The Principles, Theories & Precepts of Biology

This chapter requires a companion activity book in which students respond to questions on text content. Answers are found in the *Teacher's Resource Kit*.



Chapter 4

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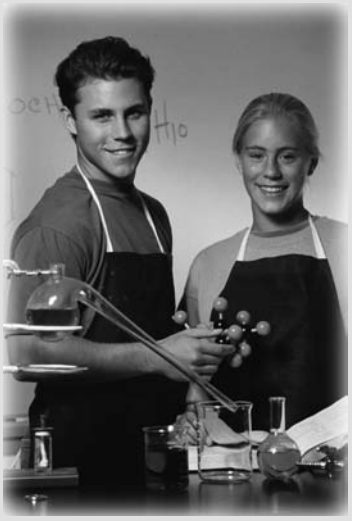
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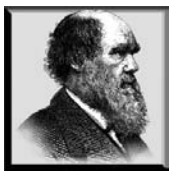
"Biology is man's attempt to understand who he is, where he came from, why he is here, and where he is going."

—Ronald E. Johnson, C.Ph.D.



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Lesson 1

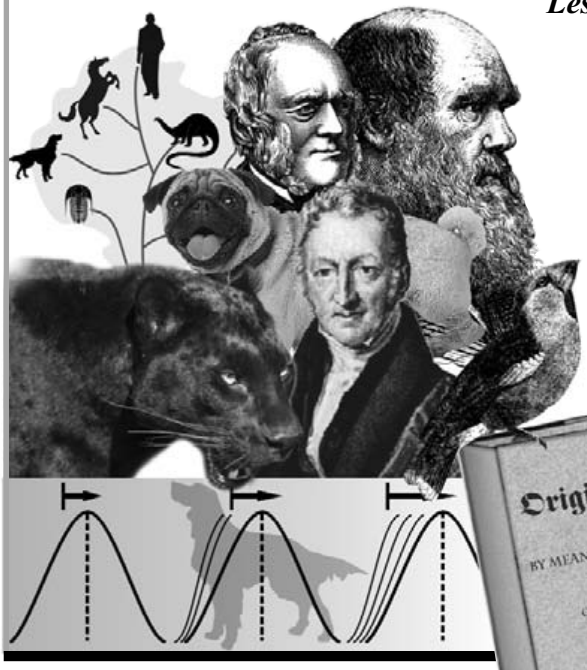
Understanding Evolution

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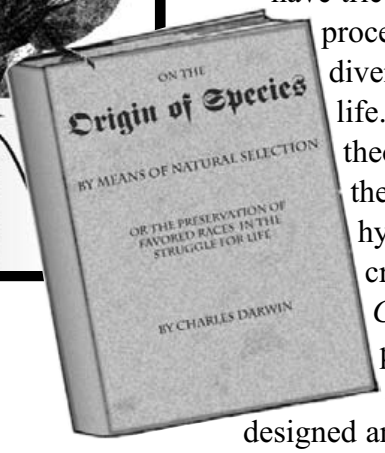
THE SCIENTIFIC METHOD AND UNCONFIRMED HYPOTHESES

Section 1

Lessons 1-5



Humans share the earth with millions of other species—from bacteria to blue whales. Among the vast majority of multicellular species, no two individuals are exactly alike. Yet, all forms of life are regulated by similar molecular messages written in the living code of DNA. Scientists have tried to discover what scientific process accounts for the incredible diversity and the apparent unity of life. Scientists, philosophers and theologians have tried to answer the puzzle of life through hypotheses ranging from special creation to evolution by chance. *Creation* is defined as the process by which the world and all living creatures were designed and created in fully functional, completely developed form. *Evolution* is defined as life that has evolved upward from an inorganic, primordial mixture in eons past to the complex diversity that exists today by the process of natural selection without supernatural input. As we studied in an earlier lesson, Charles R. Darwin published a book entitled *On The Origin of Species by Means of Natural Selection or The Preservation of Favoured Races in The Struggle for Life*. Typically, this book title is abbreviated as *The Origin of Species,* or simply *Origin*. In *The*



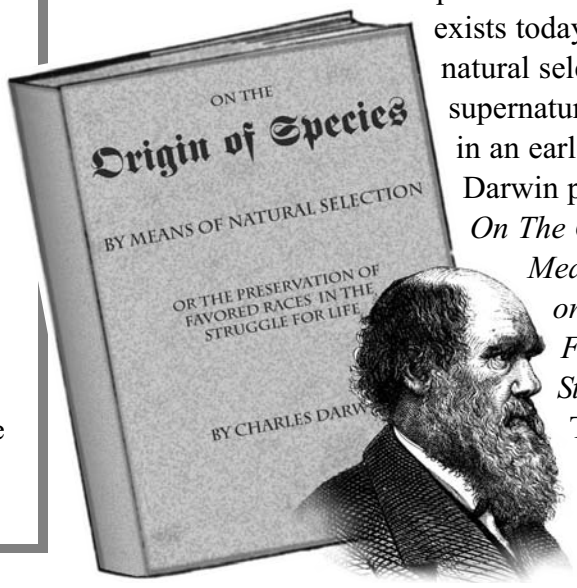
VOCABULARY

Naturalism: a theory denying supernatural significance; the doctrine that scientific laws are adequate to account for all phenomena

Abominable: detestable, worthy of contempt

Validate: to confirm the truth concerning a thing

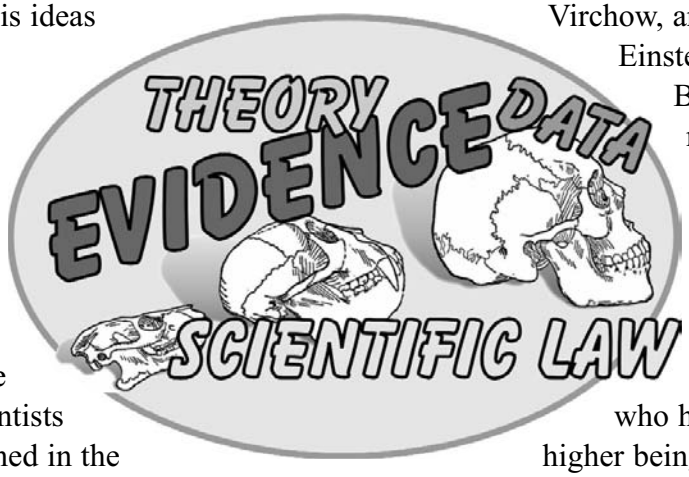
Scientific law: begins as a theory, is validated or proven true by many lines of evidence and many years of successful experiments and observations



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Origin of Species, Darwin proposed a theory that attempted to explain, from a standpoint of ***naturalism***, the diversity of life which exists on Earth. His ideas sent shock waves throughout the religious and scientific communities. At that time, science was inseparably linked to the concept of a divine creator. Most scientists were formally trained in the Bible. Many scientists were clergy of the church. For hundreds of years, scientists seldom published findings that did not refer to God or the Bible. This was because the founders of most fields (nearly 70) of modern science subscribed to a belief in a divine creator to whom man was accountable. These pioneers included such renowned scientsts as Sir Isaac Newton, Lord Kelvin, Louis Pasteur, James C. Maxwell, Michael Faraday, Gregor Mendel, Rudolf Virchow, and later, Albert Einstein and Wernher von Braun. Therefore, to many of his fellow scientists, Darwin's work was degrading and ***abominable*** and purported a meaningless existence. Others, who had either no belief in a higher being, or who seemingly did not want to be accountable to one, embraced Darwin's works.



Thomas Huxley, called "Darwin's Bulldog" because of his aggressive defense and promotion of Darwinism, stated:

> The *Origin* provided us with the working hypothesis we sought. Moreover, it did the immense service of freeing us forever from ...the creation hypothesis....

According to Julian Huxley (grandson of Thomas Huxley), in a 1959 television show, "Darwinism removed the whole idea of God as the creator from the sphere of rational discussion."

Julian's brother, Aldous Huxley, had previously stated in his 1937 book on *Ends and Means*:

> Our conviction that the world is meaningless lends itself to furthering (various) ends....I had motives for not wanting the world to have meaning....The philosophy of meaninglessness was essentially an instrument of liberation....we desired liberation from ...a certain system of morality...."

George Wald, winner of the 1967 Nobel Prize for Medicine, Harvard

VOCABULARY

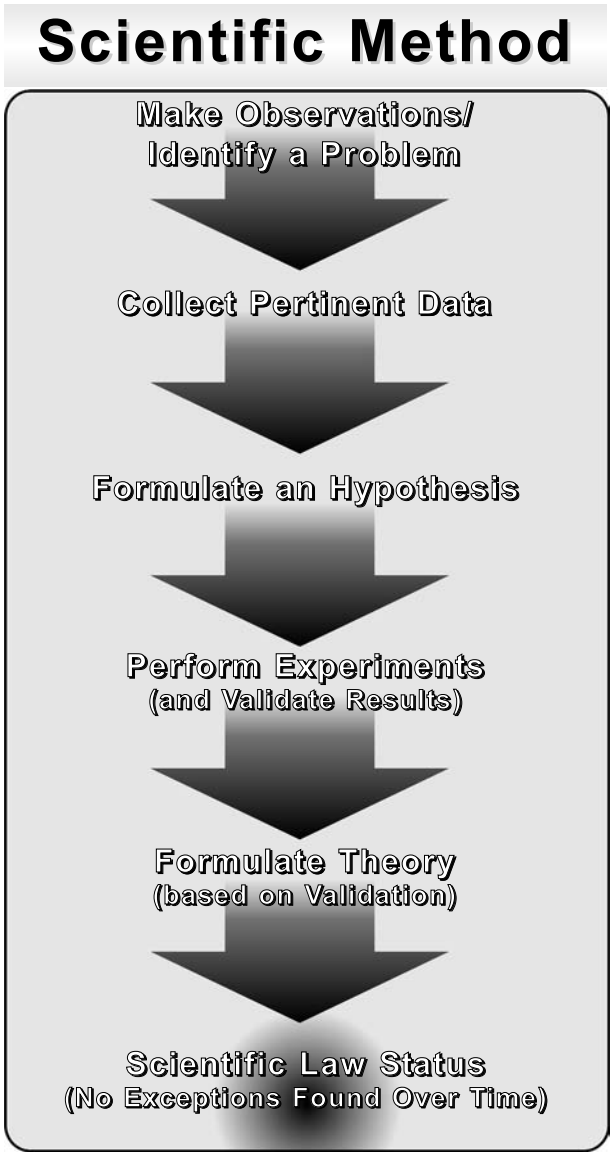
Scientific method: the process by which a general statement (the hypothesis) is written and tested through experimentation in order to reach a conclusion regarding the hypothesis.
Theory: a scientifically acceptable and tested hypothesis offered to explain observed facts.
Hypothesis: an assumption made in order to test and prove a logical conclusion.
Paleontologist: one who studies ancient life forms, such as plant and animal fossils
Design: a theory that the irreducible complexity of organisms could not have come about by chance, that complex organisms illustrate plan and purpose

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University biology professor and author of *Frontiers of Modern Biology on Theories of Origins of Life* (1972) stated plainly:

> "I do not want to believe in God. Therefore I choose to believe in that which I know is scientifically impossible, spontaneous generation leading to evolution."

Although Darwin's theories have been somewhat modified over time by scientists, his work is the basis of the modern concept of evolution. For most scientists to be persuaded of evolution as the accepted explanation for the origin of life on this planet took about 20 years and much publicity. Although the theory of evolution has never been ***validated*** by the ***scientific method***, it is nevertheless accepted by many scientists as ***scientific law***. However, based on the scientific method we studied in the first chapter of this course, many parts of the evolutionary ***theory*** never actually left the stage of being an ***hypothesis***.



The scientific method is quite simple and is a logical, systematic procedure that we all use daily to make decisions. Very simply stated, we use observations in the natural world as well as in the experimental world to draw conclusions. In the world of science, we begin with a given premise called an *hypothesis* based on some initial observations. Next, we go about trying to prove or test the hypothesis by collecting data, then designing and performing experiments. Once enough test evidence is collected to validate the hypothesis, a *theory* is established. Over time, and supported by much experimental evidence, the theory gains enough acceptance from the scientific community to become a *scientific law* because no exceptions to the theory have been found.

During the process of collecting data, the scientist must be willing to alter, or even abandon, his most cherished generalizations when they are contradicted by new facts. The scientist's question must always be: "What is the evidence?"

Unfortunately, because scientists are human, they are not always objective, open-minded people. Often, a scientist will cling to old ideas simply because the scientific community rejects radically new ideas. On the other hand, a scientific discovery may be accepted well before it is thoroughly tested. The history of science is full of scientific

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dogmas that turned out to be wrong, although for a time they were widely accepted by other scientists and taught as truth. This is one reason why the cautious scientist—and biology student—will not place too much faith or invest heavily in any theory until it clearly withstands the scientific method test.

Some aspects of the idea of evolution have been proven with sufficient evidence. However, numerous aspects have not been proven and are still in the hypothesis stage. We will review evidence that has caused many in the scientific community to reject some aspects of the theory of evolution. Scientists who insist on following the scientific method are abandoning the theory of evolution until more evidence can be brought to light through research.

Colin Patterson, senior ***paleontologist*** at the British Museum of Natural History, delivered a keynote address in 1981 at the American Museum of Natural History in New York City. His remarks startled the audience:

> One of the reasons I started taking this anti-evolutionary view, or let's call it a non-evolutionary view, was last year I had a sudden realization. For over twenty years I had thought I was working on evolution in some way. One morning I woke up, something had happened in the night; it struck me that I had been working on this stuff for twenty years, and there was not one thing I knew about it. That's quite a shock to learn that one can be misled so long. Either there was something wrong with me or there was something wrong with evolutionary theory.
>
> Naturally, I knew there was nothing wrong with me, so for the last few years I've tried putting a simple question to various people and groups of people.
>
> The question is: 'Can you tell me anything you know about evolution, any one thing, any one thing that is true?' I tried that question on the geology staff at the Field Museum of Natural History and the only answer I got was silence. I tried it on members of the Evolutionary Morphology seminar in the University of Chicago, a very prestigious body of evolutionists, and all I got there was silence for a long time and eventually one person said 'I do know one thing—that it ought not to be taught in high school.'

As meticulous scientists begin to understand the implications of DNA and the irreducible complexity of the "simple cell", and at the same time realize how little actual evidence exists for evolution, many are beginning to propose the idea of a new theory of ***design***: that all living things seem to reflect evidence of planning and purpose. This chapter will examine the hypothesis of evolution and the evidence that scientists have presented. You will learn what has been scientifically proven by the scientific method and what has not been scientifically proven.

In the next lesson, you will learn how Darwin's work became the basis for the modern ideas of evolution.

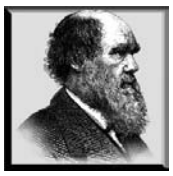
LIFE PRINCIPLE



"Whatever the scientists may say, if we take the supernatural out of life, we leave only the unnatural."

—Amelia Barr (1831-1919)
English-born American novelist

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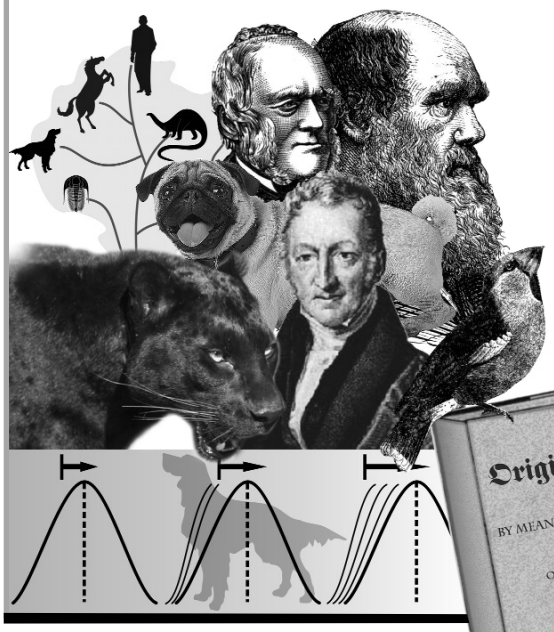
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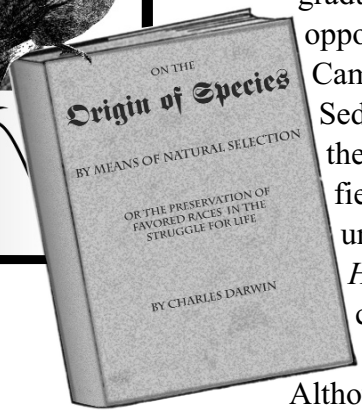
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THE DEVELOPMENT OF AN HYPOTHESIS

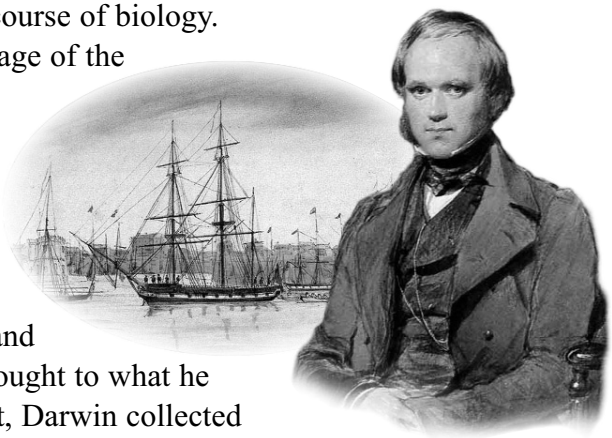
Section 1

Lessons 1-5





Charles Darwin was at one time a religious man who accepted the biblical account of creation. By 1831, young Darwin had graduated from Cambridge University with a degree in ***theology***. During his schooling, however, Darwin had become increasingly interested in botany, geology and collecting insects. Thus, after graduation, he took advantage of an opportunity to accompany his Cambridge science professor, Adam Sedgewick, on a geology field trip in the summer of 1831. While on that field trip, Darwin was offered the unpaid position of ***naturalist*** on the *HMS Beagle*, a ship that planned to circumnavigate the globe on a 5-year scientific excursion. Although it may seem a bit unusual that a ship would employ a naturalist, many merchant ships of that time had such a position available. Darwin eagerly accepted this assignment and took the voyage that changed both Darwin's life and the course of biology.



During the voyage of the *HMS Beagle*, Darwin observed many things that other naturalists may not have had opportunity to study. He studied specimens, read scientific books, and gave a great deal of thought to what he observed. At each port, Darwin collected fossil, plant and animal specimens and shipped literally tons of them back to England. He was amazed at the tremendous variety of animals and plants that inhabited the Earth. Just one day's work in a Brazilian rain forest produced

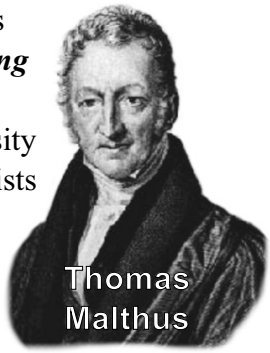
VOCABULARY

Theology: the study of God and His relationship to the world
Naturalist: a student of nature, specifically plants and animals
Living diversity: the existence of many varieties of life in the plant and animal kingdoms
Catastrophist theory: the theory that Earth experienced a major catastrophe such as a flood, in which most of Earth's creatures and plants were destroyed; their fossilized remains reveal that their descendents have changed very little over time

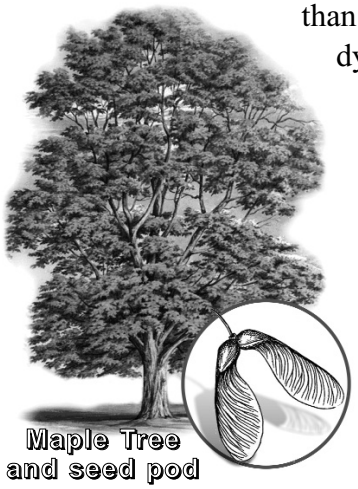
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a collection of more than 68 different species of beetles. The young Darwin called the variety of things the *diversity of life*, or ***living diversity***. He began to wonder how all this diversity came to be. Today, scientists know that living diversity is far greater than Darwin imagined. Contemporary scholars estimate the Earth is home to more than 50 million species of living things!


Thomas Malthus

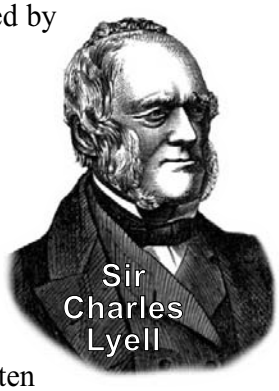
Several authors greatly influenced Darwin's thinking and helped formulate his conclusions. Before his voyage, Charles Darwin had read the work of British economist Thomas Malthus: *An Essay on the Principles of Evolution*. In 1788, Malthus observed that babies were being born faster than people were dying. If this growth continued, Malthus hypothesized, the world would eventually be overrun with humans. However, if that happened, Malthus also suggested that war, famine and disease, as well as marriage later in life, would limit human population. Malthus' work caused Darwin to speculate that plants and animals produce more offspring than humans do. For example, a mature maple tree produces thousands of seeds in a single summer. One oyster produces millions of eggs each year. Seemingly, if all the offspring of any species survived for several generations, they would probably dominate the world! Obviously, this does not happen. Continents are not covered with maple trees and oceans are not filled with oysters. Darwin knew that undetected factors must be at work that limited global dominance by trees and oysters or any other particular organism. He wondered what factors determined which living organisms survived and reproduced and those which did not.


Maple Tree and seed pod

Another influence on Darwin's thinking was the work of a controversial geologist named Sir Charles Lyell, whose books accompanied Darwin on his voyage.

Lyell speculated that the Earth had to be older than people generally thought. At the time, most scientists adhered to the ***catastrophist theory*** (also know as *creationist theory*) which states that the Earth is less than ten thousand years old and that much of the Earth's ***topography*** was formed by a huge, world-wide catastrophe. Lyell, however, argued that the modern world must have been shaped by the same geological forces which can be observed today. Thus, if river valleys were dug by a process as slow as erosion, he hypothesized the Earth had to be much older than ten thousand years.


Oyster shell


Sir Charles Lyell

VOCABULARY

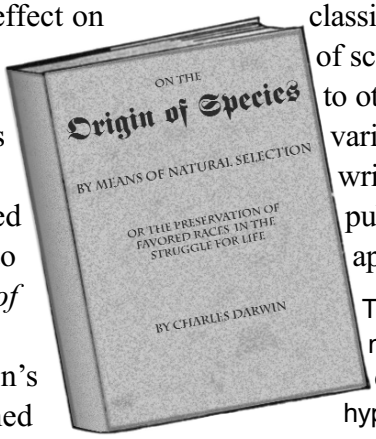
Togography: physical features of the land such as lakes, rivers and mountains

Natural selection: the process which results in the survival of individuals or groups best suited for their environment

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Observations made during Darwin's voyage were merged with the ideas of Malthus and Lyell to formulate Darwin's hypothesis called ***natural selection***. Although his hypothesis was formulated by the end of the *HMS Beagle's* journey, Darwin did not publish his work for another twenty-three years. Part of the delay was due to Darwin's attempt to perfect his work. Another factor causing the delay was his wife. She was convinced that his faith in God had eroded, and that Darwin's work would have a devastating effect on people who professed faith in God. Darwin respected his wife's wishes for some time, but eventually he felt compelled to communicate his ideas to the world and *The Origin of Species* was published in 1859. According to Darwin's autobiography, he abandoned his faith in God while on the *HMS Beagle*. He boarded the ship accepting the Bible as the authority on the origin of life; but five years later, he had completely abandoned any belief in divine creation.



Although Darwin proclaimed himself to be an agnostic, a surprising and little-known inconsistency in his life surfaced and was featured in Paul Harvey's "The Rest of the Story": During the *Beagle* excursion, Darwin spent time on the island of Tierra del Fuego (named by the explorer, Magellan), observing the natives who lived there—the most miserable human beings he had ever seen—living in abject physical and spiritual squalor. Missionaries worked the island, bringing to the natives salvation of souls and civility of behaviour. Darwin kept track of the progress, amazed that anything could change such horrific conditions. Seeing that Christianity could do what science could not, Darwin regularly sent checks to finance missionary efforts to these people until he died.

