
<u>Transitional forms</u>	6. If evolution is true, there should be hundreds of thousands of these in the fossil record. (Also called link fossils, or intermediate forms.)
<u>Extinct</u>	7. These organisms have no living examples.
<u>Fossils</u>	8. The study of these is hampered by too little of the organisms to give them link status and no soft tissue to examine.
<u>Archaeopteryx</u>	9. This is considered a bird by creationists because some modern birds have claws on their wings and flat breastbones and some extinct birds have teeth; also, it has no half-way features between scales and feathers.
<u>The whale serie</u>	10. One problem with this series is that most of the specimens have nothing in common with the creature they are supposed to be ancestors of except a few ear bones.
<u>Coelacanth</u>	11. This was considered a link fossil between fish and amphibians until a live one was discovered.

Chapter 7

<u>Radioactive atoms</u>	12. These are unstable because they have an excess of protons, an excess of neutrons, or their nuclei are too large for stability.
<u>Daughter element</u>	13. The radioactive element is often called the parent element. The element into which the radioactive element decays is called (Also called decay element.)

- Half life 14. The time it takes for 50% of a rock's radioactive material to break down. Know how to figure this! (See Chapter 7)
- Three (3) 15. Most radioactive dating rests on _____ premises or assumptions.
16. State the 3 assumptions of radioactive dating on the lines below.
The rate of decay has always been constant.
The original composition of the rock is known.
There is no other way that radioactive material or daughter material has gotten out of the rock
 Which of these assumptions has the most support and why?
The rate of decay has been constant for the past 100 years and efforts to change it have been largely unsuccessful, so this is the best argument.
- Leaching 17. Rubidium, strontium, uranium, and lead can all be washed out of rock by ground water. What is this called? Because of this problem, scientists using radioactive dating methods tend to get widely varying results when dating the same rock formation.
- Uranium-lead
Rubidium-strontium
Potassium-argon
isochron 18. These are considered long-range dating methods.
- Potassium-argon 19. This method is flawed because the decay element can be absorbed from the air, forced to the surface of the rock from the rock's interior, and trapped within the rock.
- Isochron 20. This method is an attempt to date the age of rocks by measuring the ratio of different isotopes within the rocks. It has problems because it is impossible to determine the original ratio of isotopes. Also, the isotopes can be leached from the rocks.
- Isochron
Rubidium-strontium 21. These long-range methods, like uranium-lead and potassium-argon, give dates that are out of line with other methods of dating. (Two)
- Carbon-14
or radiocarbon 22. A short-range, radioactive dating method that dates artifacts up to 50,000 years old.
- Stabilized 23. In formulating this method, Libby inaccurately assumed that this element was _____ in the atmosphere. This means that the same amount of the element has been constantly present in the atmosphere for at least 50,000 years. However, since it isn't, samples tested using this method would appear to be older than they actually are.

Chapter 8

- Brontosaurus 24. This creature is really an *Apatosaurus* with the wrong head.

- A. anamensis 25. The parts of this so-called hominid were found in 3 different locations and in rock strata dated, using evolutionists' methods, to be very different in age. The bones appeared to be from both a human and a primate.
- A. afarensis 26. Forty per cent of this fossil was found by Donald Johanson. It lacked a head. Johanson later found a head in a different location and declared it to be the same species. There is some argument as to whether it was really bipedal.
- A. africanus 27. The holotype of this species consisted of a skull. Later specimens consist of bones that are often fragmentary and found in several locations. Evolutionary scientists generally believe it was not bipedal.
- Homo habilis 28. The parts of this "hominid" were found with other creatures scattered over an acre of ground. The leg bones are more similar to living great apes than to humans. There is also no proof that *Homo habilis* walked upright. Some evolutionists believe it has become "a wastebasket taxon".
- Homo erectus 29. The parts of the original fossil of this "hominid" (Java Man) consisted of a skull plate and a femur found 50 feet apart in what was once river gravel. Other, more recent specimens appear to be smaller Neanderthals.
- Ar. ramidus 30. Pieces of a skull, and some teeth and arm bones were found in one location and a pelvis and some tibia bones in another. Later, about 100 more fossil fragments were found, together with the original find making up about 45% of a skeleton. Had a divergent big toe.
- Ar. kadabba 31. The bone fragments of jaw, arm hand and feet together with a collar-bone and some teeth. The fragments were of at least five different specimens. Toe bone found 10 miles away in rock 200,000 years difference in age.
- K. platyops 32. a partial skull and a fragmentary upper jaw found near Lake Turkana in Kenya. These are the only parts that can be definitely assigned to this species. The skull is cracked and distorted.
- H. erectus,
H. heidelbergensis and
H. neanderthalensis 33. Judging by their size, bone structure, brain capacity, and evidence of social behavior, these species were obviously human.
- Lake Laetoli footprints 34. The footprints of unshod humans in hardened, volcanic ash dated radiometrically to be 3.6 million years old, older than many of the proposed hominids.
- Kanapoi hominid 35. A human upper arm bone dated to be as old or older than the Australopithecines.