* * *

Darwin was a careful, meticulous naturalist. Of importance is the fact that he considered his hypotheses just that—hypotheses, not theories or laws. Over 800 times in *The Origin of Species*, he used the words "we may suppose", or words to that effect. This may have prompted *Origin* to be classified by some as "one of the great works of scientific imagination." Darwin confided to others his doubts about his hypotheses on various occasions. In a letter to a colleague written in 1858, just one year before the publication of his work, Darwin was apprehensive:

> Thank you heartily for what you say about my book; but you will be greatly disappointed; it will be grievously too hypothetical. It will very likely be of no other service than collating some facts….

In *Origin*, Darwin wrote:

> Geology assuredly does not reveal any finely graduated organic change, and this is the most obvious and serious objection that can be urged against the theory.

In a letter written in 1887, Darwin expressed concern:

> Often a cold shudder has run through me, and I have asked myself whether I may not have devoted myself to a phantasy.

In the next lesson, we will learn about some of Darwin's observations and the theory of natural selection.

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LIFE PRINCIPLE

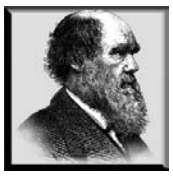


"...a scientist....is a curious man looking through...the keyhole of nature, trying to know what's going on."

—Jacques Cousteau (1910-1997)
French oceanic explorer and researcher

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Understanding Evolution

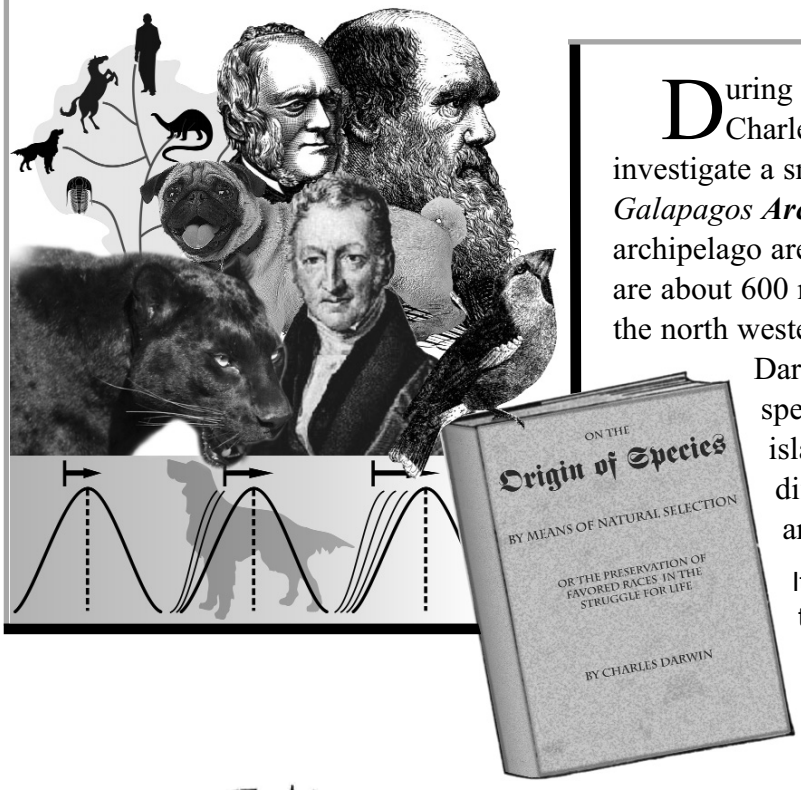
Lesson 3

Chapter 4

DARWIN'S CONCLUSIONS

Section 1

Lessons 1-5

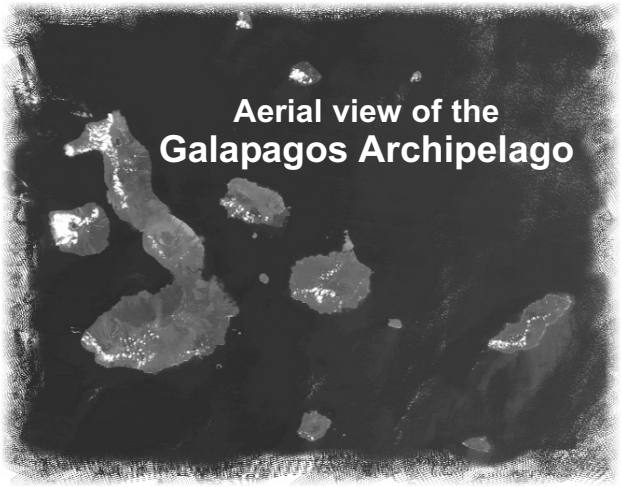


During his time on the *HMS Beagle*, Charles Darwin had an opportunity to investigate a small chain of islands called the *Galapagos* ***Archipelago***. The 13 islands of the archipelago are the result of volcanic activity and are about 600 miles west of Ecuador, a nation on the north western coast of South America.

Darwin was able to observe many species of animals and plants. Each island had species that were distinctly different. This fascinated Darwin, and many years later he wrote:

> It was evident that such facts as these could be explained on the supposition that species gradually became modified, and the subject haunted me.

Of particular interest to Darwin were various types of finches he collected. Although similar, the finches' beaks varied in size and shape, based on how food was captured. Darwin thought the finches, as well as other plants and animals, had migrated from South America sometime in the past and had evolved into new species over time in the Galapagos Islands. Darwin began to record his thoughts and observations on the hypothesis that would eventually divide the scientific community.



VOCABULARY

Archipelago: an expanse of water with many scattered islands

Eon: the largest division of geologic time

Artificial selection: method of selective breeding of organisms to produce offspring with desirable characteristics

Natural selection: the process which results in the survival of individuals or groups best suited for their environment

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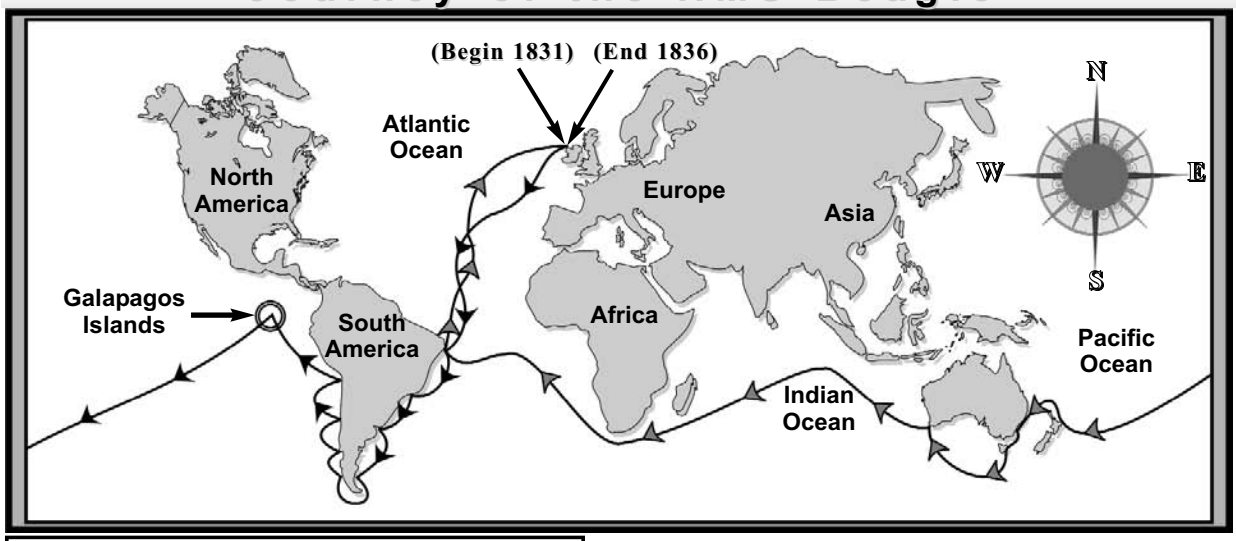
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Although Darwin returned to England in 1836, he waited until 1844 to express most of his ideas in writing. Then, in 1859, nearly 30 years after his *HMS Beagle* voyage, Darwin published *The Origin of Species* which sold out the same day it was released. At the same time, another gentleman named Alfred Russel Wallace was poised to publish a very similar work. Mr. Wallace had been studying natural history in Malaysia and had drawn the same conclusions as Darwin. Darwin raced to publish his ideas in order to receive full credit for the concept of natural selection.

Darwin's work was primarily based on observations of living diversity. His observations were not spectacular. Contemporary people were as diverse as the animal and plant life that Darwin observed while on his sea voyage. Like snowflakes, no two humans are exactly alike (except perhaps for identical twins). Some of us have blond hair, some red, some brown, and some black. People differ in skin color, size, shape, height, and many other ways. None of us has the same fingerprints, eye characteristics or DNA sequencing.

From the variety of plants and animals he observed, Darwin assumed that all species—the entire plant and animal kingdom—had resulted from environmental adaptations over ***eons*** of time. As we examine Darwin's reasoning process that brought him to make this hypothesis, let us keep in mind the scientific process necessary to establish scientific law.

Journey of the HMS Beagle



VOCABULARY

Survival of the fittest: theoretical results of the natural selection process

Common descent: hypothesis suggesting that species have descended from a common ancestor

ARTIFICIAL SELECTION

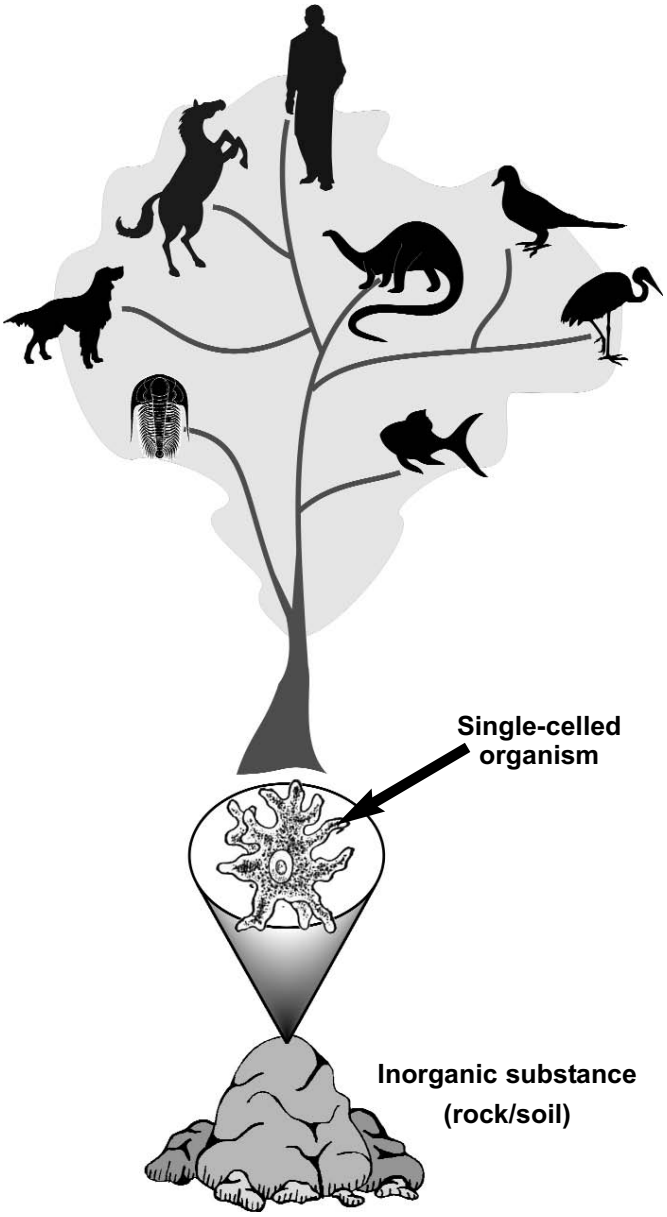
Darwin began his discussion with observations that he made at home with farm animals and agricultural crops in England. He knew that over the years, farmers had greatly altered and improved domesticated plants and animals. Once again, Darwin observed great variety. No two animals or plants were exactly alike. Some were larger or smaller. Some

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cows gave more milk than others. Some plants produced larger fruit than others. Often these variations were inheritable, which means that the traits could be passed down from one generation to the next.

To take advantage of inherited traits, farmers decided which animals and plants had the characteristics for breeding strong herds and flocks. Generation after generation, the farmers would select only the largest hogs, the fastest horses or the cows that gave the most milk. Darwin called this process ***artificial selection***. Today, this is known as *selective breeding*.

Common Descent



Natural Selection

Darwin was convinced that a process such as artificial selection occurred in nature. Darwin suggested that ***natural selection*** determines the course of biological change. Remembering the work of Malthus, Darwin believed that life is a competitive struggle to survive and often in the face of limited resources: living things must compete for food and space; they must evade the dangers of predators and disease while dealing with unpredictable shifts in their environment, such as climate changes. Darwin suggested that within a given population, certain individuals have characteristics that make them more likely to survive and reproduce. Darwin believed that these individuals passed critical characteristics to their offspring; therefore, the population gradually contained only those individuals with characteristics critical for survival. Darwin proposed that through several generations the struggle for existence selects the fittest individuals in nature. He called this process ***survival of the fittest.***

By this process, organisms adapt to new environments by eliminating weaker genetic material. Interestingly, Darwin was not the first person to propose this concept. Creationist Edward Blyth formulated the concept some 25 years before Darwin published his work. Blyth regarded this process quite differently, however. He believed that natural selection was used by nature to remove *defective* organisms, thus conserving the health of the population as a whole.

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COMMON DESCENT

Darwin imagined that living organisms have descended by gradual change from ancient ancestors quite unlike modern beings. Such a process, of course, would require many, unobservable eons. Until Darwin's time in history, most people believed in a young Earth, that is an Earth less than ten thousand years in age. However, English geologist Charles Lyell's work convinced Darwin that the Earth's age was many millions and even billions of years.

The central and historically controversial component of Darwin's evolutionary theory is that all living organisms, from microscopic bacteria to plants, insects, birds and mammals, share a common ancestor. This hypothesis is called ***common descent***. Accordingly, closely related species theoretically share a recent common ancestor, while distantly related species have a common ancestor further in the past. Scientists who embrace the concept of common descent speculate that the animal most closely related to humans, for example, might be the chimpanzee. If we go back far enough, evolutionary theory allows humans to have bacteria as a common ancestor. The theory states that bacteria arose from a primordial mixture, consisting of non-living materials. Therefore, evolutionary theory claims that humans ultimately evolved from non-living materials.

Darwin's original hypothesis has been periodically modified and updated to reflect new biological and geologic discoveries. However, the debates between evolutionary theorists and catastrophist theorists continue. Evolutionists insist that their theory has been proven; catastrophists insist that evolutionists have no real scientific evidence to prove that the concept of evolution is anything more than an hypothesis.

Future lessons will examine more evidence some scientists use to support the evolutionary hypothesis. You will have opportunity to use the scientific method and to determine whether the theory of evolution is actually an hypothesis, theory or scientific law.

In the next lesson, we will learn how new information in genetics has changed evolutionary ideas.

LIFE PRINCIPLE

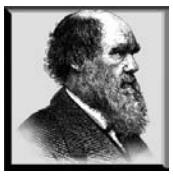


"Natural selection can explain the survival of the fittest, but not the arrival of the fittest."

—Hugo DeVries (1848-1935)
Dutch botanist who rediscovered Mendel's Laws of Heredity

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Understanding Evolution

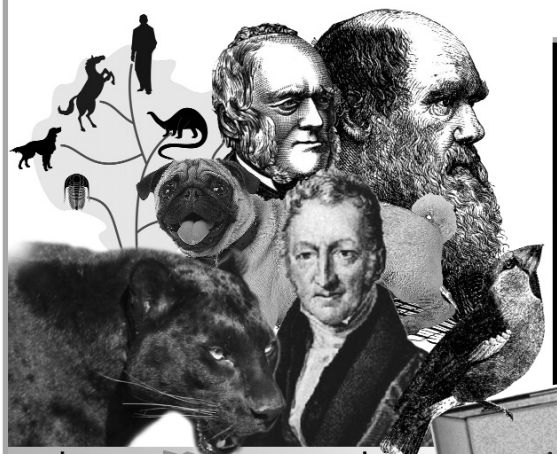
Lesson 4

Chapter 4

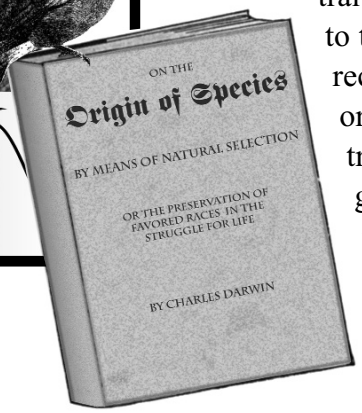
Section 1

Lessons 1-5

DARWIN AND DNA—THE MODERN MECHANICS OF EVOLUTION







When Charles Darwin was formulating his ideas about natural selection and evolution, he knew nothing about genes and DNA. As you may recall, Gregor Mendel's work was ignored during Darwin's time and was not rediscovered until the early part of the 20th century. Darwin did not know how inheritable traits were passed from one generation to the next. When biologists recognized that genes in an organism's cells were the carriers of traits, the scientists realized that genes were the source of all the incredible variety of living things. As researchers learned more and more about genetics, a new view of the evolutionary process developed.

VOCABULARY

Species: a particular kind of organism; members of a species group possessing similar anatomical characteristics and the ability to interbreed

Reproductive isolation: separation of different species that cannot interbreed

Gene pool: all the alleles of all the genes of the members of a population that interbreed

Gene shuffling: the process that produces variations due to the crossing-over mechanism during gamete formation

Gene flow: the variation in genes that occurs when one population group breeds with another

SPECIES

Contemporary scientists also have a better understanding of the meaning of the term ***species***. In Darwin's time, biologists defined a species as a group of organisms that looked alike. Today, a species is defined as a group of similar-looking organisms that can breed with one another and produce fertile offspring. Members of different species cannot interbreed. This biological restriction is called ***reproductive isolation***.

Scientists realize the importance of understanding that genes, and ultimately individual alleles, define a species. For example, a cat is a cat because of the alleles within the cat's genes. A dog is not a cat because of the different alleles within the dog's genes. For this reason, cats cannot interbreed with dogs. Neither can humans interbreed with apes or any other animal. Each creature can produce offspring only with its own kind.

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Individuals within a species share a group of alleles called a ***gene pool***. Because of that common gene pool, a genetic change that occurs in one member of a species could spread throughout the entire population; however, because members of different species do not share genes, that genetic change will not affect the neighboring specie group. The gene pool of each species contains a certain number of alleles for each trait. Each allele typically occurs at a particular, relative frequency. Sexual reproduction by itself does not change the relative frequency. To get a better understanding of this, think of sexual reproduction as being similar to the different color combinations that can be assembled from a stack of 50 cards, colored blue, red, green or yellow. Shuffling and reshuffling the 50 cards can produce an enormous number of combinations of colored cards. However, shuffling will not change the relative frequency of blue, red, green or yellow cards in the stack. This can only be done if cards are added or subtracted from the 50-card stack.

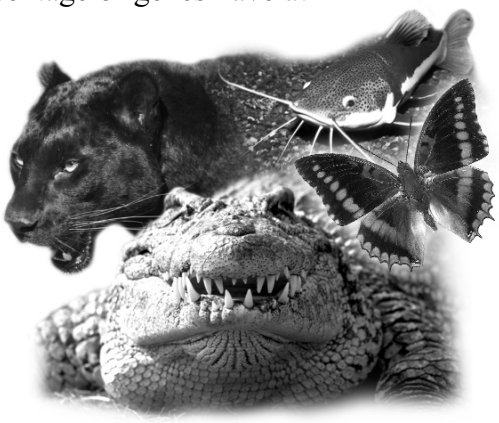
In modern genetic terms, evolution is defined as any change in the relative frequency of alleles in the gene pool of a species. Since sexual reproduction alone will not cause this change, others factors which cause this change in alleles must be examined.

VOCABULARY

Evolutionary fitness: an organism's ability to pass on its genes successfully to its offspring
Normal distribution: the bell shaped curve that is characteristic of inheritance
Stabilizing selection: the natural selection process that occurs when the environment continually eliminates individuals at extremes of a population
Disruptive selection: the natural selection process that occurs when the environment favors extreme types in a population at the expense of intermediate forms, thereby splitting the population into two or more populations

GENE SHUFFLING

None of us looks exactly like either of our biological parents, even though both parents provided our genes. The differences are due to the extent of ***gene shuffling*** that occurred when the egg and the sperm were produced in the crossing-over process during meiosis, as discussed in chapter two. Gene shuffling is a very important source of genetic variation in nature. As you may recall, geneticists have discovered that a significant percentage of genes have at least two different forms called *alleles*. In insects, as many as fifteen percent of all genes have more than one allele. In fishes, reptiles and mammals, about five percent of all genes have more than one allele.



GENE FLOW

Another source of variation is called ***gene flow***. This occurs when individuals migrate from one group to another and interbreed. For example, gene flow occurs

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when wind carries seeds far beyond the bounds of the parent plant population. As another example, animals may be driven away from a specific herd. This forces them to migrate to a different population group, thereby bringing new genes to the other population.

Gene shuffling and gene flow cannot, by themselves, change the relative allele frequency; however, with the pressure of natural selection, these two processes can lead to change in allele frequency.

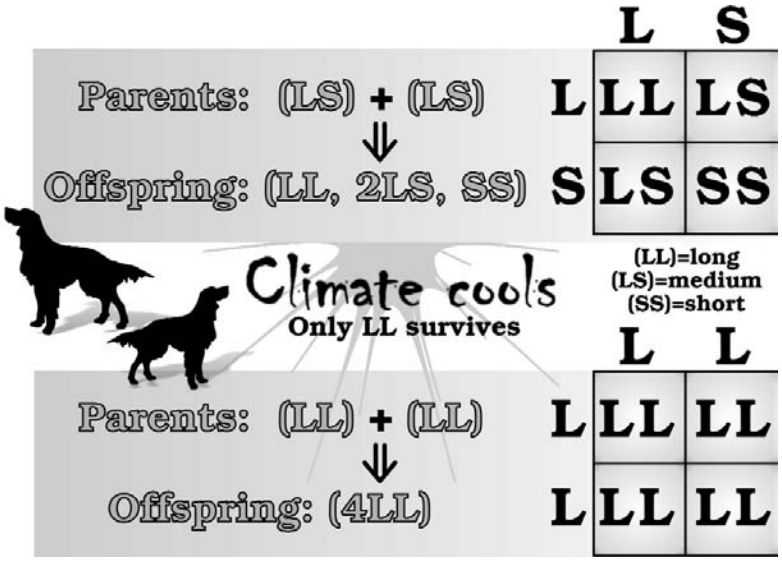
Natural Selection

Natural selection is another source of genetic variation in nature. As we have studied, natural selection is the process which occurs when the environment puts pressure on a population and causes the more fit individuals to survive. Examples would be shortages of food, too many predators or a drought. Natural selection can also result in a change in the relative frequency of alleles.

It is important to understand that natural selection cannot act directly on the genes or the genotype of an organism. "Survival of the fittest" process acts on the ability of an organism to survive and reproduce so that its genetic characteristics will be passed down to the offspring.

If a trait is controlled by a single gene with two alleles, three possible *genotypes* (genetic compositions) exist. Depending on the trait, and the way the gene operates, these genotypes may produce either two or three *phenotypes* (physical appearances). Each phenotype may have different fitness for the environment. If one is better suited for its environment, this phenotype will survive to pass on its genes to the next generation.

For example, let us suppose that the first dog/wolf kind had the genetic information for a variety of fur lengths. The first animals may have had a medium-length fur. The possible alleles are (L) for long hair or (S) for short hair. In the first row, we begin with medium-furred animals interbreeding. These dogs have both alleles, LS, which results in medium-length fur (LS). Each of the offspring of these dogs can get one of either allele from each parent to make up their two alleles. In the second row, we see that the resultant offspring has either short (SS), Medium (LS) or long (LL) fur. Now suppose that conditions develop that cools the climate considerably. Only those dogs with long hair will survive to reproduce. So from then on, all dogs in this population will have the LL alleles and be of the long-furred variety.



This example helps us to understand several principles.

1. The long-furred dogs have better ***evolutionary fitness***, as they have had success in passing their genes to the next generation.

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2. The long-furred dogs are now adapted to their environment and have become more specialized than their ancestors.

3. No new genes have been added. In fact, genes have been lost from the population. A loss of genetic information has occurred and the allele frequency within the gene pool has changed slightly. (This will become a crucial point for understanding the next unit of study on speciation.)

4. These changes have occurred through natural selection due to pressures caused by weather and food conditions.

5. Now, the populations are less able to adapt to future environmental changes. If the climate were suddenly to become hot, these long-furred dogs might overheat and expire because the genetic material for short hair would have been lost.

VOCABULARY

Directional selection: the natural selection process that occurs when the environment acts for or against an extreme characteristic and the likely result is the replacement of one gene group with another gene group

Genetic drift: random change in allele frequency, often producing offspring that will be different from the original population by chance

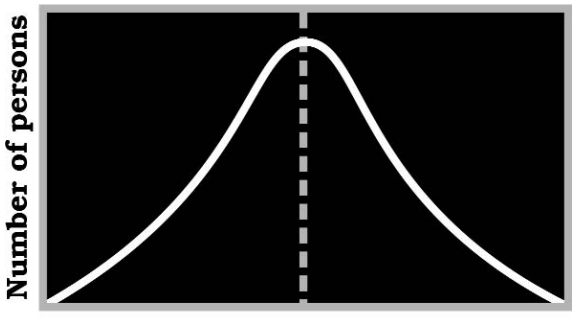
Founder effect: the change in allele frequencies produced when a new population arises from one or a few colonizing individuals

Mutation: inheritable alteration in the genetic information of a cell

Adaptation: development of physical and behavioral traits that make organisms better suited to survive in their environment

Many traits are *polygenic* which means that they are controlled by two or more genes. Often, each of these genes has two or more alleles. As a result, a large number of possible genotypes and an even larger number of possible phenotypes for such traits occur. A good example of a trait controlled by several genes is height in humans. If you were to measure and graph the height in a group of people, you would find that people are not just short, medium, and tall. Instead, you would find a wide range of heights. In fact, the graph would be shaped like a bell. This is called a bell-shaped curve and is referred to as ***normal distribution***. Normal distribution is observed quite commonly in nature.

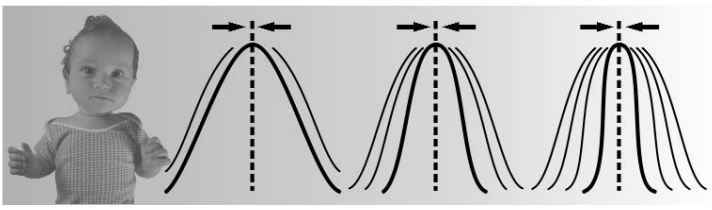
Normal Distribution



Normal distribution of height

Several types of natural selection appear to act in populations. One type is called ***stabilizing selection*** and occurs when the environment continually eliminates individuals at extremes of a population. Evolution is either minor or absent in this case. An example would be the mass of human infants at birth. Infants that are born much smaller or larger than average are less

Stabilizing Selection



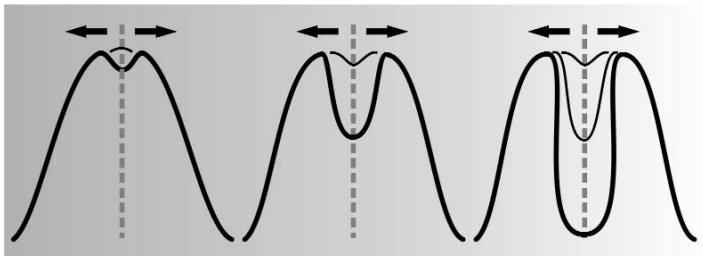
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healthy and have a greater chance of developing serious complications that may lead to death.

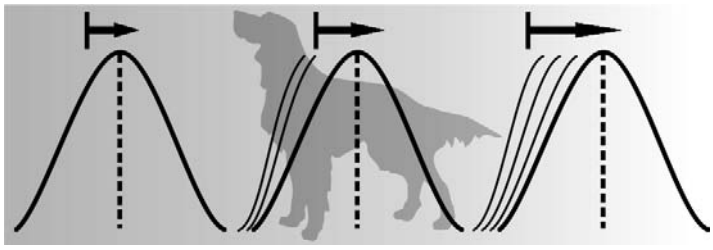
Another type of natural selection is called ***disruptive selection***. This occurs when individuals at both the upper and lower end of the curve have higher evolutionary fitness than individuals in the middle. In such a case, natural selection acts most strongly against individuals of an intermediate type. If the pressure of natural selection is strong enough and lasts long enough, this situation can cause the single curve to split into two curves.

Disruptive Selection



A third type of natural selection is called ***directional selection***. In this case, individuals at one end of the curve have higher fitness than individuals in the middle or at the other end. This will cause the entire curve to move as the trait changes. This is what happened with our example of the dogs with long fur. The long-furred dogs were at one extreme of the curve, but as the short and medium-furred dogs were eliminated by natural selection, more and more dogs had long hair.

Directional Selection



Genetic Drift

Studies have shown that an allele can become more or less common in a population simply by chance. Such a change is called ***genetic drift***. This can happen when a small group of individuals leaves a population and establishes a new one in a geographically isolated region. For example, when a small population of fish is placed in a lake, the fish population will evolve into one that is different from the original. Genetic drift is more likely to occur in smaller, rather than larger, populations.

Founder Effect

An extreme case of allele frequency change would occur when a single pregnant animal or single pair is isolated by being blown or washed onto a desert island. In this case, a number of genes from the original population might be lacking. When the descendants fill the island, this new population would be different from the old one, with less information. This is called the ***founder effect***.

Mutations

Mutations are a source of genetic variation and allele frequency in a population. However, mutations are rare events. As we studied in the last chapter, a mutation is an inheritable change in genetic information. Mutations may occur in any cell and in any gene. At the molecular level, a mutation consists of an alteration, deletion, or insertion of one or more DNA nucleotides. Once a change has occurred, the altered genes continue to replicate in their changed form unless another mutation occurs. Although mutations may occur in any living cell, they are most important when they occur in gametes because the change affects the traits of future generations.

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Most laboratory mutations have been induced artificially by chemicals, heat and radiation or other such disturbing influences. Fortunately, mutations in nature are quite rare and when they do occur, they usually tend to disappear rather quickly and are eliminated out of the population by natural selection. Mutations are usually harmful. In human beings, they are classified as "birth defects" or human genetic disorders. Harmful mutations are usually not carried on to future generations and therefore do not affect the alleles in the gene pool.

Mutations are the only method that nature can use to add information to existing genetic material. This would mean that new alleles would have to occur by mutation. Scientists know that a mutation having a positive effect on the evolutionary fitness of individuals in a gene pool is a rare occurence. If this did happen, and a new allele was introduced by mutation into a gene pool, then the relative frequencies of alleles would change slightly. We will be taking a much closer look at mutations and their role in the evolutionary process later in this chapter.

Fitness and Adaptation

An organism's evolutionary fitness can be defined as its success in passing genes to the next generation. This may involve an organism's ability to avoid predators, or its ability to resist disease. Fitness may be measured by the ability to obtain food or by having a better resistance to drought. Fitness may also be measured as enhanced reproductive ability, such as the ability to attract a mate. The better an organism's ***adaptation*** to a new or altered environment, the more offspring individuals are likely to produce and thereby pass on their genes more efficiently than would poorly-adapted individuals.

In the next lesson, we will examine speciation in the process of evolution.

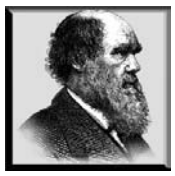


Life Principle

"To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science."

—Albert Einstein (1879-1955)
German-American physicist and mathematician

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Lesson 5

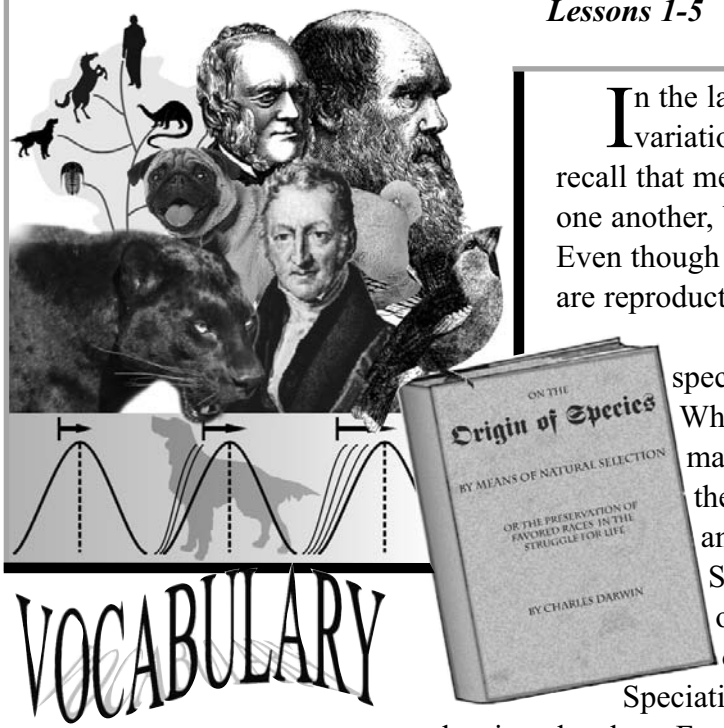
Understanding Evolution

Chapter 4

SPECIATION—THE BIRTH OF A NEW SPECIES

Section 1

Lessons 1-5



In the last lesson, we saw several ways in which variations occur within a species. You will recall that members of a species can interbreed with one another, but not with members of other species. Even though many species may live side by side, they are reproductively isolated from one another.

Speciation is the assumption that new species form through evolutionary processes. What we know about speciation comes mainly from circumstantial evidence: from the fossil record, from population genetics, and from studies of closely related species. Some scientists speculate that speciation occurs when a population is isolated from others by geographical barriers. Speciation may also occur when reproductive barriers develop. For example, some proponents of evolution postulate that if members of a population species develop anatomical barriers that make mating with other members of the population difficult, a new species could develop.

VOCABULARY

Speciation: the formation of a new species through evolutionary processes

Horizontal evolution (microevolution): evolution or change of an organism by natural selection so that the organism transforms into a more specialized form or variation of the same species

Vertical evolution (macroevolution):the hypothesis that the same processes which work in microevolution can, over eons of time, transform an organism into a completely different kind of organism, in a totally different specie group, such as a cow evolving into a whale

HORIZONTAL EVOLUTION VS. VERTICAL EVOLUTION

Most of the arguments for evolution have been based on variation within species rather than development of new species. For example, Charles Darwin documented many examples of variation within a species. This is called ***horizontal evolution*** or ***microevolution***. However, Darwin never cited an example of true speciation, which is called ***vertical evolution*** or ***macroevolution***. Darwin conceded in his writings that: "Not one change of species into another is on record…we cannot prove that a single species has been changed." In fact, in the more-than-140 years since *Origin*, no one has ever experimentally observed the evolution of a single new species or even a true indication that the process was about to begin.

Geneticist Thomas Hunt Moran, who won a Nobel Prize for his work on heredity, acknowledged that:

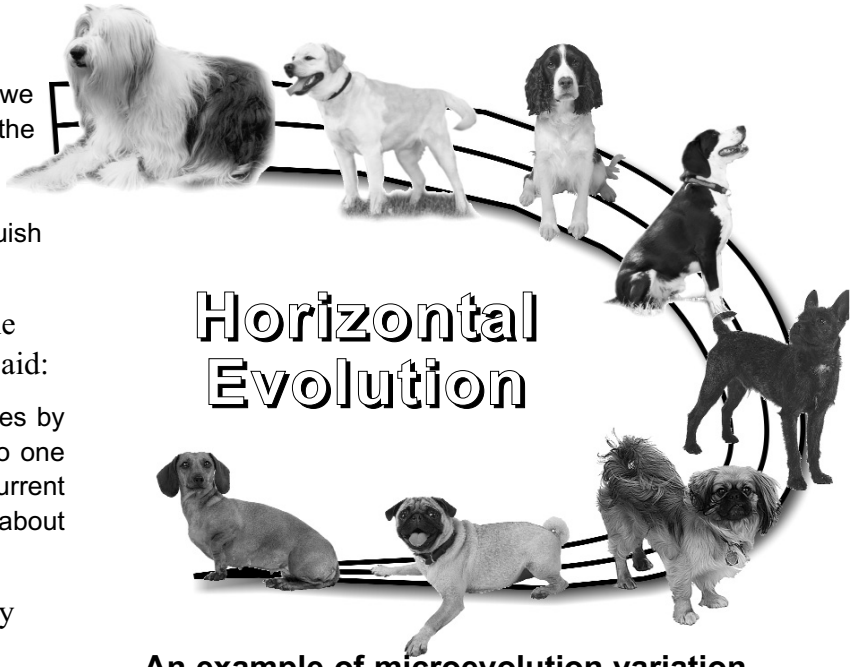
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> "Within the period of human history, we do not know of a single instance of the transformation of one species into another, if we apply the most rigid and extreme tests used to distinguish wild species from each other."

Colin Patterson, director of the British Museum of Natural History, said:

> "No one has ever produced a species by mechanisms of natural selection. No one has gotten near it and most of the current argument in ***neo-Darwinism*** is about this question."

Part of the problem is the hazy definition of the word "species". ***Taxonomists*** are constantly adjusting the classification of species—the science is inexact. In 1940, scientists defined separate species as those that do not interbreed. However, this does not hold up consistently. Dogs are considered a different species from coyotes, wolves and jackals—yet occasionally interbreed with all of them.



An example of microevolution variation.
These dogs are different from one another in various ways, but are not separate species.

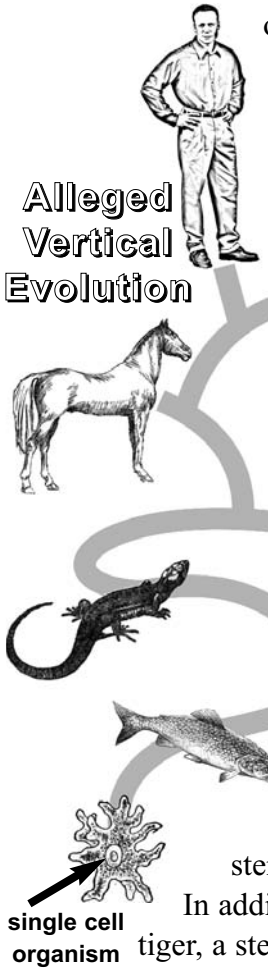
As we discussed in the previous section, scientists can easily document *horizontal evolution* (or *microevolution*) through the pressure of natural selection or through artificial selection (also known as *selective breeding*.) For example, breeders of dogs and horses have produced animals with desirable traits through selective breeding. This gives rise to new *varieties*, but not new *species*. In nature, animals may become geographically isolated. The population they sire inherits their particular genes and thus their distinctive characteristics. Although scientists may show that a species of wild dogs could, over time, give rise to several species of domestic dogs, it is quite another thing to show and prove that a species of dogs could give rise to radically different species, such as horses or cows.

Vertical evolution (or *macroevolution*) of one kind of organism into an entirely new organism is purely speculative. Scientists have never seen evidence in any form for such a process, including the fossil record that many claim to be at least millions of years

VOCABULARY

Neo-Darwinism: updated or modern Darwinism; combines Darwinism with the findings of modern genetics
Taxonomists: a scientist trained to classify organisms
Banded: colored bands or rings applied to bird legs for identification purposes
Hybridization: interbreeding to produce new variations
Divergence: the evolutionary process by which life forms evolve into different organisms with different characteristics as a result of their environment

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old. Dogs do not appear to turn into horses, roses do not become grass, and giraffes do not evolve into elephants. Genetic boundaries between kinds of plant and animal life are very real and very stubborn biological facts. When abnormal crosses are attempted, sterility is nearly always the result. If you cross a horse with a donkey, a sterile *mule* results. If you cross a zebra with a donkey, a sterile *zebronkey* or *zedonk* results. In addition, if you cross a lion with a tiger, a sterile *liger* is produced.

The more a species is pushed from its normal breeding pattern, the weaker the offspring become. Evolutionist Ernst Mayr demonstrated this fact when he tried to modify fruit flies through breeding. The flies normally averaged 36 bristles on their bodies. When the insects were bred to grow only 25 bristles, they became sterile. When he bred them to produce 56 bristles, they again became sterile.

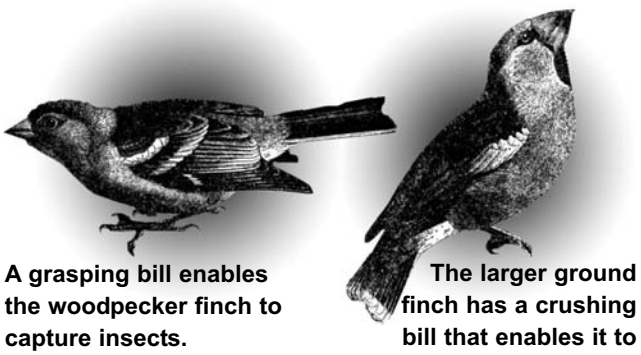
Genes impose limits. An elephant may be bred to produce a longer trunk, but his trunk will never become a hundred feet long or become a paw. Plant and animal breeders cannot manufacture new genes; they can only use what is already operative in the species.

Darwin's Finches and Natural Selection

Although the finches had little in fact to do with the development of Darwin's evolutionary ideas, the birds have attracted considerable attention from modern evolutionary biologists as further evidence of natural selection. In the 1970's, researchers Peter and Rosemary Grant visited the Galapagos Islands where Charles Darwin had observed the different varieties of finches. With the help of several other biologists, the Grants caught and ***banded*** finches on seven of the islands. The finches were carefully measured, with a special interest in their beak shapes and sizes. The Grants noted a 5 percent increase in beak size of a finch population after a severe drought. Other scientists had claimed the beak size changed because the finches had only hard-to-crack seeds to eat. The change, though small, was significant; yet some scientists claimed that the increased beak size was evidence for vertical evolution.

A booklet published in 1999 by the U.S. National Academy of Sciences describes Darwin's finches as "a particularly compelling example" of the origin of the species. The booklet explains the Grants' work and tells how a "single year of drought on the islands can drive evolutionary changes

Microevolution of Finches



A grasping bill enables the woodpecker finch to capture insects.

The larger ground finch has a crushing bill that enables it to feed on seeds.

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in the finches." The booklet further claims that "if droughts occur about once every 10 years on the islands, a new species of finch might arise in only about 200 years."

However, the booklet failed to mention that the beaks of the finches returned to normal after the rains recurred in a few years. As Peter Grant wrote in 1991, "The population, subjected to natural selection, is oscillating back and forth." Therefore, some sort of long-term trend would have to be superimposed on the back-and-forth oscillations to produce long-term change; however, that is not what the Grants' evidence showed. In addition, evidence confirms that several finch species in the Galapagos Islands are merging through ***hybridization***. Hybridization is counter to the way evolution is supposed to occur, which is ***divergence*** of species through natural selection.

According to evolutionary theory, the term *adaptive radiation* is applied to a group of organisms in a new area that evolve—sometimes quickly—into different species and live in different ways. In this scenario, different groups might produce species that are adapted to similar feeding habits or ways of moving from place to place.

In the evolutionary model, *convergent radiation* refers to unrelated species that may evolve superficial similarities independently because of adaptations to similar environments.

To summarize our study of evolution thus far, we have seen that ample, absolute, hard evidence exists for horizontal, or microevolution (variation within a species), that occurs repeatedly through natural selection. On the other hand, absolute evidence for vertical evolution, or macroevolution (the evolving of a new species), is lacking. More research and hard evidence is needed before scientists can honestly state that life, as we know it, is the result of macroevolution.

Next, we will begin to study the evidence of the evolutionary process.

LIFE PRINCIPLE



"Each species is a masterpiece, a creation assembled with extreme care and genius."

—Edward O. Wilson
Noted American biologist/entomologist,
foremost world authority on ants

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Evolution— The Evidence

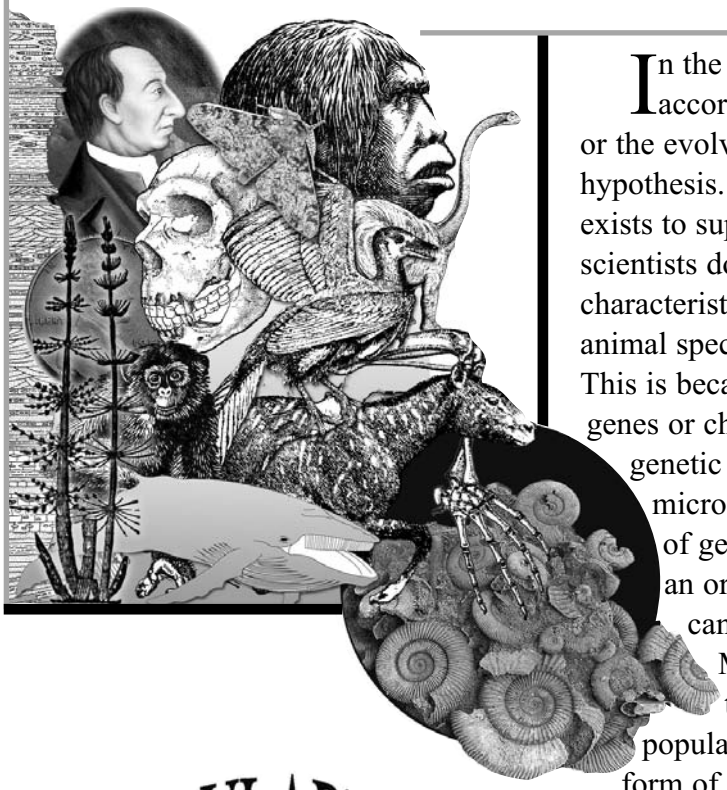
Lesson 6

Chapter 4

MUTATIONS AND EVOLUTION

Section 2

Lessons 6-10



In the previous section, we discovered that, according to the scientific method, *speciation*, or the evolving of a new species is still an hypothesis. This means that no absolute evidence exists to support the idea of speciation. However, scientists do know that distinctly new characteristics can be generated within a plant or an animal species by the phenomenon of mutation. This is because mutations are abrupt alterations in genes or chromosomes. As we have learned, genetic variations (called horizontal or microevolution) represent mere recombination of genetic factors that are already present in an organism. On the other hand, mutations can create something altogether new. Mutation is the only conceivable process that could add genetic material to a population, thereby contributing to a higher form of species. An accumulation of beneficial mutations preserved by natural selection could, in theory, eventually develop new species. (Macroevolution would require intricate coordination among organisms that become increasingly complex, therefore requiring a sustained increase of genetic information.)

When scientists began to recognize the importance of genetics in the evolutionary process, Darwin's hypothesis was changed to include the process of mutation. The ***Neo-Darwinian hypothesis*** proposes that over eons of time mutations, coupled with natural selection, led simple life forms to evolve into modern, complex life forms. In other words, proponents of evolution postulate that mutations produced the multiplicity of changes that have transformed a microbe into a human being. Therefore, if we assume that life began as a single cell, then the entire living world around us resulted from thousands of beneficial mutations that occurred strictly by random chance.