Chapter 9

- The pervasiveness of perfection 36. The idea that everywhere there are irreducibly complex machines and systems working together.
- Irreducibly complex structures 37. A machine that possesses at least 3 parts working well together and all necessary to the function of the machine.
- Gated transport 38. Movement through the cell's or an organelle's membrane; extremely complex.
- Bacterial flagellum 39. An irreducibly complex structure on a bacterium.
- Bat's brain 40. Separates the reflected sound of its own pulse from those of other bats, determines the size of an object, and its distance away from the bat.
- Giraffe 41. Has specialized arteries and specialized veins with valves in both legs and neck.
- Giraffe's neck 42. In this part of the giraffe's body, blood is shunted to the vertebral artery and arteries expand and contract to control the blood pressure.
43. List five different components of oxygen balance.
1. Animals giving off carbon dioxide which is used by plants that then give off oxygen.
2. Chemical weathering removing oxygen from the air
3. Algae producing more oxygen
4. Bacteria removing phosphorus from the ocean
5. Density currents in the oceans mixing surface and deep water
- The Earth 44. It has the right tilt, oceans of the right size, the right atmosphere, and the right amount of carbon.
- Water's thermal, & chemical properties & surface tension 45. The characteristics of water that are necessary for life on Earth.
- Near ultraviolet, visible light & near infrared bands 46. The sun produces the majority of its radiation in this narrow band.
- Harmful radiation 47. The sun produces very little of this and the Earth's atmosphere acts to block it.

Chapter 10

- Day-age Theory or Long Day Theory 48. The belief that there was an earlier creation which was destroyed when Satan fell is known as the Gap Theory. What is the theory that proposes that the days in Genesis were actually very long periods of time? (Two names for this theory)

- Young Earth Creationists 49. Scientists who believe that the Earth and its inhabitants are too complicated to have happened by chance are known as the Intelligent Design Group. Those who believe the days mentioned in Genesis were literal 24 hour days are known as _____.
- Runaway Subduction Theory 50. This theory, the best from a scientific standpoint, states that the Earth once had ocean plates that were much denser than the continental plates. This caused the ocean plates to subduct rapidly beneath the continental plates, causing much of the catastrophic results of Noah's flood such as tsunamis and rapid continental drift.
- Young Earth and Old Earth Creationists 51. These theorists attempt to use scripture for support (more than one). (Students might also mention Day-age and Gap Theorists.)
- Circumstantial evidence 52. This is evidence left behind that is difficult to explain in any other way. It has a basis in fact.
- Noah's flood 53. The structure of the fossil beds, many rock layers, and polystrate fossils offer good evidence for this.
- Ice age 54. In order for this to occur there must be a combination of abnormally cool summers and abnormally warm arctic oceans.

Chapter 11

- Marx 55. He viewed religion as the "opiate of the people". He was very excited when he read Darwin's book because it made atheism scientifically acceptable. He was so impressed and grateful he offered to dedicate a book to Darwin.
- Lenin 56. He was deeply influenced by Darwin's theory and became the atheistic leader of the communist revolution in Russia. He used social Darwinism as an excuse for violence and killing.
- Stalin 57. He read Darwin in his early teens and became an atheist. While in power, he introduced several 5 year plans in the Soviet Union, enforced cruel grain quotas, and forcibly removed millions of people from their land. It is said the number dying as a result of his actions was greater than the number of people lost in World War I.
- Hitler 58. His entire justification for enslaving and killing non-Germanic peoples was that the Germans were the most "fit" and had a right to take what they wanted. When he realized the Russians would win the war, he still believed in the "survival of the fittest".

- Mussolini 59. He believed Darwin to be one of the great thinkers of the 19th century. As a result, he believed the Aryan race was superior and used Social Darwinism as an excuse to conquer and enslave other races. He even passed laws preventing his people from intermarrying with “inferior” races.
- Survival of the fittest 60. This belief was held by Lenin, Stalin, Hitler and Mussolini, as well as by many other non-dictators.
- Spenser 61. An English philosopher who felt that victory of the strong over the weak was the natural way of life.
- Singer 62. This Australian-born philosopher and professor, because of his belief in evolution, advocates not only abortion, but also infanticide, and euthanasia. However he is considered moderate by many.
- Euthanasia 63. This is killing of the weak, sick, or old, with or without their permission.
- The Netherlands 64. In this country, guidelines to prevent abuse of assisted dying are left to the judgment of the attending doctor, leading to cases of unauthorized euthanasia.
- Moral relativism or situational ethics 65. In this moral belief system, right and wrong depend on the circumstances of the situation.
- Oregon, Washington, and Montana 66. Advocates of assisted suicide have been successful in passing laws to allow it in three states. What are they?
- Death with Dignity Act (DWDA) 67. Allows terminally ill adults 18 years of age or older to obtain lethal doses of medication if they are terminally ill.

68. On the lines below, state the logical progression of thought leading from the premise that evolution is true.

If evolution is true, Genesis is false. If Genesis is false, the rest of the Bible is unreliable.

If the Bible is unreliable, there are no moral absolutes to live by. Man does what he thinks is right, and right and wrong are determined by circumstances. This is moral relativism.