VOCABULARY

Neo-Darwinian hypothesis: includes updated or more recent additions to original Darwinism; same as *neo-Darwinism*

MIT: Massachusetts Institute of Technology; one of the world's leading centers of higher learning for scientific and technological education and research

Pathogen: a disease-causing organism

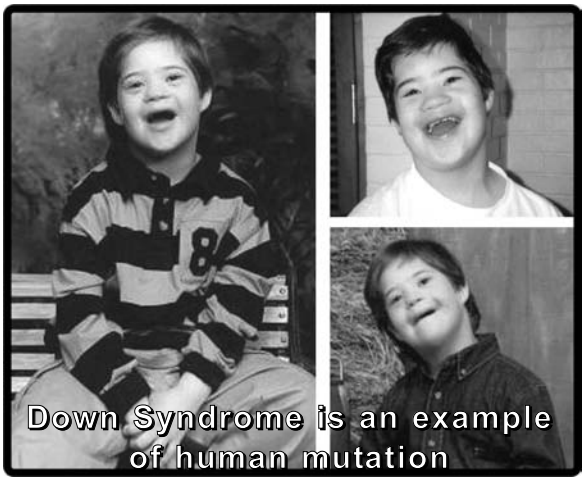
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Let us review the evidence supporting this hypothesis.

Frequency of Mutations

Estimates of mutation frequency vary, but scientists agree that mutations occur quite rarely. Darwinist Richard Dawkins states: "the probability that a gene will mutate is often less than one in a million." Fritjof Capra, director of the Center for Ecoliteracy in Berkeley, California notes that: "It has been estimated that those chance errors occur at a rate of about one per several hundred million cells in each generation". The reasons that most mutations are harmful is a matter of logic. Mutations represent random, non-ordered restructuring of the very complex, highly organized replicating systems of living cells. When any complex system undergoes a random change, that system will become less organized and, therefore, less functional. Increased organization requires intelligent data input, rather than a random reshuffling caused by an accidental force. Nevertheless, Neo-Darwinists propose that sufficient time (eons) has passed to allow organisms to produce and select abundant, favorable mutations to be utilized in the evolutionary process.


Down Syndrome is an example of human mutation

Frequency of Beneficial Mutations

Fortunately, mutations are rare and are almost always universally harmful. In terms of the genetic code, a mutation is essentially a mistake in transmission of hereditary information caused by one or more random changes in the DNA molecular structure. In human beings, mutations are classified as birth defects and they often result in death or sterility. Down's syndrome, cystic fibrosis, and sickle cell anemia are familiar examples. The few "beneficial" mutations that have been cited as evolutionary proofs are recognized today as either simple recombinations of genetic factors already present or an actual loss of genetic material. If mutations are to be part of an upward evolutionary process, they must be beneficial by *adding* genetic information, not by *subtracting* it. No such mutation process has been witnessed. As Dr. Lee Spetner, PhD in physics from ***MIT***, stated:

> But in all the reading I've done in the life-sciences literature, I've never found a mutation that added information…. all point mutations that have been studied on the molecular level turn out to reduce the genetic information and not increase it.

Mutations and Natural Selection

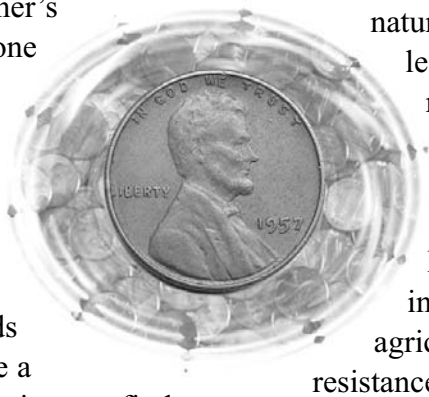
Natural selection is a conservative process that tends to insure the survival and perpetuation of fit organisms, while at the same time eliminating unfit organisms. Almost all mutations cause organisms to be weaker than the original and at a marked disadvantage to compete for survival. If mutations produce less-fit organisms, natural selection will destroy those very organisms. Time, therefore, tends to bring disintegration

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and death. The logical conclusion is that mutations contribute greatly either to the deterioration of species or to the extinction of species. Some scientists estimate that 99.9 percent of all species that have ever lived are now extinct! While evidence does exist for a few beneficial mutations, no evidence exists for thousands of continuous, beneficial mutations that would bring about major improvements, let alone a new species.

Possibility Reasoning

Dr. Lee Spetner has calculated the odds of developing a single new species through mutation, taking into account the rate of mutation, the chances of a mutation being beneficial, the chances of the mutation spreading throughout the species, and the number of steps required to form a new species. He was careful to use rates that were very generous to the evolutionary process hypothesis. Dr. Spetner's calculations yielded odds of one chance in 3.6×10^{2738} (that is a 36 with 2,737 zeros after it!). Scientists usually consider anything with odds greater than one in 10^{50} to be impossible. Spetner's analogy concerning these odds is: "It is like trying to become a millionaire by picking up pennies you find on the street."



Theodosius Dobzhansky, one of the twentieth century's leading Darwinists, summarized the problem with mutations and evolution:

> And yet, a majority of mutations, both those arising in laboratories and those stored in natural populations, produce deteriorations of viability, hereditary diseases, and monstrosities. Such changes, it would seem, can hardly ever serve as evolutionary building blocks.

Antibiotic-Resistant Bacteria

The continual change of human ***pathogens*** has come to pose a serious health problem. Many strains of bacteria have become increasingly resistant to antibiotics as natural selection has amplified resistant strains that arose through naturally occurring genetic variation.

These instances do appear to involve mutation, and it does appear that better-fit organisms are surviving. However, many scientists question whether this adaptation is true evolution of new kinds of species due to new genetic information. What has actually happened in these cases is that some bacteria already had the genes for resistance to the antibiotics. When antibiotics are applied to a population of bacteria, those lacking resistance are killed and any genetic information they carry is eliminated. By the process of natural selection, the survivors carry less information, but they are all resistant. The same principle applies to rats and insects. Rats have developed resistance to the poison called *warfarin*. Likewise, many hundreds of insect species and other agricultural pests have developed resistance to the pesticides used to combat the various pests. Again, through natural selection, organisms without resistance are eliminated. *Survival* of the fittest is at work, but not *evolution* of a new species.

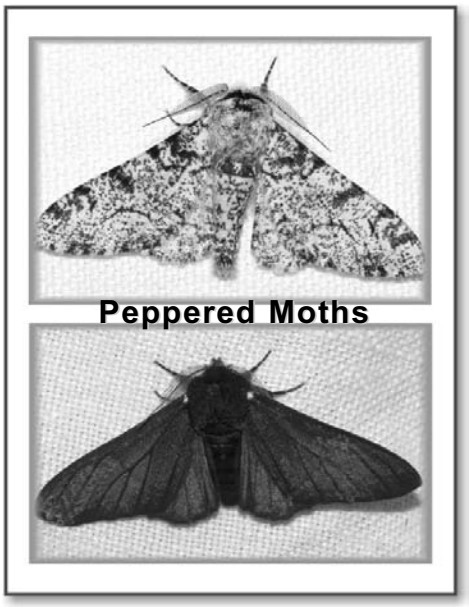
Peppered Moths

The case of the peppered moth of England is often cited as a striking example of Neo-Darwinian evolution. Peppered moths have always existed in light,

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intermediate, and dark-colored varieties. Before the advance of the industrial revolution, the tree trunks were light-colored and the light-colored moths were camouflaged; whereas, the dark-colored moths were easily spotted and eaten by birds. Consequently, few dark-colored moths survived. However, as the Industrial Revolution progressed and pollution increased, the tree trunks became darker, and within 45 years the ratio of dark and light colored moths was reversed. In one area, 96 percent of the moths were of the dark-colored variety.



Many scientists question whether this phenomenon is true evolution of new kinds of species due to new genetic information. This process of survival of the fittest did not produce anything new. It did not result in increased complexity and organization. The dark-colored moths had always existed. The air pollution simply caused a shift in the populations of the dark versus light colored moths.

No evolutionary change occurred. No new genetic material developed and, therefore, no new species was produced. However, the case does illustrate the principle of natural selection.

The scientific community recently discovered that the peppered-moth study in England was flawed—including the fact that peppered moths don't normally rest on tree trunks. Instead, they fly by night and apparently hide under upper branches during the day. By releasing moths onto nearby tree trunks in daylight, the researchers created an artificial situation that does not exist in nature. Many biologists now consider the results invalid and some even question whether natural selection was responsible for the observed changes.

In the next lesson, we will examine the evidence of the geologic column and index fossils.

Life Principle



"The great tragedy of science (is) the slaying of a beautiful hypothesis by an ugly fact."

—T.H. Huxley (1825-1895)
English surgeon and biologist,
chief defender and promoter of Darwinism

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Evolution— The Evidence

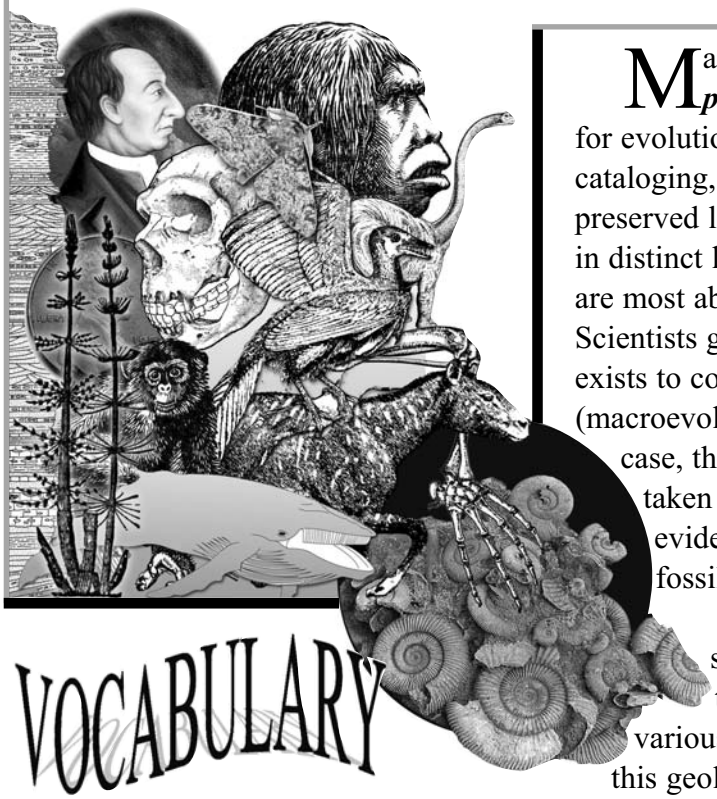
Lesson 7

Chapter 4

THE GEOLOGIC COLUMN AND INDEX FOSSILS

Section 2

Lessons 6-10



VOCABULARY

Paleontology: study of prehistoric life forms represented by fossilized plants and animals

Strata: distinct layers of rock in the Earth's crust

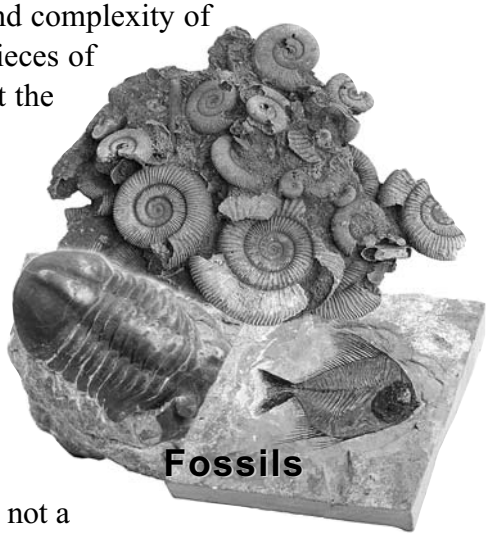
Sedimentary rocks: rocks that form when salt, sand, or clay builds up in the bottom of a river, lake or ocean

Geologic column: a continuum of geologic strata in the Earth's crust with a presumed time scale based on the type of fossils found in each of the strata

Geology: the study of the Earth's crust and surface features and their history

Many scientists believe that the study of ***paleontology*** provides the best evidence for evolution. Paleontology deals with locating, cataloging, and interpreting fossils. Fossils are the preserved life forms of once-living organisms found in distinct layers or ***strata*** of the earth's surface and are most abundant in ***sedimentary rock*** layers. Scientists generally acknowledge that no evidence exists to conclude that vertical evolution (macroevolution) is occurring today. If that is the case, then all macroevolution that may have taken place has occurred in the past. For evidence of this past, we must appeal to the fossil record.

Fossils have been organized into a standard ***geologic column*** (often called the *geologic time scale*), representing the various proposed geologic ages of the past. In this geologic column, only simple and unspecialized forms of life are assumed to be found in the lower strata. Then, as one approaches the surface of the earth, increasingly higher and complex life form fossils are found. This gradual increase in size and complexity of the fossils is one of the main pieces of evidence that is used to support the hypothesis of macroevolution (vertical evolution).



Fossils

HISTORY OF THE GEOLOGIC COLUMN

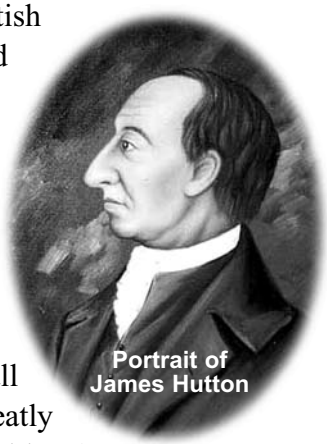
Geology, unlike chemistry and physics, deals with past events in Earth's history that scientists cannot reproduce. Geologic activity is not a

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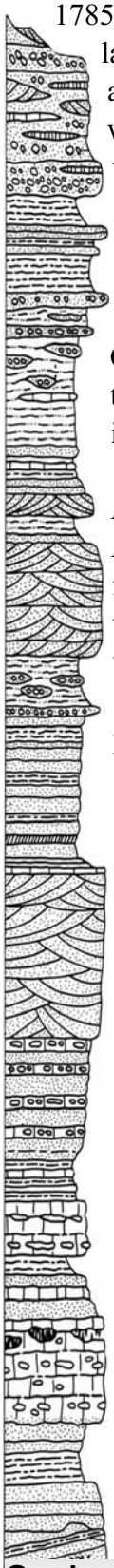
constant, unlike the speed of light or the law of gravity which are constants. Geologic activity can occur slowly, but also rapidly, as during a flood, earthquake or volcanic activity. Before the nineteenth century, the vast majority of scientists interpreted Earth's history in terms of biblical creationism and catastrophism; consequently, most scientists believed in a young Earth of less than 10,000 years. The basic philosophy of historical geology since the early nineteenth century has been ***uniformitarianism***.

However, Uniformitarianism minimizes the impact of catastrophic events and states that the origin and development of all things can be explained exclusively in terms of the same natural laws and processes operating today. As applied to geology, this means that Earth's mountains, rivers, canyons and all other features of Earth's surface and crust are a result of the slow processes of sedimentation, erosion, contraction and other actions of natural processes, all working over an almost indefinite period of time. This concept, first called the *Huttonian Theory,* was introduced by James Hutton in his book entitled *The Theory of the Earth*, published in 1785. Hutton was a Scottish lawyer, physician and amateur geologist who is credited as the *Father of Geology*. His concepts were popularized in the early 1800s by Sir Charles Lyell. (Recall that Lyell's work greatly influenced Darwin's ideas.)


Portrait of James Hutton

Hutton also published *An Investigation of the Principles of Knowledge* (1794) in which he set forth his "Principle of Variation" which explains plant and animal variations by means of natural selection 65 years before Darwin published *Origin of Species*. Hutton's "Principles" included the belief that variations in species showed evidence of ***benevolent*** design in nature and classified the possibility of evolution being responsible for originating species as "romantic fantasy".

Uniformitarianism is in stark contrast to the catastrophist theory which proposed that a great catastrophe (such as a global flood) was responsible for nearly all of Earth's present, major features. Uniformitarianism has been the backbone of modern historical geology and is responsible for the assumption that the earth is approximately 4.6 billion years old. (Some geologists point out that modern man has conveniently "aged" the Earth from just a few


Geological layers
Courtesy of the National Park Service Museum

VOCABULARY

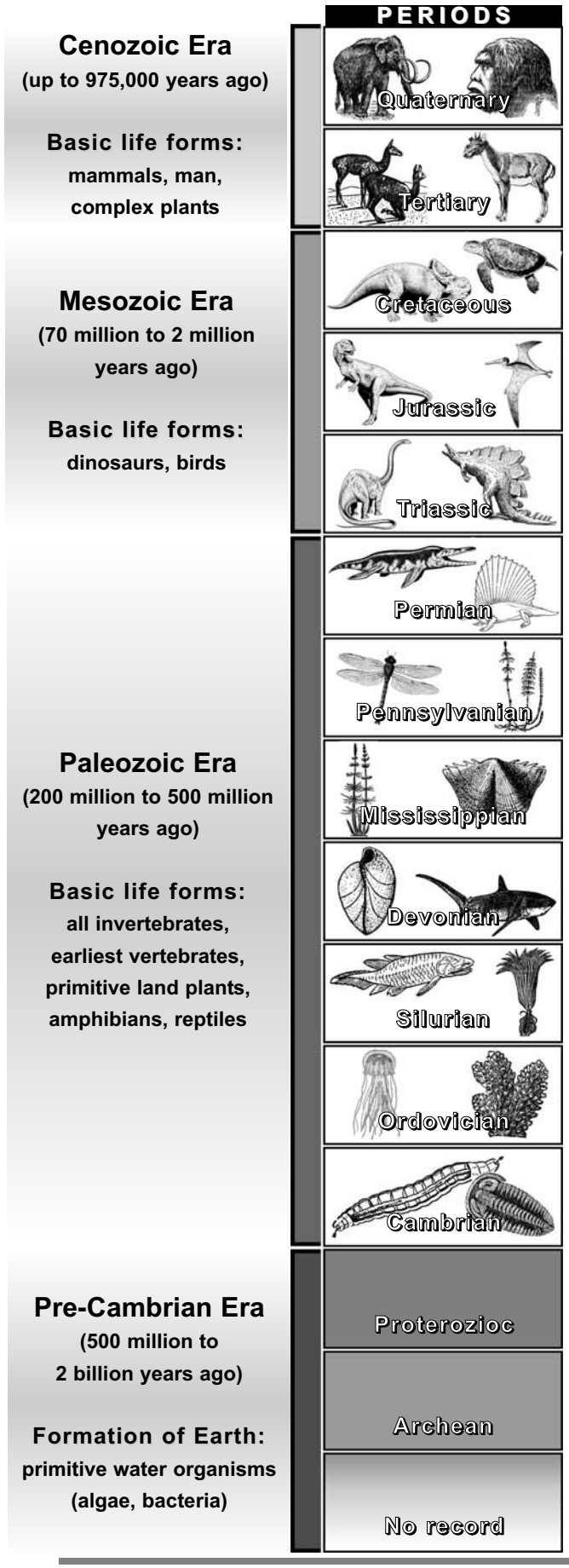
Uniformitarianism: the hypothesis that the origin and development of Earth's physical features can be explained exclusively in terms of current natural processes

Benevolent: characterized by kindness and goodwill

Index fossils: "marker fossils" assumed to have been widespread in occurrence, and to have lived a limited duration; marks a specific age of strata in the geologic column

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thousand years to almost 5 billion years in a little more than a century in order to support the concept of uniformitarianism.)

Based on the assumptions that uniformitarianism and macroevolution were established scientific facts, geologists began to compile the geologic column. They speculated that the Earth's strata was based on the various types of fossils contained in rock layers. The types of fossils found in each layer are called ***index fossils***. Index fossils are allegedly "marker fossils" which are easily recognized, and assumed to have been widespread in occurrence, and to have lived for a limited duration of time. Thus, an index fossil is supposed to mark a specific age of strata in the geologic column.

The geologic column or time scale was worked out by Lyell and others and has been used by many scientists ever since. It is built around four great eras: *Precambrian*, *Paleozoic*, *Mesozoic* and *Cenozoic*, that are subdivided into twelve periods. Those, in turn, are further subdivided into epochs.

Primitive, one-celled organisms are supposed to have evolved in the Precambrian era while all the animal phyla, including the invertebrates, appeared in the Cambrian era. The Mesozoic era was the age of the great reptiles, with birds and mammals proliferating in the Tertiary period. Man is supposed to have evolved in the Pleistocene epoch of the Quaternary period, or possibly in the Pliocene epoch of the later Tertiary period.

Scientists who follow the scientific method note that nowhere in the world, except for textbooks, has the complete geologic column been found to occur. Only a few of the twelve periods are normally found at any given location, and many places have no evidence of the assumed geologic periods. The geological column is simply an ideal evolutionary series of geologic systems

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and not an actual column of rocks that can be observed at a particular locality. Real rock formations are characterized by gaps and reversals of this hypothetical evolutionary and geologic sequence. Even the Grand Canyon includes less than half of the proposed geologic systems. Furthermore, no correlation seems to exist between rock characteristics and the age of the rock. Many rock types (sandstone, shale, etc.) can be found in any of the geologic ages. Minerals and metals of all types, coal and oil, and all degrees of rock and soil compactness can be found in any of the geologic strata.

These presumed geological ages had been worked out in considerable detail long before the discovery of radioactive dating. Therefore, the system has not been confirmed by radiometric methods. As a matter of fact, the geological column is based on the assumption that macroevolution is scientific law—that animal life always moved from the simple to complex, from protozoa to human and that the evidence should be consistent throughout the earth.

Many scientists now question how the age of the rocks was determined well over a century ago. The geological age of rocks is determined primarily by fossils trapped in a strata. The only justification used for assigning fossils to a specific geological strata is the assumed place the fossil has in the evolutionary progression of life. Unfortunately, this is *circular reasoning* and such reasoning cannot be used in advancing an hypothesis if following the scientific method.

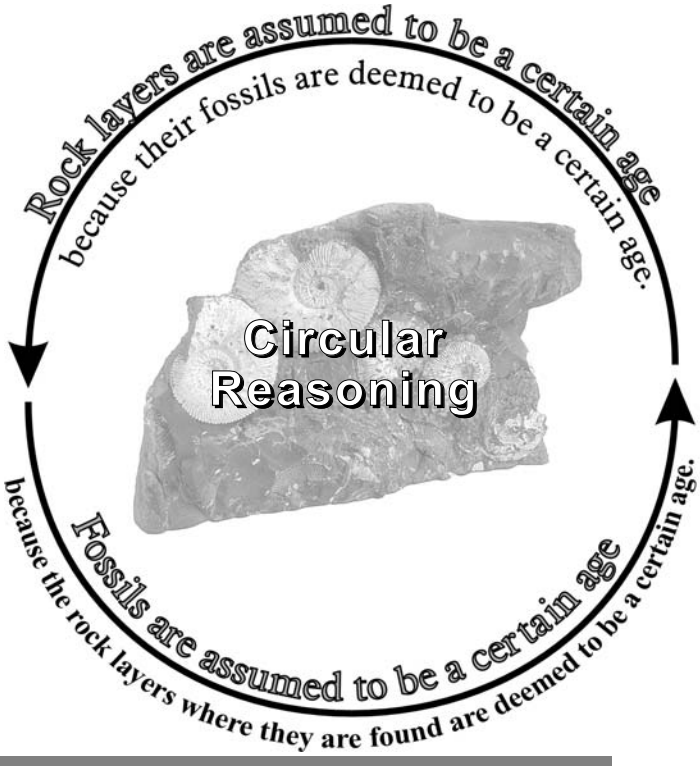
R.H. Rastall, lecturer in economic geology at Cambridge University, admitted:

> It cannot be denied that from a strictly philosophical standpoint geologists are here arguing in a circle. The succession of organisms has been determined by a study of their remains embedded in the rocks, and the relative ages of the rocks are determined by the remains of organisms that they contain.

Paleontologist Niles Eldredge of the American Museum of Natural History stated:

> . . .And this poses something of a problem: if we date the rocks by their fossils, how can we then run around and talk about patterns of evolutionary change through time in the fossil record?

It is generally true that in any local column that geologists examine, the simpler life forms are preserved in the deeper strata, land vertebrates in the higher strata, and human life forms at the very top. This could be evidence for macroevolution, if you assume the uniformitarian model. However, if you assume a catastrophic event occurred such as a major flood, this type of fossil stratification would also be expected. Such a flood would necessarily tend to affect and bury first the creatures in the deep oceans, then those in shallower waters. Then, the floodwaters would overtake the amphibians



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and land-bordering creatures. Next to be buried would be swamp, marsh, and low river creatures, including reptiles. Higher-order mammals would usually be able to retreat from the rising waters, but if the waters were to rise high enough, even the taller mammals would be drowned. Finally, humans would be overtaken and drowned.

From a scientific standpoint, scientists who are committed to the evolutionary model of Earth's history really do not know what caused the formation of the geologic strata and relative positions of the fossils. Disagreement persists among scientists as to whether these formations and positions were caused by the processes of uniformitarianism and macroevolution or by a major catastrophe. At the present time, scientifically admittable evidence is inconclusive.

In the next lesson, we will examine the fossil evidence for evolution.

LIFE PRINCIPLE



"A lie told often enough becomes the truth."

—Vladimir Lenin (1870-1924),
Russian revolutionary

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Evolution— The Evidence

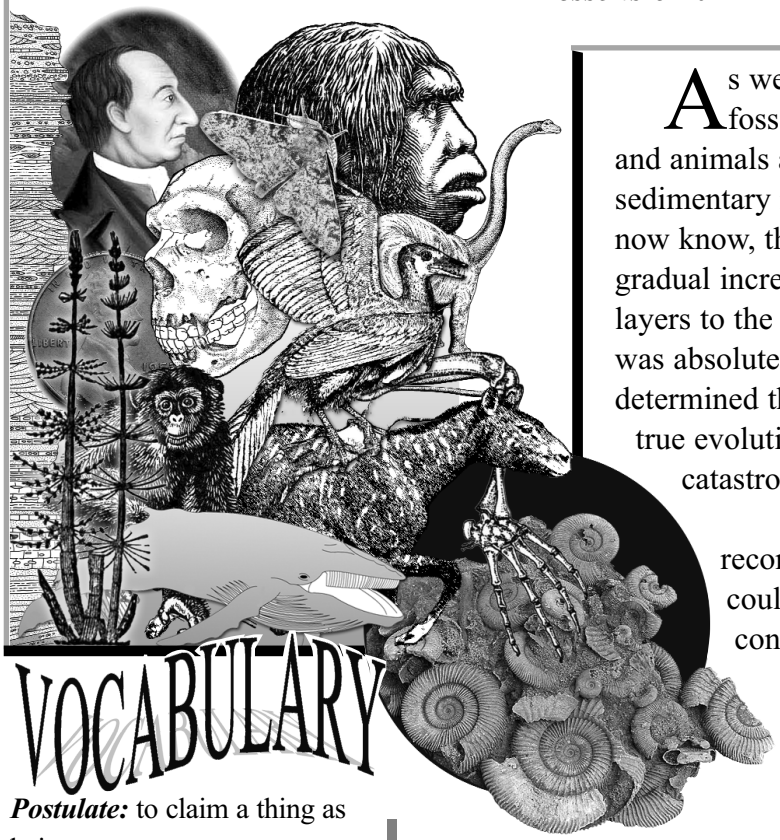
Lesson 8

Chapter 4

Section 2

Lessons 6-10

EVOLUTION AND THE FOSSIL RECORD



As we studied in the previous lesson, the fossil remains of formerly living plants and animals are found in great numbers in sedimentary rocks of the Earth's crust. As we now know, the general trend in fossils is a gradual increase in complexity from the bottom layers to the top. We questioned whether this was absolute proof of vertical evolution. We determined that it might very well be evidence of true evolution or it might be evidence of a catastrophic event such as a flood.

Let us examine the actual fossil record to discern more observations that could lead us to draw more precise conclusions.

VOCABULARY

Postulate: to claim a thing as being true

Degenerate: to pass from a higher, more functional condition to a lower, less functional condition; to deteriorate or move from better to worse

Atypical: unusual; out of the ordinary

Gargantuan: gigantic; enormous; colossal; of tremendous size or volume

Polystratic Trees: upright, fossilized tree remains extending through several layers of geological strata; literally means "many strata"

TRANSITIONAL FOSSILS RECORD

Billions of fossil remains exist in the mile-deep graveyard that extends throughout the earth. In the Cambrian sedimentary deposits, every one of the major invertebrate forms of life appear quite abruptly in the fossil record, with no preliminary or intermediate forms leading up to them. This is known as the "Cambrian Explosion." The complexity of these animals is so great that evolutionists estimate at least 1.5 billion years would have been necessary for some of the animals to evolve. Archeologists, then, would expect to find billions of evolutionary ancestors of Cambrian life forms in Precambrian rocks. However, no fossils of evolutionary ancestors of the Cambrian period have ever been found.

Researchers would reasonably assume that if life has always been in a continual stream of evolutionary change from one form to another as the hypothesis of evolution suggests, then geologists should certainly expect to find many fossils

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exhibiting transitional or intermediate stages of development. However, no fossils of true evolutionary transitional form have been found. Instead of finding a record of fine graduations preserved in the fossil records, large gaps exist. Even Darwin acknowledged this problem in *The Origin of Species*:

> *Why is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain; and this is the most obvious and serious objection which can be urged against the theory.*

Darwin was honest in acknowledging the problem of "missing links" and he hoped that in time this issue would be corrected through archaeological research. However, using the scientific method, research has not been able to fill the critical missing gaps. As geologist David B. Kitts, PhD of the University of Oklahoma, stated: "Evolution requires intermediate forms between species and paleontology does not provide them." The late Stephen Jay Gould, Professor of Geology and Paleontology at Harvard University, quipped:

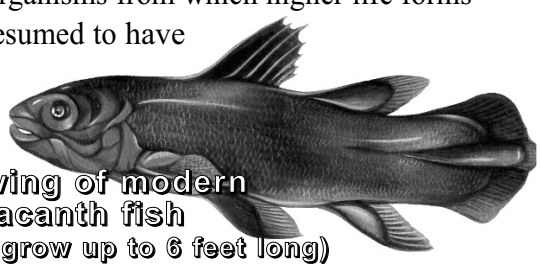
> All paleontologists know that the fossil record contains precious little in the way of intermediate forms; transitions between major groups are characteristically abrupt.

Surprisingly, over 140 years have elapsed since Darwin proposed his hypothesis, yet scientists have been unable to provide new samples to substantiate Darwin's ideas of evolution. This is because many of the fossils that were originally claimed to be transitional have been discarded or reclassified, due to new information.

For example, over the years various "ape-men" were each ***postulated*** as being the missing link between apes and man. These included the Neanderthal man, the Java man, and the Peking man, which have since been reclassified as human kind.

"Living fossils"—Unchanging Life Forms

Another puzzlement in the fossil record is that many species have remained virtually unchanged throughout all the "geological ages" since they first appeared. For example, fishermen in modern times have caught live *coelacanth* fish which, for years, scientists claimed had become extinct 200 million years ago. Examination of modern coelacanths showed no difference from the "prehistoric" coelacanth. Among the organisms that have remained unchanged throughout the course of presumed eons of evolutionary history are the protozoa—the very organisms from which higher life forms are presumed to have



Drawing of modern coelacanth fish (may grow up to 6 feet long)

VOCABULARY

Hydraulic: accomplished by means of water; pertaining to pressurized water in motion

Tarpan: a small European wild horse about 4 1/2 feet tall with a long head, short thick neck and upright mane

Ass: an Old World wild horse having a short mane, long ears and short tail hairs; they run in large herds (up to 1000) having much endurance and speed (30-40 miles per hour); donkeys are domestic asses

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evolved. This is a difficult problem for scientists who assume that vertical evolution is the universal law of nature.

Function of Intermediate Organs and Body Parts

Another problem arises in light of both the unchanging life forms and lack of transitional fossils. Scientists who search for truth (facts) about the origin of life must question the function of intermediate organs and body parts. For example, if a bat or bird evolved from a land animal, the transitional forms would have forelimbs that were neither good legs nor good wings. Based on the concept of survival of the fittest, a creature with body parts and organs in transitional form would be eliminated by natural selection. Transitional body parts, such as a half-wing half-leg, are found only in artists depictions of the evolutionary process, not in the fossil record.

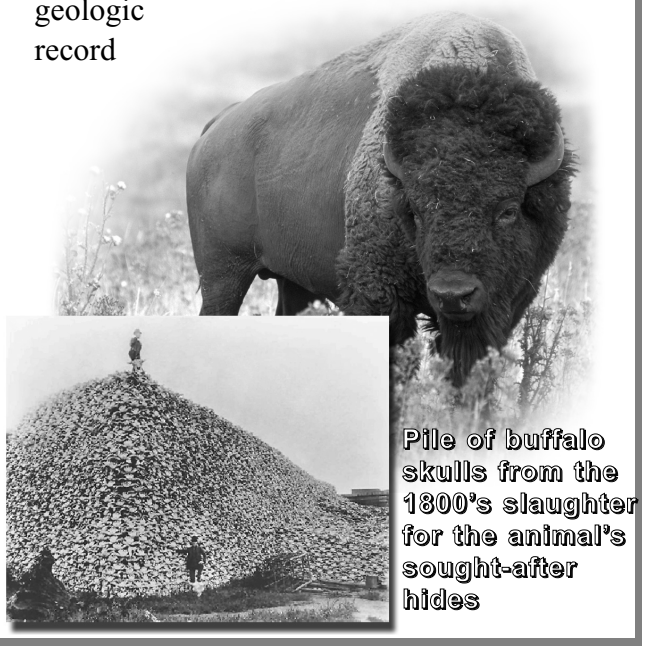
Apparent Degeneration of Life Forms

Still another problem that arises as the fossil record is examined is that a great many modern kinds of animals appear to have ***degenerated***, rather than evolved to higher forms, as evolution proposes. Mammals such as elephants, tigers, wolves, bears, hippos, and many others seem to have degenerated in physical attributes. This is also true of a multitude of plants, insects, birds, fish, amphibians, and reptiles. Such evidence of degeneracy is contrary to the hypothesis of evolution.

Fossilization Conditions

Although fossilization is not taking place today in mass, fossilization on a very large scale did take place sometime in the past. Billions and billions of fossils are found in the fossil record. Many scientists now question the idea of uniformitarianism on which all of the fossil evidence is based. If uniformitarianism is assumed (meaning all features of the Earth have been formed by the slow, gradual, geological processes that we witness today), then fossilization of this vast order should be occurring today for scientists to study.

Actually, such fossilization as found in the geological strata of the Earth is very uncommon. When a fish dies, it does not sink to the bottom of the sea and become a fossil. Instead, it either decomposes rapidly or is eaten by scavengers. Consider also that hardly a trace exists of the hundreds of thousands of buffaloes that were slaughtered all over the plains of the United States in the 1800s. Fossilization necessitates a quick burial. Once again, the global fossil record attests to a strictly ***atypical*** worldwide catastrophe involving astronomical amounts of water. In a 1975 article in the periodical, *Science*, Steven J. Gould is quoted as concurring: "The geologic record



Pile of buffalo skulls from the 1800's slaughter for the animal's sought-after hides

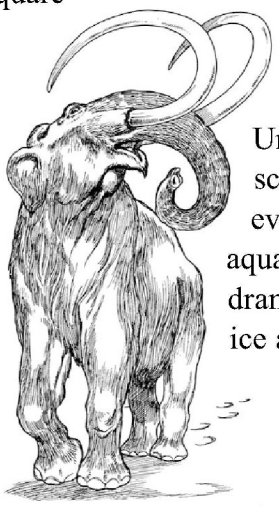
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does seem to require catastrophes." Let us examine a few examples in the fossil record that corroborate the theory of a sudden, water-related catastrophe.

Fossil Graveyards

Mass burial sites throughout the world, some covering numerous square miles, are literally packed with masses of fossils. Often these fossils represent animals from widely separate climates, seemingly thrown together in disorderly masses by great forces. We must ask ourselves how such bizarre situations could have occurred in the uniformitarian model. However, a worldwide catastrophe would explain these graveyards. Dinosaur National Park in Utah displays fossilized remains packed in tangled groups suggesting to scientists that numerous drowned creatures had washed into ***gargantuan*** piles of rubbish as a result of turbulent flood waters, then were covered with sufficient mud (often several feet deep) to ensure their preservation.



Mammoths

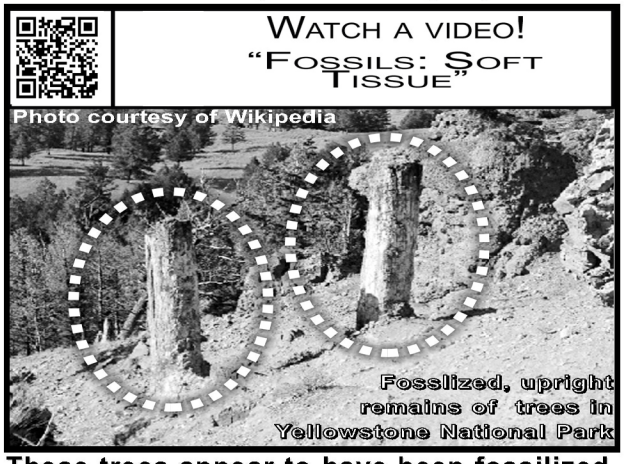
Another bizarre occurrence is the mammoths preserved in Siberia and Alaska. Great herds of these huge animals are buried in the frozen soils of the Artic, and occasionally have been found intact, some standing either upright or kneeling, some with food still in their mouths. Amazingly, even the eyes and red blood cells of some have been preserved which indicates sudden and sustained freezing conditions. Uniformitarianism fails the test of scientific assessment of such data and evidence. On the other hand, a sudden, aquatic catastrophe causing abrupt and dramatic environmental change, such as an ice age, offers a viable explanation.

Polystratic Trees

Polystratic trees are fossilized tree remains that extend through several layers of geological strata, often found extending for twenty feet or more. This kind of fossil must have been formed rather quickly; otherwise, the tree would have decomposed during passage of the millions of years necessary for the different strata to form. Such trees often cross over strata that, in the evolutionary model, allegedly took



Images of polystratic trees embedded in multiple levels of strata



These trees appear to have been fossilized in the depth they had been covered by volcanic brecia.

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millions of years to form. Again, a climatic catastrophe in which the tree was quickly buried is a more logical explanation than the alleged, gradual process of uniformitarianism. Rapid burial of upright trees was observed in recent times in the aftermath of the Mount St. Helen's volcanic eruption in the state of Washington.

N.A. Rupke, a young geologist from the Netherlands, observed a polystratic tree fossil in Scotland. He describes it as "a lofty trunk no less than 25 meters and intersecting 10 or 12 different strata, leaned at an angle of about 40°." This tree appears to have been buried while falling down!

Soft Tissues

Researchers have discovered actual fossilized soft tissues in the fossil record, such as beds of jellyfish and an entire field of pumpkins still on their vines. Soft-tissue fossils have been discovered in large masses in even the oldest levels of the Earth's strata and could not have been formed by normal, gradual processes as suggested by the uniformitarianism model. In normal conditions, soft tissue decays rapidly, long before fossilization can take place. Again, a reasonable explanation for such fossils is a ***hydraulic*** catastrophe. N.D. Newell, paleontologist of the American Museum of Natural History, recently commented on this type of fossil deposit:

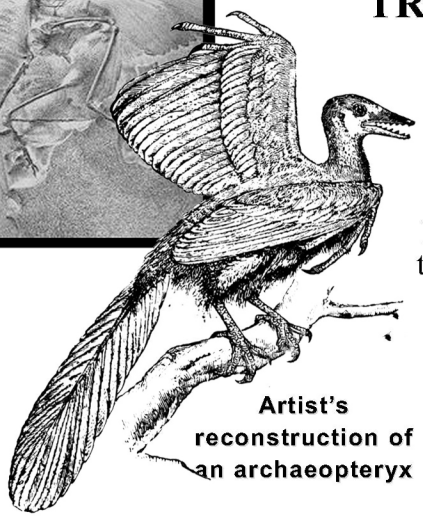


One of the most remarkable examples of preservation of organic tissues in antiseptic swamp waters is a "fossil graveyard" in Eocene lignite deposits of the Geiseltal in central Germany…..More than six thousand remains of vertebrate animals and a great number of insects, mollusks, and plants were found in the deposits. The compressed remains of soft tissues of many of these animals showed details of cellular structure and some of the specimens had undergone but little chemical modification.

The fossil record appears to present evidence contrary to macroevolution. The late Dr. Colin Patterson, senior paleontologist of the British Museum of Natural History, wrote a book entitled *Evolution*. In answer to a question he received concerning the lack of information about transitional fossils in the book, Dr. Patterson responded:

I fully agree with your comments about the lack of direct illustration of evolutionary transitions in my book. If I knew of any, fossil or living, I would certainly have included them…. I will lay it on the line—there is not one such fossil for which one could make a watertight argument.

TRANSITIONAL FOSSILS



Artist's reconstruction of an archaeopteryx

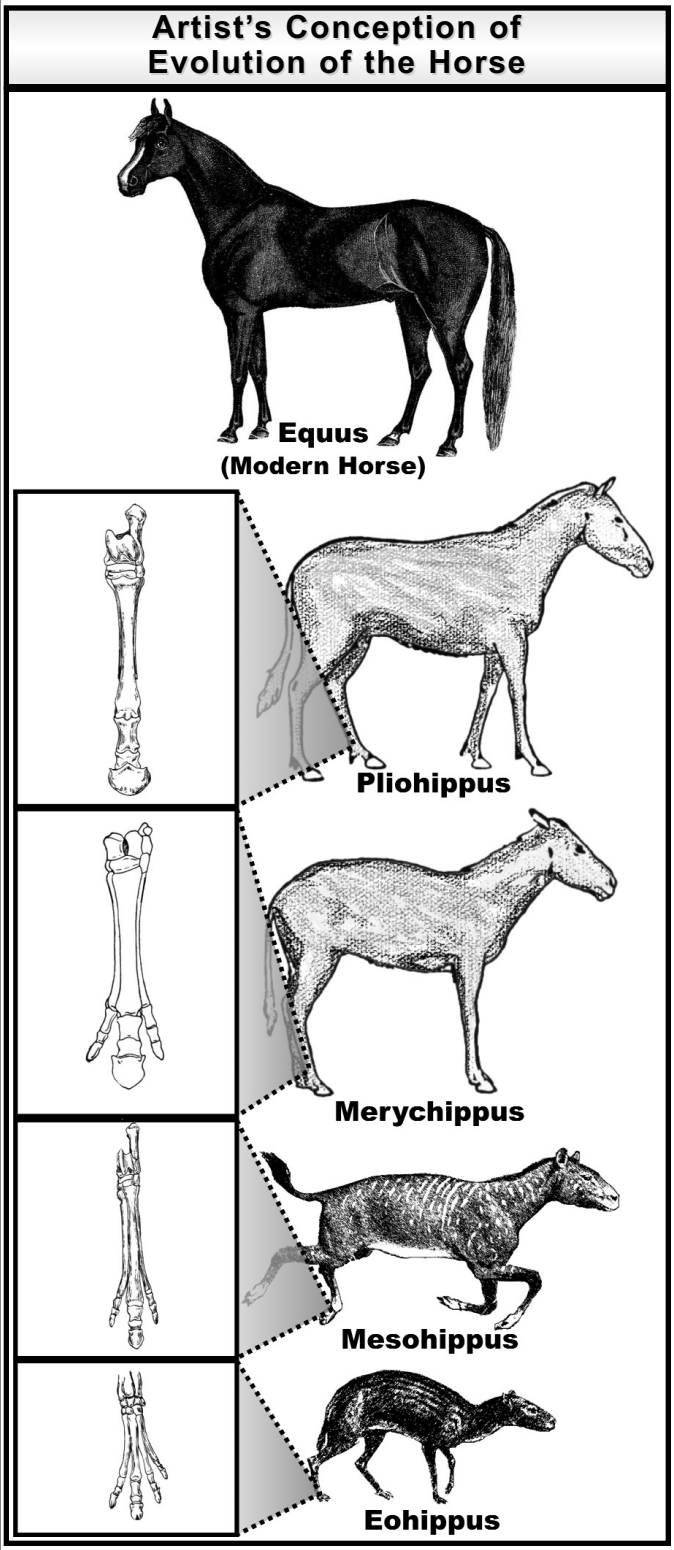
Archaeopteryx

One of the few fossils found and proposed to be a transitional link is called *Archaeopteryx*, meaning "ancient wing." At one time, scientists accepted this fossil as good evidence for proving that some reptiles had evolved into birds. This peculiar

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creature appears to have had teeth and claws like a reptile and wings and feathers like a bird. However, today it is classified by most paleontologists as a true bird and a "curious mosaic"—not an intermediary fossil. This is because each of the seemingly unique features of this fossil has been found to exist today in true birds and to be noticeably absent in many reptiles. A further point that discredits this fossil as evidence for evolution is the fact that a fossil resembling a modern bird has been found in the same geologic strata as *Archaeopteryx*. Fossilized bones of modern birds have been found in Colorado and Utah, both in and below the same type of rock strata—the Jurassic—in which *Archaeopteryx* was found.



Two crow-size birds were discovered in the Triassic Dockum Formation in Texas. Because of the strata in which they were located, those birds, according to evolutionists, would be 75 million years older than *Archaeopteryx*. Commenting on this find, Richard Bliss concludes in his book, *Origins:*

> *Perhaps the final argument against Archaeopteryx as a transitional form has come from a rock quarry in Texas. Here scientists from Texas Tech University found bird bones encased in rock layers farther down the geological column than Archaeopteryx fossils.*

EOHIPPUS

Another well-known example of alleged fossil proof is the famous "horse sequence," which originated with Othniel C. Marsh, a nineteenth century fossil hunter who found many horse fossils. Marsh then arranged these fossils in what was proposed to be a logical sequence which was consequently displayed by Yale University. This series began with *Eohippus* (a little creature named for the

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Eocene epoch of the Tertiary Period), about the size of a large rabbit or a small dog that today is known to be a rodent-like animal. For many years, this series of "horses" was claimed to demonstrate evolutionary progression from the smallest, multi-toed horses to the larger, single-toed horses of today.

This sequence, however, has been discredited by researchers who have applied the scientific method of assessing evidence. Researchers determined that the mere arrangement of similar looking fossils in order, according to size, does not prove that one organsim evolved into another. Marsh simply arranged the fossils from smallest to largest and assumed the incremental sizes were the result of time. Many difficulties and discrepancies are now known about this horse series. No valid scientific reasoning exists for assuming that horses evolved. Various, distinct kinds of horses may have been living all at the same time in the distant past, simlar to today's horse family relatives which include many varieties of zebras, ***tarpans***, and ***asses***. However, because of the discrepancies involved, the horse sequence is no longer considered valid evidence for evolution.

In the next lesson, we will examine the evidence in the fossil record for human evolution.

LIFE PRINCIPLE



"An honest man alters his ideas to fit the truth, and a dishonest man alters the truth to fit his ideas."

—Anonymous

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Evolution—
The Evidence

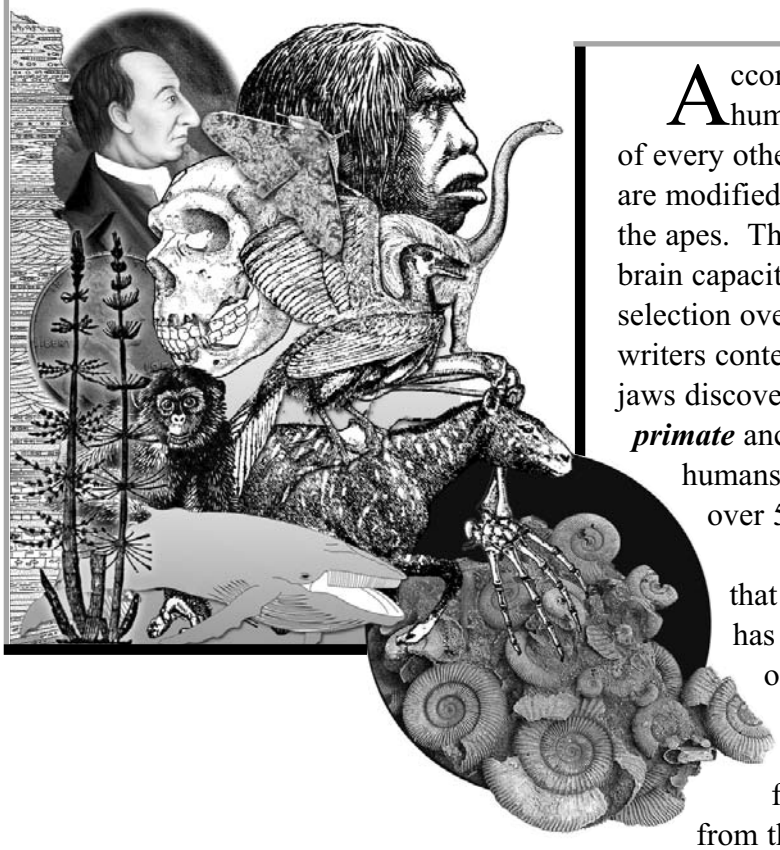
Lesson 9

Chapter 4

Section 2

Lessons 6-10

EVOLUTION OF MAN— FOSSIL EVIDENCE



According to Darwin, the origin of the human species was similar to the origin of every other species. He proposed that humans are modified descendants of a common ancestor, the apes. The distinctive human features and brain capacities are allegedly due to natural selection over millions of years. Some textbook writers contend that fossils and fragments of jaws discovered in Africa and Java suggest that ***primate*** ancestors of monkeys, apes, and humans began their evolutionary journey over 50 million years ago.

In the previous lesson, we noted that the study of fossils (paleontology) has failed to produce transitional forms of animals. The field of ***paleoanthropology*** has also failed to produce verifiable ***hominid*** fossils that suggest man has evolved from the apes. Most students have seen drawings of man's presumed progression from ape to human. Each picture shows the creature less hairy, less brute-like, and walking more upright. Rarely are students informed, however, that this alleged progression of ape to man is strictly the product of an artist's imagination! Little or no proof exists to support such an illustration. Mere bones cannot adequately communicate the appearance of fleshed-out creatures. As Austin H. Clark of the Smithsonian Institution stated:

> *Man is not an ape, and in spite of the similarity between them there is not the slightest evidence that man is descended from ape…. From time to time various 'missing links' supposed to connect man with the apes have been described…. but in light of all the evidence available at the present time there is no justification in assuming that such a thing as a 'missing link' ever existed, or indeed could have ever existed.*

VOCABULARY

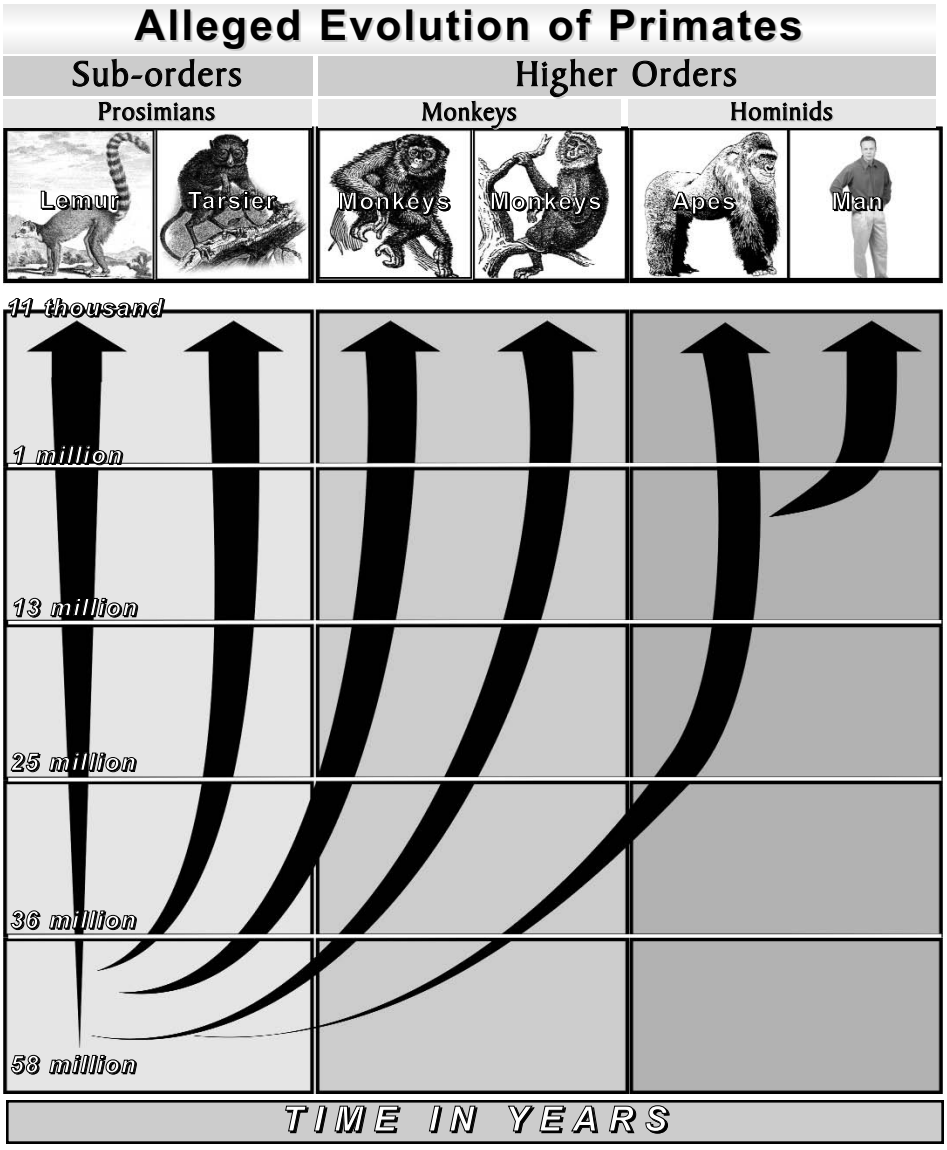
Primate: any member of the highest order of mammals; includes man, apes, monkeys, lemurs and tarsiers

Paleoanthropology: the study of hominid life based on fossil remains found in the earth

Hominid: any of a family of two-legged primates; includes humans and closely related primates

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The fossil remains of these supposed hominids are fragmentary and questionable. Since many fossils of true apes and true men have been found, scientists now question why so few fossils exist that could be possible intermediate forms between apes and men. Only a few bone fragments have been found that have been suggested to be some lower form of man. This would seem unusual in view of the millions of "ape-men" that would have needed to live during the million or so years required to have evolved to man's present state. Experts in the field of paleoanthropology admit that their field is one of great controversy, disagreement, and conjecture.

Mary Leakey, matriarch of the famed British Leakey paleoanthropological "dynasty" of Kenya, Africa, was quoted by the Associated Press in 1996 as saying, "All these trees of life, with their branches of our ancestors—that's a lot of nonsense."

Paleoanthropology is without solid evidence for the far-reaching claim that all humans evolved come from a common, ape-like ancestor. The problem with this field of science is that much room for interpretation exists when scientists analyze a fossil. This is because individual specimens can be reconstructed in a variety of ways. In addition, fossil records do not come with a pedigree or a family tree. In other words, a fossil cannot accurately indicate to the scientists who or what the ancestors were. Therefore, the concept of apes evolving to humans is purely conjecture and subject to personal opinion. Obviously, these kinds of parameters in science lead to disagreement, controversy and often to pure fiction. As Henry Gee, chief science writer for *Nature Magazine*, concludes:

> *To take a line of fossils and claim that they represent a lineage is not a scientific hypothesis that can be tested, but an assertion that carries the same validity as a bedtime story—amusing, perhaps even instructive, but not scientific.*

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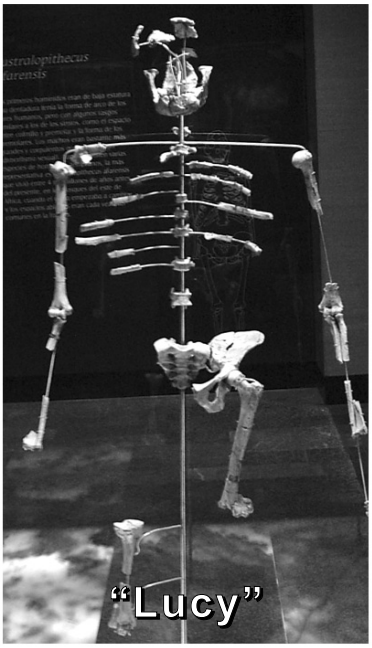
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Since individual fossils are subject to such varied interpretation, and evolutionary history cannot be reconstructed from the fossil record, scientists must question the validity of the theories of human evolution.

Many of the fossils offered as evidence of human evolution by paleoanthropologists have been discredited by researchers who insisted on actual evidence gained by the scientific method. Perhaps the greatest example was the alleged fossilized transitional hominid called *Nebraska Man*, often depicted in museums and textbooks. A single tooth had been found among the remains of some ancient tools, and scientific artists were commissioned to create full-body pictures of Nebraska Man, his family and environment —all based on that one tooth. The pictures were very convincing and did indeed look like a transitional link between man and ape. This "evidence" was used in the famous so-called Scopes Monkey Trial in 1925 to further the concept that only evolution should be taught regarding the true, scientific origin of man. Many years later, however, application of serious research proved that the tooth actually belonged to a member of the pig family. Yet, for many more years, museums and textbooks continued to display Nebraska Man as a legitimate piece of science.

Another example of discredited transitional fossils is *Piltdown Man* which was heralded in 1912 as "Darwin's missing link." Some bones, teeth and primitive tools were purposely "planted" and then "found" in a gravel pit at Piltdown, Sussex, England by an amateur archeologist. Anthropologists acclaimed the find to be about 500,000 years old. A flood of literature followed in response to this discovery and over 500 doctoral dissertations were prepared concerning these "fossilized" remains. In 1956, however, application of the scientific method of research proved that Piltdown Man was a fraud. Researchers discovered that the jawbone of Piltdown Man belonged to a very recent ape and that the teeth had been filed down to make them appear human. Moreover, the bones had been chemically treated to make them look old. Such deliberate fraudulent attempts to prove evolution of humans cast much doubt on the hypothesis of evolution.

Today, little fossil evidence for the evolution of man exists and experts cannot agree on the value of the evidence that does exist. In most discoveries of alleged human fossils, only a fraction of the entire skeleton is available. For example, the most famous fossils of the *Australopithecus* group were found in eastern Africa in 1974, one of which was called *Afarensis*, and popularly named "Lucy". *Australopithecus* is proposed to be the first hominid group to appear about 4 million years ago. In the case of "Lucy",



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only sixty percent of her bones were found. Based on her acclaimed knee joint, archeologists proclaimed that "Lucy" walked upright which would suggest she was proof of evolution. However, skeptics pointed out that her knee joint was found over 200 feet down in a lower strata and more than two miles away! Very possibly, the knee joint did not belong to "Lucy". Additionally, the knee joint was severely crushed, making the conclusions even more speculative.

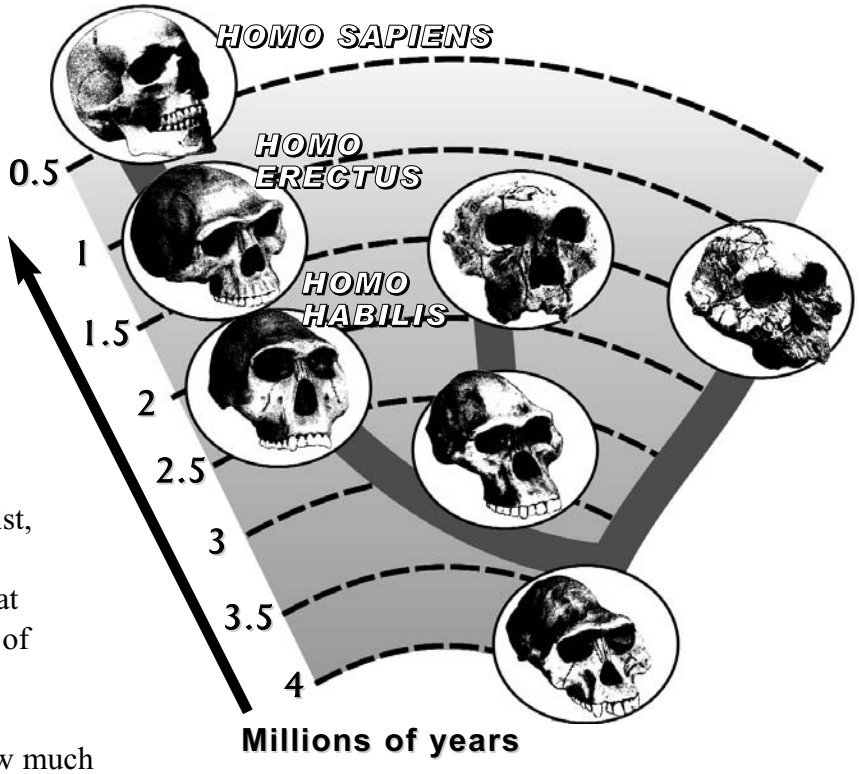
Richard Leakey, a second-generation leading paleoanthropologist, echoed critiques made of his father's *Homo Habilis* skulls in remarking that Lucy's skull was "imagination made of plaster paris" because it was so incomplete.

Obviously, limits exist on how much one can deduce from a bone. Molecular biologist Michael Denton notes that "ninety-nine percent of the biology of any organism resides in its soft anatomy, which is inaccessible in a fossil." Arranging a few bone fragments in a sequence does not prove ancestry. Even if the complete, fossilized bones of an adult and a child were available, scientists would be unable to prove by the fossil record that the two were linked together in life.

In good scientific procedure and methods, a theory results from a series of evidence and observations. In the case of human evolution, the evidence as well as the observations seem to be missing. Dr. Lyall Watson sums up the problem in an article that appeared in *Science Digest*:

> *The fossils that decorate our family tree are so scarce that there are still more scientists than specimens. The remarkable fact is that all the physical evidence we have for human evolution can still be placed, with room to spare, inside a single coffin!*

A Phylogenic Tree of Hominids



Human Evolution—The Hypothesis

Let us examine a generally accepted hypothesis of human evolution. Please note that because of the subjective nature of the study of ancient bones, many different opinions exist on the subject of the origin of humans.

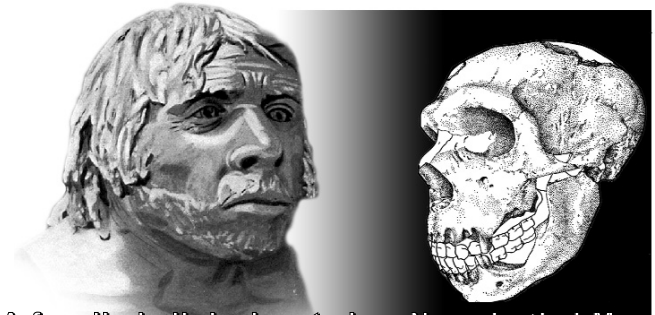
Evolutionists propose that the first hominids belonged to a group called *Australopithecus*. Members of this group are believed to have displayed the ability to walk upright on two feet. *Homo Habilis* is the next group in the evolutionary hypothesis of man; members of this group appeared to have walked erect and have much larger brain size than did *Australopithecus*. These were supposedly the first humans who appeared on

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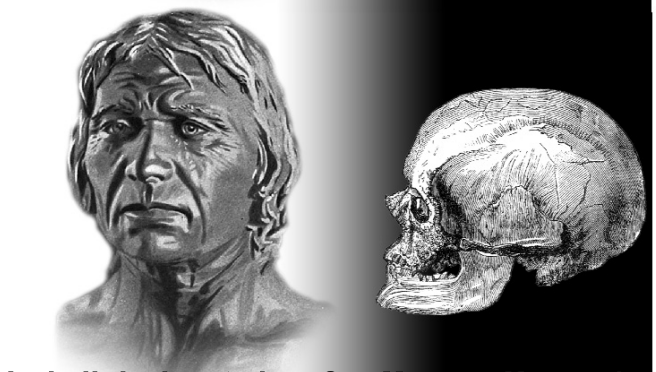
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the earth about 2 million years ago, and became extinct about 35,000 years ago. Both of these hominids were thought to have lived in Africa. However, a growing concensus exists among most paleoanthropologists who now classify *Homo Habilis* as a "junk" category that incorporates "bits and pieces of various other types." This would indicate that *Homo Habilis*, once claimed by scientists to be the "missing link" between apes and humans, never existed.

Some anthropologists speculate that the first hominid to leave Africa and migrate to Europe and Asia was *Homo Erectus*. Members of this group were thought to be skillful hunters and fully adapted for walking upright. Finally, *Homo Sapiens* or "intelligent humans" are said to have existed about 200,000 years ago, having evolved from *Homo Erectus*. Modern humans are classified as *Homo Sapiens*. The oldest fossils classified as *Homo Sapiens* are the *Neanderthals*, who are said to have lived 125,000 to about 35,000 years ago in Europe. The Neanderthals had large skulls and heavy faces, sloping foreheads and small chins. Neanderthals made tools of various types and supposedly lived in caves and huts, hence the nickname "cavemen".



A fossil skull designated as Neanderthal Man and an artists' conception of his appearance



A skull designated as Cro-Magnon Man and an artists' conception of his appearance

Cro-Magnon men are thought to have come after the Neanderthals. Cro-Magnon men seemed to display more culture and social structure. About 5,000 years ago, *Homo Sapiens* started to build great cities, and civilizations began to flourish. Today's humans are considered by some scientists to be variations of the descendants of *Homo Sapiens*.

In the next lesson we will continue examining the fossil record evidence for human evolution.

LIFE PRINCIPLE



"No science is immune to the infection of politics and the corruption of power."

—Jacob Bronowski (1908-1974)
Polish-British mathematician and philosopher of science

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Lesson 10

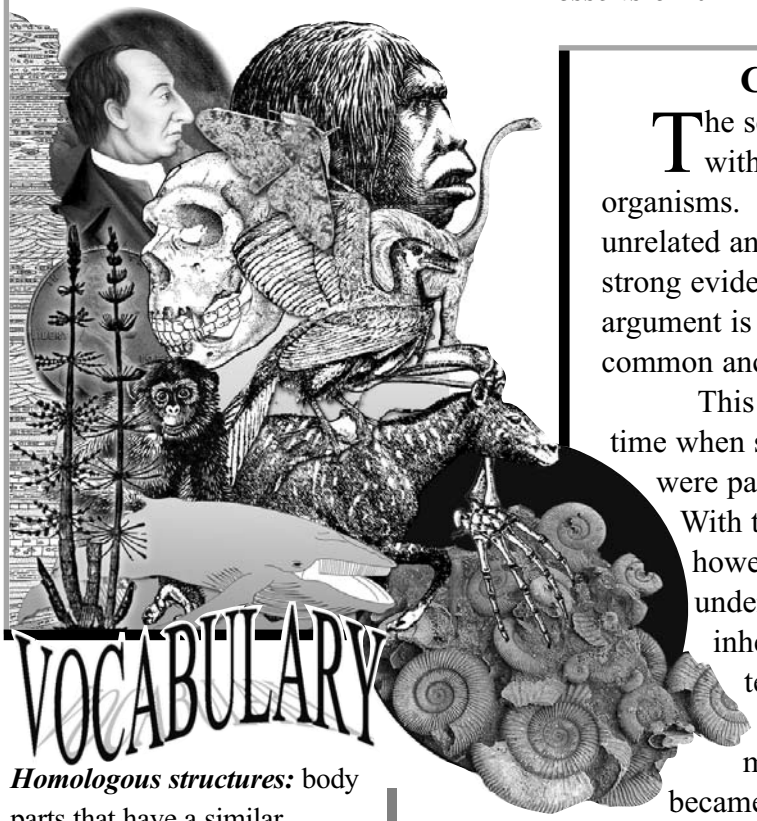
Evolution—
The Evidence

Chapter 4

EVOLUTION, ANATOMY, AND EMBRYOLOGY

Section 2

Lessons 6-10



VOCABULARY

Homologous structures: body parts that have a similar structure but not necessarily a common function

Vestigial organ: structure in an organism that seems to have little or no obvious use

Coccyx: the tailbone; forms the lower end of the spinal column in humans and tailless apes

Biogenetic law: also known as the *recapitulation theory*; an hypothesis that maintains that the development of an embryo retraces the evolutionary development of the organism

Ontogeny: the process of embryonic development

COMPARATIVE ANATOMY

The science of comparative anatomy deals with the study of physical structures in organisms. Structural similarities among various unrelated animals were at one time considered strong evidence for macroevolution. The argument is that ***homologous structures*** prove common ancestry.

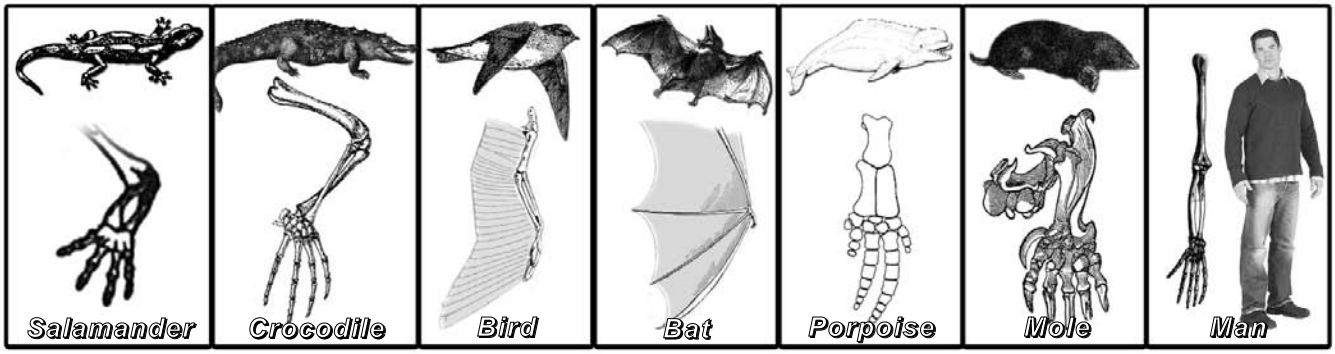
This argument was reasonable in Darwin's time when scientists had no idea of how traits were passed on from generation to generation. With the advent of Mendelian genetics, however, scientists finally began to understand the molecular mechanics of inheritance. Researchers developed technology to determine the nucleotide sequence in an organism's DNA. As more DNA sequencing information became available, application of comparative anatomy as evidence of macroevolution became less and less valid.

If structural homology was the result of common ancestry, then evidence to prove common ancestry should show up in the genetic codes of the organisms. Consider the examples used in the illustration on the next page. If the forearms of a bat, man, porpoise and bird look so similar because they all came from a common ancestor, then the genes that contain the forearm information should also be similar. If each one of these animals inherited its forearm structure from a common ancestor, then the portions of DNA which contain information about the forearm would have come from the same common ancestor. Those portions of DNA should be similar in these animals. However, the evidence for such gene similarity does not exist. As Michael Denton, evolutionist and molecular biologist, states:

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Homologous Appendages

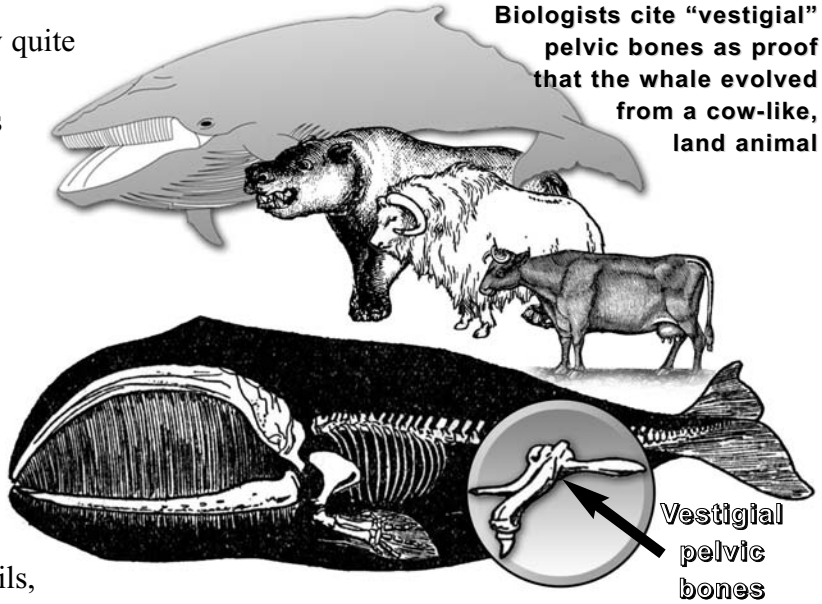


> The evolutionary basis of homology is perhaps even more severely damaged by the discovery that apparently homologous structures are specified by quite different genes in different species…. With the demise of any sort of straightforward explanation for homology, one of the major pillars of evolution theory has become so weakened that its value as evidence for evolution is greatly diminished.

Dr. Denton's statement that "homologous structures are specified by quite different genes in different species" indicates that the homologous structures could not have been inherited from a common ancestor. Basic Mendelian genetics verifies that the only way to inherit something from an ancestor is through the genetic code.

Vestigial Organs

An older, invalid argument for macroevolution is the existence of ***vestigial organs***. According to this idea, certain organs in man such as tonsils, appendix and ***coccyx*** were declared to be useless remains of organs that were once fully developed and operational in the evolutionary process. At one time, 180 such organs were cited in man. Today, as our knowledge of the human anatomy has increased, scientists recognize that all of these so called "useless" organs have important functions. Rushing to judgement in labeling theory as "fact", only to be disproved in light of new evidence, causes other supposed scientific "facts" to be questioned. For example, a whale has three "vestigial" pelvic bones that serve no yet-known purpose. Biologists, however, cite this as proof that the whale evolved from a hippopotamus or other cow-like, land animal. Additionally, scientists now know that organs



Biologists cite "vestigial" pelvic bones as proof that the whale evolved from a cow-like, land animal

VOCABULARY

Phylogeny: the process of evolutionary development

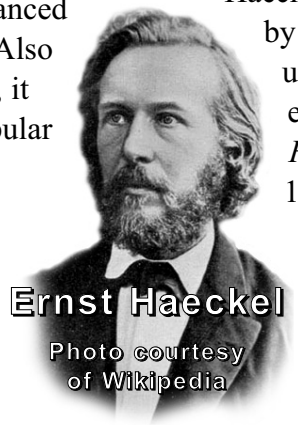
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can be modified only by genetic alterations in the chromosomes. The use or disuse of an organ or appendage has no effect whatsoever on subsequent generations.

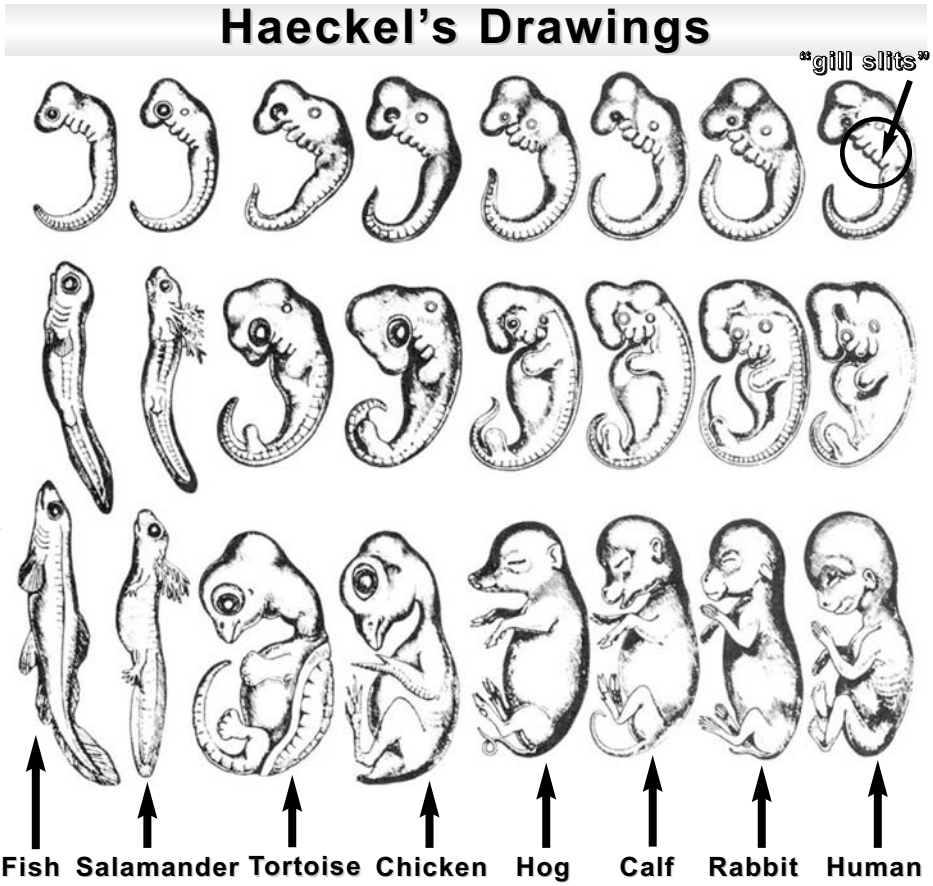
EMBRYOLOGY— HAECKEL'S DRAWINGS

In 1866, Ernst Haeckel advanced an idea called the ***biogenetic law***. Also known as the *recapitulation theory*, it can be summarized in the once-popular saying, "Ontogeny recapitulates phylogeny." This means that the development of an embryo (***ontogeny***) is supposed to retrace an evolutionary development (***phylogeny***) of the organism. This "law" suggested that the human fetus went through several evolutionary stages during development: a one-celled organism stage, the tadpole stage, fish stage, amphibian stage and so forth, on its way to becoming human. Ernst Haeckel created a series of drawings to illustrate his hypothesis. He drew embryos from various classes of vertebrates to show that they were virtually identical in their earlier stages, then became very different as they developed. Charles Darwin found this idea quite helpful in advancing his evolutionary concepts and wrote about it in his later book, *The Descent of Man*, in which he stated: "The human embryo itself at a very early period can hardly be distinguished from that of other members of the vertebrate kingdom."



Truth-searching biologists have known for over a century that Haeckel faked his drawings. At Jena, the University where Haeckel taught, he was charged with fraud by five professors and convicted by a university court. His deceit was exposed in the book, *Haeckel's Frauds and Forgeries*, published in 1915.

When Haeckel's embryos are viewed side-by-side with actual embryos, researchers have no doubt that the drawings were deliberately distorted to fit an unsubstantiated hypothesis. Researchers have demonstrated conclusively that the various stages through which an



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embryo passes are essential for its development from a single cell into a highly complex and ordered being. Additionally, the DNA is very specific and uniquely programmed for each type of organism. Embryologists know now that one species is distinct and distinguishable from other species from the very earliest stages all through the development process. The "gill slits" (allegedly depicting evolutionary progression from fish-type creatures with gills) have nothing to do with breathing, as do fish gills. Rather, these are *pharyngeal clefts*, commonly called "throat poaches", that develop into thymus and parathyroid glands and middle ear canals.

Unfortunately, Haeckel's disproven biogenetic hypothesis is still taught today in many high school and college textbooks and, consequently, is still deeply rooted in the minds of many biologists. However, conscientious scientists are recognizing the problems associated with Haeckel's biogenetic hypothesis.

Dr. Michael Richardson, an embryologist at St. George's Medical School in London, thoroughly researched the matter and stated in London's *The Times*:

> This is one of the worst cases of scientific fraud. It's shocking to find that somebody (who was) once thought (to be) a great scientist was deliberately misleading. It makes me angry…What he (Haeckel) did was to take a human embryo and copy it, pretending that the salamander and the pig and all the others looked the same at the same stage of development. They don't…. These are fakes.

Regarding various inaccuracies in high school scientific textsbooks, Alfred Romer (1906-1998), science teacher and author of *The Restless Atom,* admonished fellow scientists: "Teach genuine science. Don't make things up."

In the next lesson, we will examine the molecular unity of life.

LIFE PRINCIPLE



"True science is more concerned with discovery of truth than with protection of held theories and hypotheses."

—Mary Ames
Science textbook author

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Evolution—
Special Topics

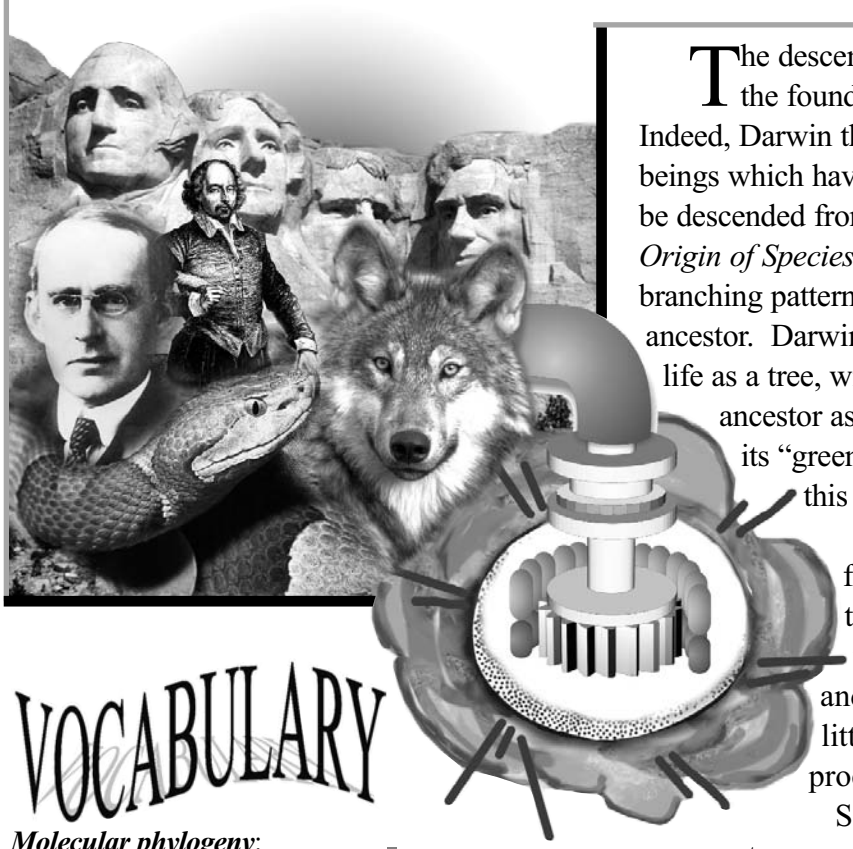
Lesson 11

Chapter 4

EVOLUTION AND MOLECULAR BIOLOGY

Section 3

Lessons 11-15

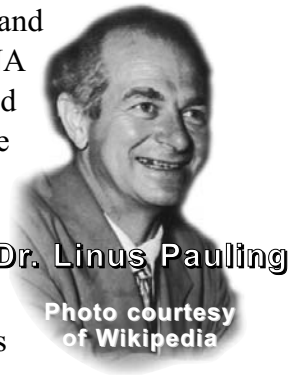


The descent from a common ancestor is the foundation of Darwin's theory. Indeed, Darwin thought that "all the organic beings which have ever lived on this earth may be descended from some primordial form." *The Origin of Species* included an illustration with a branching pattern suggesting one common ancestor. Darwin thus pictured the history of life as a tree, with the universal common ancestor as its root and modern species as its "green and budding twigs." He called this the "Great Tree of Life."

As we have seen, the fossil record offers Darwin's theory little support. Mutation theory, anatomy similarities and embryology likewise present little basis for evolutionary processes.

Since evolution assumes common ancestry, researchers reasoned that studies in DNA might provide some validation or proof. Mendelian genetics offers solid proof that all genetic instructions come from ancestors' DNA. Thus, researchers decided to look closely at DNA molecules and proteins produced by DNA instructions. As a result, a relatively new discipline called ***molecular phylogeny*** developed.

In 1962, Biologists Emile Zuckerkandl and Linus Pauling suggested that by comparing DNA and their protein products, their sequences could be used to determine how closely organisms are related. Organisms whose DNA, or related proteins, differ by only a few subunits are presumably more closely related in evolutionary terms than those which differ more. The biologists reasoned that if mutations



Dr. Linus Pauling

Photo courtesy of Wikipedia

VOCABULARY

Molecular phylogeny: evolutionary history of a group of organisms based on DNA and protein comparisons

Molecular clock: hypothesis that mutations in DNA occur at a constant rate; used to estimate time frames of departure from a common ancestor

Phylogenetic tree: modern version of the Darwinian tree of life; estimation of the time needed for organisms to evolve from a common ancestor

Cytochrome C: a protein used in cellular metabolism

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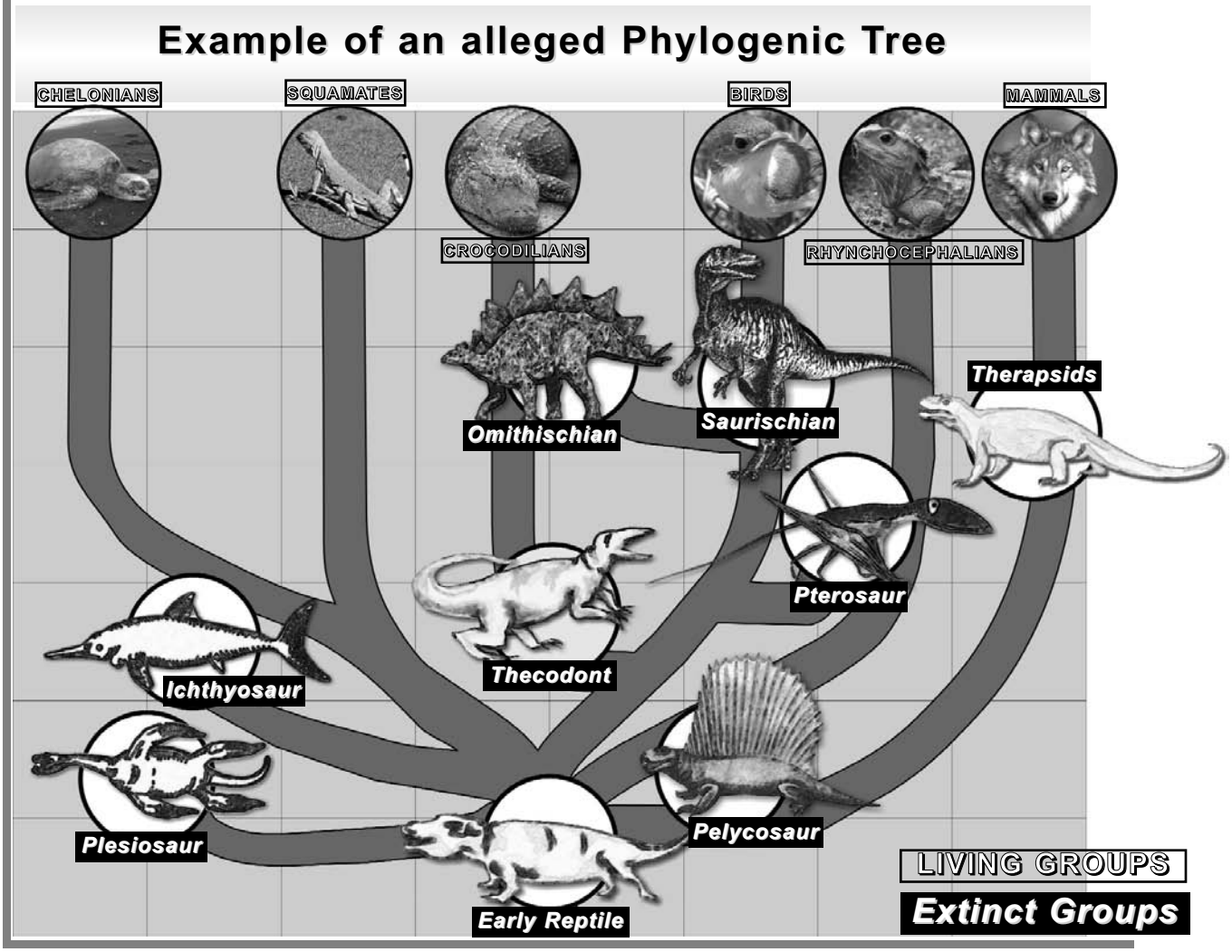
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have accumulated steadily over time, the number of differences between organisms could serve as a ***molecular clock*** indicating how many years may have passed since their DNA or protein was identical to that of their common ancestor. This would determine the length of time necessary to evolve from a common ancestor. From this proposed molecular clock information, researchers began to build what are today called ***phylogenetic trees***. Phylogenetic trees are simply modern versions of the Darwinian tree of life.

Until recently, these trees were conjectures (guesses) based on anatomical and physiological features, such as number of limbs, or warm-bloodedness. Since the advent of modern molecular biology, many phylogenetic trees are based on DNA, protein comparisons and the resultant molecular clock calculations.

Biologists recognize that certain proteins are common to many species. Most animals, for example, have the protein, *hemoglobin*, which transports oxygen through the bloodstream to cells. In addition, most organisms have the protein, ***cytochrome C***, which participates in cellular metabolism.

As biologists examined the sequence of amino acids in cytochrome C, they noticed that from species to species the sequences of amino acids varied but were quite similar. That is not surprising at all because the protein performs the same function in each



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organism. However, cytochrome C works with the specific chemistry of each organism in a slightly different manner. For example, after examining a small section of cytochrome C in both the horse and the kangaroo, the only difference is one amino acid.

Recall what you have learned about how proteins are made. Proteins are made in the cells according to the instructions of the DNA in that cell. Therefore, by looking at the amino acid sequences in a protein, you are also looking indirectly at the DNA sequence. If macroevolution does indeed take place through years and years of accumulated mutations, researchers would expect the genetic codes of closely related species to be very similar. If they are distantly related, scientists could expect genetic codes to be significantly different. Looking at the differences between the amino acid sequences of proteins is an accepted way of determining the differences in DNA sequences. For example, when the cytochrome C of a yeast is examined, we find a much greater difference than that of a horse's cytochrome C. This would make sense. After all, a yeast is a much less complex life form than a horse.



The cytochrome C discovery appeared to be a great breakthrough for the concept of macroevolution. However, as more and more amino acid sequences were mapped out, evidence once again refuted the theory of macroevolution. In fact, when researchers map the amino acid sequences of virtually any protein, and compare the differences among organisms containing that protein, scientists find no significant trend to support the concept of macroevolution. Instead, each kind of organism seems to be equally, or nearly equally, different from every other kind of organism. Exceptions to this process exist and have been used as evidence for evolution. By using highly selective data, scientists can find examples of molecular biological data that seem to indicate a trend that would support macroevolution. However, selecting data that is not the norm in order to prove a hypothesis, and/or ignoring data that does not fit a favored theory is considered to be unscientific and unethical.

Chromosome Numbers

Researchers can reasonably assume that if macroevolution is to be proven through genetics, then organisms with the fewest number of chromosomes would be the first to evolve, followed by organisms with greater numbers of chromosomes. However, when researchers gather examples from nature, they discover that more complex creatures may have fewer chromosomes than less complex creatures. For example, a human being has 46 chromosomes and a chicken has 78; a goldfish has 94 chromosomes, whereas a chimpanzee has only 48. This would mean the evolutionary order would go from human to chimpanzee to chicken to goldfish. Obviously, chromosome numbers do not support the theory of macroevolution progressing from simple to complex.

In the next lesson, we will study how evolution and the laws of physics interact.

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LIFE PRINCIPLE



"Where we have strong emotions, we're liable to fool ourselves."

—Carl Sagan (1934-1996)
Evolutionary anthropologist, astronomer, biologist

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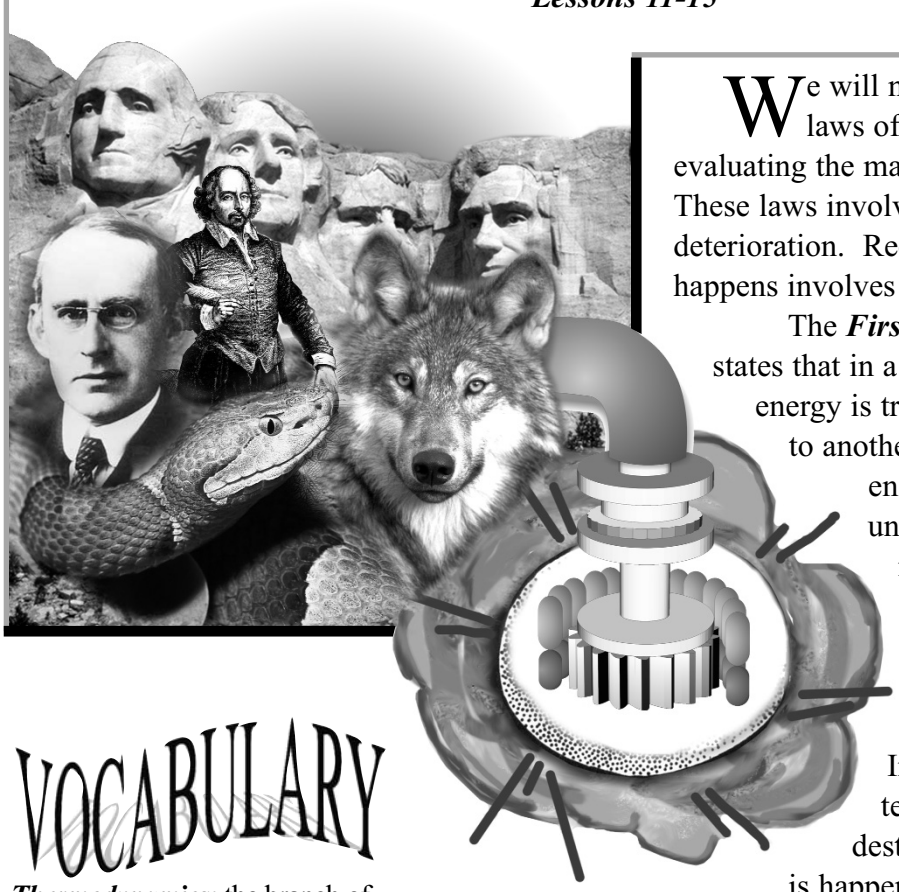
Lesson 12

Evolution—
Special Topics

Chapter 4

EVOLUTION AND NATURAL LAW

Section 3
Lessons 11-15



We will now consider two basic laws of ***thermodynamics*** in evaluating the macroevolution hypothesis. These laws involve energy conservation and deterioration. Recall that everything that happens involves energy transformations.

The ***First Law of Thermodynamics*** states that in a ***closed system***, when energy is transformed from one form to another, the total amount of energy in the system remains unchanged. Energy can neither be created nor destroyed. Although matter may be changed in state, density, or form, its total mass is unchanged. In other words, this law teaches that no creation or destruction of matter or energy is happening anywhere in the physical universe. The First Law of Thermodynamics is generally recognized as the most important, basic law of science.

The ***Second Law of Thermodynamics*** states that heat flows naturally from hotter substances to cooler substances, which means that the amount of usefulness and availability of energy is always decreasing. Part of this law is the ***Law of Entropy Increase***. Entropy is the measure of *unavailable* energy in a system. Entropy is always increasing, which means that available energy is always *decreasing*.

The Law of Entropy Increase shows up in life in many ways. Material possessions deteriorate and all living organisms eventually return to dust, a state of complete disorder. A house which is given no maintenance will soon be in disrepair. Your room at home will become chaotic if you do not spend

VOCABULARY

Thermodynamics: the branch of physics that deals with heat in relationship to other forms of energy and the conversion of one into the other

First Law of Thermodynamics: also known as the *Law of Energy and Mass Conservation*:

Closed system: neither matter nor energy leaves the system, as in the universe

Second Law of Thermodynamics: known as the *Law of Energy Decay or Deterioration*

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some time organizing and cleaning it. Relationships deteriorate if not nurtured. Weeds take over a garden that is not continually tended. Entropy pervades all of nature in a principle called ***morpholysis.*** Left on its own, everything in life moves from order to disorder. In other words, the universe is proceeding in a downward, degenerative direction of decreasing organization.

Nearly all of Earth's energy comes from the Sun. Most of the Sun's energy is dissipated into space in the form of unusable heat energy. Eventually, the Sun must burn itself out, and then all activity of life will cease. The same principle applies to the stars. In fact, the entire universe is "growing old" and wearing out—this is commonly called *heat-death*. British astrophysicist Sir Arthur Eddington (1882-1944) referred to the Second Law of Thermodynamics as "time's arrow", as the arrow points continuously downward, toward death.

Let us examine macroevolution in terms of the universal laws of science, with specific attention to the Second Law of Thermodynamics. Macroevolution requires an inherent, natural, undirected, unaided trend toward *increasing* organization and complexity. This is an accepted requirement of evolution: if we have all evolved from a common unicellular ancestor, nature must progress from the simple to the more complex.

Since the natural tendency of almost all things is to proceed from an organized state to one of chaos and degeneration, researchers have difficulty validating macroevolution on a mass scale. Macroevolution would require constant violations of the second law of thermodynamics over billions of years. For example, as we learned in an earlier lesson, mutations are proposed to be the only way an organism could evolve. However, mutations represent random, non-ordered restructuring of the very complex, highly organized replicating systems of the living cell. When any complex system undergoes a random change, it will become less organized and, therefore, less functional. Increased organization requires the input of organized data, rather than a random reshuffling of data caused by an accidental force.


Sir Arthur Eddington

The "law" of evolution and the Second Law of Thermodynamics, as we understand them, seem to be incompatible. As Sir Arthur Eddington stated:

> If your theory is found to be against the Second Law of Thermodynamics, I can give you no hope; there is nothing for it but to collapse in deepest humiliation.

VOCABULARY

Law of Entropy Increase: states that entropy is always increasing, and conversely that energy is always decreasing

Morpholysis: a principle of nature; from a Greek word which means the "breaking down or losing of structure"

Open system: either matter or energy can leave the system, as in the Earth

Law of Cause and Effect: a basic universal law requiring that every material effect (result) must have an adequate cause that existed prior to the effect

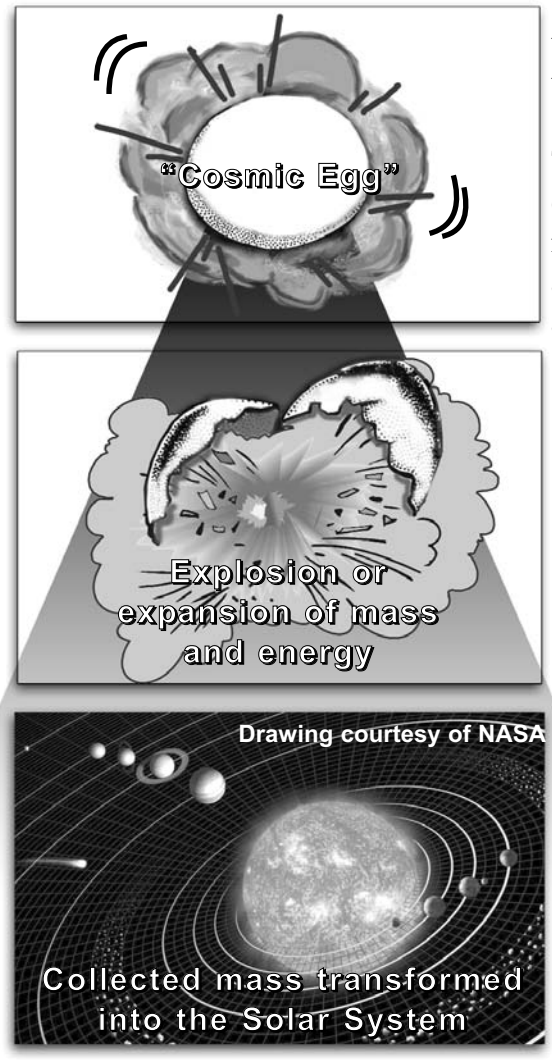
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One argument used to explain this apparent conflict is that the Second Law of Thermodynamics does not apply to ***open systems*** such as the Earth. However, equations of thermodynamics show that an open system will show more decay (increased entropy) than a closed system. Therefore, an open-system argument cannot be applied if one is using the scientific method to verify macroevolution.

Another argument often used to support macroevolution is that the Second Law of Thermodynamics does not apply to living systems. Initially, the advent of life does appear to defy the entropy principle. A seed, for example, develops into a tree and an embryo grows into an adult. However, the seed and the embryo are "programmed" by information hidden in the DNA to grow and unfold as instructed. This is much like a computer program. Information was put into the computer by a programmer/designer; the computer simply follows the instructions given by the user. Thus, we find that life is not really increasing in complexity. Rather, it is unfolding and expressing the order given by the genetic code. Moreover, given time, the tree will eventually decay, the person will grow old and feeble, and both will die. Researchers who apply the scientific method question how the genetic code could have developed to such a complex, sophisticated state while fighting the battle against increasing entropy or increasing disorder and decay.

Artist's depiction of Big Bang theory



Researchers recognize that life forms only *postpone* the inevitable effects of the Second Law of Thermodynamics. Entropy eventually wins. Despite man's attempt to extend life, all life forms eventually age and die. As the evolutionary biochemist Dr. Harold Blum writes:

> *No matter how carefully we examine the energetics of living systems we find no evidence of defeat of thermodynamics principles, but we do encounter a degree of complexity not witnessed in the non-living world.*

The Big Bang and Natural Laws

The most widely accepted theory of the origin of the universe purports that at one time, all mass and energy in the universe were compressed in a "cosmic egg" which somehow came into existence from nothing, unaided and for no purpose. Then, 15 billion years ago, the egg exploded, its flying fragments creating the orderly universe in what is called the *Big Bang*. The Big Bang theory, however, is in

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opposition to the First Law of Thermodynamics which states that matter and energy can neither be created (come into existence) nor be destroyed. The theory is also contrary to the Second Law of Thermodynamics which states that the universe is proceeding in a downward, degenerative direction of *decreasing* organization.

The Big Bang would have been the greatest of all explosions, and explosions produce disorder. A bomb exploded in a building or congested area does not create order. As we noted in an earlier chapter, Pogo the Possum, the hero of a classic comic strip, once stated that he did not like bombs because "they put everything too everywhere." What he may not have understood was that everything will go everywhere anyway if left to its own devices; bombs are just a faster way to arrive at that end. Researchers note that the Big Bang Theory cannot account for the orderly nature of the solar system and the perfect balance of nature on Earth to support life. The Big Bang theory would require nature to go against its own observable laws; it would require order to evolve from disorder by unaided chance.

In addition, nature would be required to oppose its own ***Law of Cause and Effect***. The Big Bang Theory provides no cause for the effect; it merely suggests that life and order "just happened." One former biology teacher concluded that the Big Bang Theory amounted to "nothing plus no one equals everything". Observable science affirms that nothingness can only produce more nothingness.

As the well-known physicist, Paul Davies, wrote in his book, *The Edge of Infinity*:

> *. . . the Big Bang represents the instantaneous suspension of physical laws, the sudden, abrupt flash of lawlessness that allowed something to come out of nothing. It represents a true miracle—transcending physical principles.*

In the next lesson, we will examine evolution in light of an intriguing side of life called *irreducible complexity*.



LIFE PRINCIPLE

"A fair result can be obtained only by fully stating and balancing the facts and arguments on both sides of each question."

—Charles Darwin (1809-1882)
The Origin of Species, 1859 edition, Introduction

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Evolution—
Special Topics

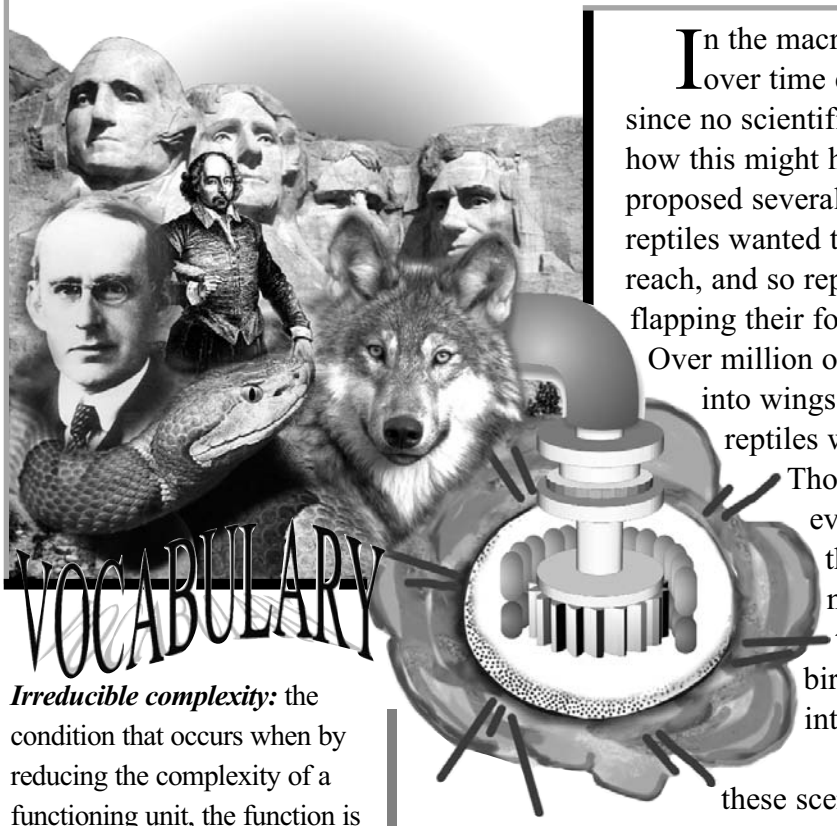
Lesson 13

Chapter 4

IRREDUCIBLE COMPLEXITY —THE DILEMMA

Section 3

Lessons 11-15



VOCABULARY

Irreducible complexity: the condition that occurs when by reducing the complexity of a functioning unit, the function is completely destroyed

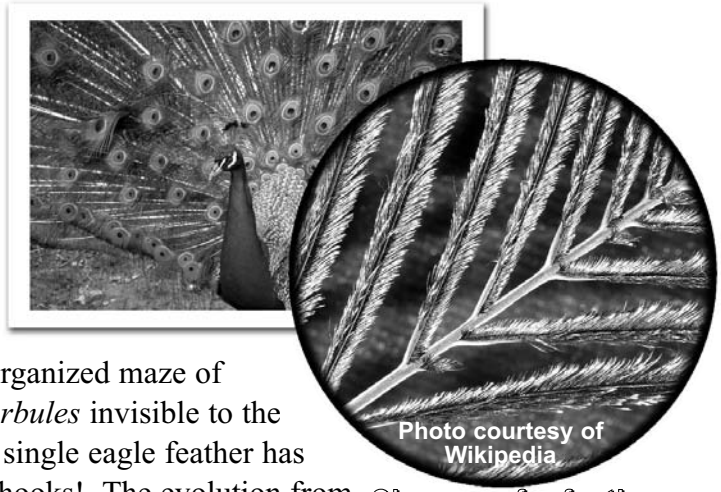
Autoimmune diseases: non-contagious diseases in which the body's immune system attacks the body's cells, such as in rheumatoid arthritis, psoriasis, lupus erythemotosus, multiple sclerosis and Crohn's disease

Neural system: central nervous system

Tommy gun: a Thompson submachine gun; a portable automatic firearm using pistol-type ammunition and fired from shoulder or hip

In the macroevolutionary model, reptiles over time evolved into birds. However, since no scientific means exist to prove if and how this might have happened, scientists have proposed several scenarios. One proposes that reptiles wanted to eat insects that were out of reach, and so reptiles began jumping and flapping their forelegs to elevate themselves. Over million of years, their limbs transformed into wings, bit by bit. In another scenario, reptiles were tree-dwellers that leaped. Those who glided well survived and eventually developed wings, but those who were poor gliders did not survive. In both scenarios, the reptiles finally became birds, whose scales had morphed into feathers.

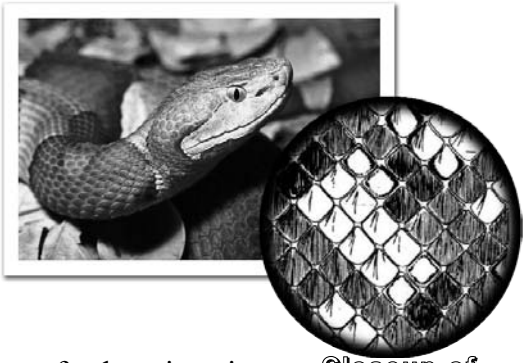
Several problems exist with these scenarios. First, reptile scales and bird feathers are not similar at all. Scales are tough, thin plates, whereas feathers are soft and delicate. Like hair or fur, feathers grow from small holes in the skin called *follicles*: but, unlike hair or fur, feathers are held together by a marvelous organized maze of "hooks" or *barbules* invisible to the naked eye. A single eagle feather has over 250,000 hooks! The evolution from



Closeup of a feather

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Closeup of snake scales

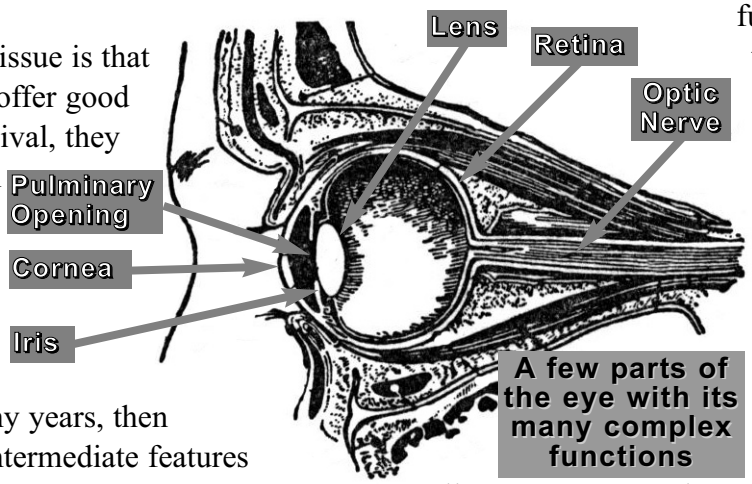
scales to feathers is quite difficult to imagine. Author Barbara J. Stahl states in her book, *Vertebrate History: Problems in Evolution*:

> It is not difficult to imagine how feathers, once evolved, assumed additional functions, but how they rose initially, presumably from reptile scales, defies analysis.

Another issue is that although wings offer good benefits for survival, they have no survival value until they are fully developed. If wings were developed slowly over many years, then creatures with intermediate features would have existed and be evidenced in the fossil record. One must question how a creature with a partial wing or partial leg would fare in nature. It could neither have flown nor walked well. Such a mutant animal would be eliminated quickly by the processes of natural selection. As evolutionist Stephen J. Gould asks: "Of what possible use are the imperfect incipient stages of useful instruments? What good is half a jaw or half a wing?"

Gradual development of the human eye would also seem highly unlikely. Many researchers are perplexed by the assumption of a step-by-step accidental development of the human eye, which is incredibly complex. This amazing organ is more complex and dependable than any man-made camera. The eye produces stereoscopic pictures and is fully automatic. The eye can see in total darkness and in very bright sunlight. The eye can focus on a tiny little bug at very close range or it can take in the beauty of snow-capped mountaintops. The human eye is constantly at work and even has its own maintenance routine.

Researchers acknowledge that the eye must be in constant communication with the brain in order to carry out its precise optics. Without all of its parts working in perfect unison with the brain, the eyes will not function. By themselves, the multiple parts of the eye are of no optical use.



A few parts of the eye with its many complex functions

Macroevolution requires that chance mutations simultaneously developed each optic part until, by sheer coincidence, all parts were complete and harmonious, at which time perfect vision occurred.

Even Charles Darwin was troubled by this improbability and had difficulty accepting the concept of an eye developing through mutation and natural selection:

> *To suppose that the eye, with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest possible*

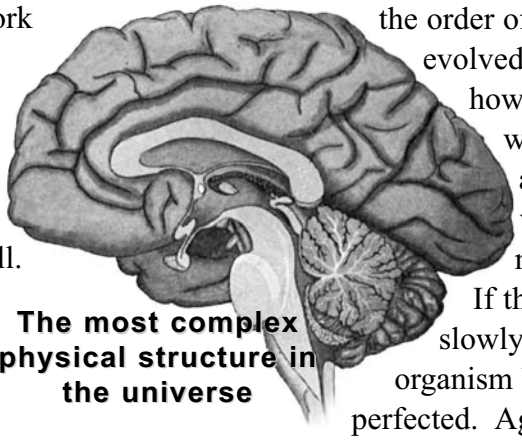
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degree….The belief that an organ as perfect as the eye could have formed by natural selection is more than enough to stagger anyone.

In his book entitled *Darwin's Black Box*, Biochemist Michael Behe calls this dilemma ***irreducible complexity***. He gives the example of a very simple machine; the mousetrap. The mousetrap would not work without a platform, holding bar, spring, hammer and catch all in the right place. If you remove just one part, the trap won't work at all. It is *irreducibly complex*. In other words, you cannot reduce its complexity without entirely destroying its function.

The Human Brain



The most complex physical structure in the universe

Many processes in the body are irreducibly complex. Blood clotting is a good example. Blood clotting is a multi-step process which utilizes numerous proteins, many of which have no other function than to cause clotting. Each protein depends on an enzyme to activate it. The dilemma here is to determine which evolved first. It could not have been the protein; it cannot function without the activating enzyme to switch it on. The enzyme would not have evolved first because it had no reason to exist without the protein. If the clotting system had developed slowly over time, the first instance a bleeding event took place, the organism would have died. The clotting system is irreducibly complex.

Another example is the human immune system. When infection occurs, this system must distinguish between the invading bacteria and the body's own cells, otherwise the body will attack its own cells, resulting in various ***autoimmune diseases***. An antibody identifies the bacterium and attaches to it. A variety of white cells, such as *lymphocytes* and *macrophages* (often referred to as "killer cells"), are notified of the bacterium's presence. These killer cells then rush in to attack the enemy bacterium. This intricate defensive operation causes many researchers to question the order of evolution. If the killer cells evolved first, they would not know how to identify the bacterium without the antibody. If the antibody developed first, it would have no killer cells to notify of invading bacterium. If the immune process developed slowly, disease would kill the organism before the process was perfected. Again, the process is irreducibly complex; its complexity cannot be reduced without destroying its function entirely.

The living body, with all of its vital organs, is also irreducibly complex. Macroevolution requires that every organ in a living system developed through chance mutation. Scientists who follow the scientific method of logical analysis must question the possibility that organs such as the kidneys, the liver, and the heart mutated by chance, simultaneously, in cooperation with each other. To noted writer Arthur Koestler, this does not seem reasonable:

You cannot have a mutation 'A' occurring alone, preserve it by natural selection, and then wait a few thousand or million years until mutation 'B' joins it, and so on, to 'C' and 'D'. Each mutation occurring alone would be wiped out before it could be combined with the others. They are all interdependent. The doctrine that their coming together was due to a series of blind coincidences is an affront not only to

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common sense but to the basic principles of scientific explanation.

Nature explodes with examples of irreducible complexity: the human brain with its ten billion nerve cells and a thousand million connections; the monarch butterfly which transforms from a caterpillar to a butterfly with two compound eyes; the ***neural system*** of a leech that uses trigonometric calculations to work out which muscles to move and by how much; and the sonar systems of dolphins and bats. The examples are endless.

The problem of irreducible complexity has become quite a dilemma to the scientific community. As Michael Behe writes:

> If you search the scientific literature on evolution and if you focus your search on the question of how molecular machines—the basis for life—developed, you find an eerie and complete silence. The complexity of life's foundation has paralyzed science's attempt to account for it.

Bombardier Beetle



Photo courtesy of Wikipedia

The Bombardier Beetle

A 1985 *Time Magazine* journalist reported on the uniqueness of the Bombardier beetle:

> . . . the bombardier (beetle) does appear to be unique in the animal kingdom. Its defense system is extraordinarily intricate, a cross between tear gas and a ***Tommy gun***. When the beetle senses danger, it internally mixes enzymes contained in one body chamber with concentrated solutions of some rather harmless compounds, hydrogen peroxide and hydroquinones, confined to a second chamber. This generates a noxious spray of caustic benzoquinones, which explodes from its body at a boiling 212^0F. What is more, the fluid is pumped through twin rear nozzles, which can be rotated, like a B-17's (bomber) gun turret, to hit a hungry ant or frog with bull's-eye accuracy.

To prevent its own destruction during this process, the beetle produces another chemical, an *inhibitor*, which is combined with the explosive chemicals and retained until an enemy appears. At the precise moment when ready to attack its enemy, the beetle produces still another chemical called an *anti-inhibitor* which allows the explosion to go forward. Interestingly, only the Bombardier's enemies come under fire—nonthreatening creatures are exempt from the beetle's chemical warfare.

This beetle is another example of irreducible complexity. The chemicals are explosive when mixed within a small space. Evolutionists have difficulty explaining how the Bombadier beetle evolved without blowing itself up. Evolution suggests that nothing evolves until it is needed. The Bombardier beetle would not have known it needed a mechanism to prevent volatile chemicals from blowing up inside the beetle's body until the chemicals mixed and exploded to kill the beetle. Obviously, if the beetle died, it would not evolve further. Evolutionary scientists admit that the Bombardier beetle is a problematic puzzle in the proposed process of evolution.

In the next lesson, we will study the mathematical probabilities of macroevolution.

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LIFE PRINCIPLE



"It's harder to crack a prejudice than an atom".

—Albert Einstein(1879-1955)
German-American physicist and mathematician

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Evolution—
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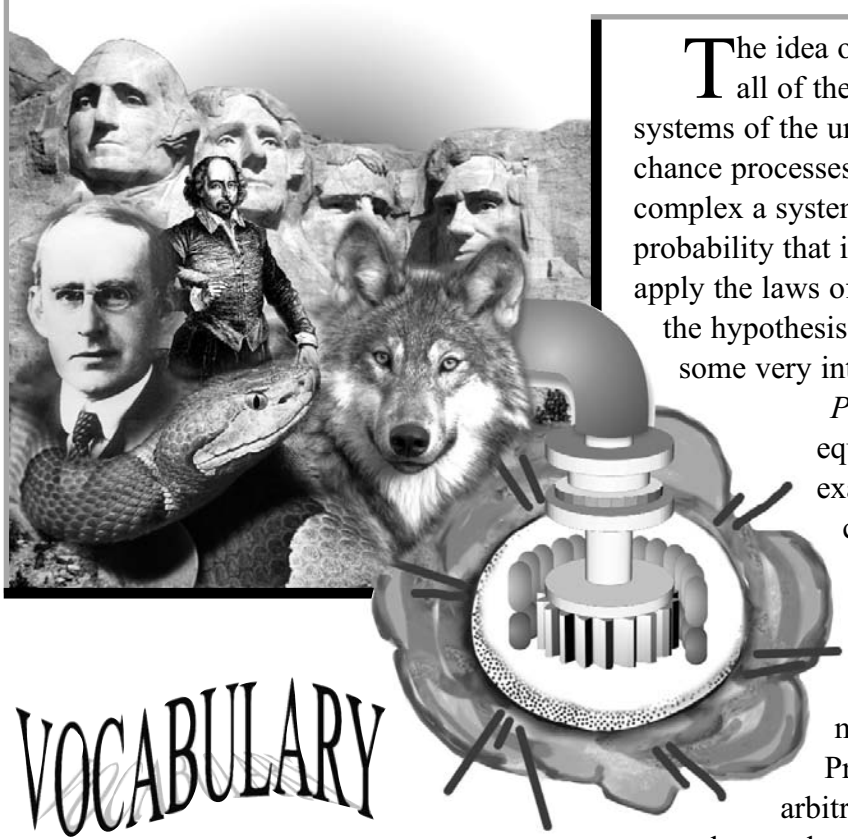
Lesson 14

Chapter 4

EVOLUTION AND MATHEMATICS

Section 3

Lessons 11-15



The idea of macroevolution proposes that all of the highly complex structures and systems of the universe are due to the pure chance processes of nature. However, the more complex a system becomes, the *lower* is the probability that it could occur by chance. If we apply the laws of mathematical ***probability*** to the hypothesis of evolution, we discover some very interesting facts.

Probability is a mathematical equivalent of "chance". For example, the probability, or chance, of being hit by lightning is about 1 in 600,000. The probability, or chance, of winning the grand prize lottery is about 1 in 5 million. The Laws of Probability are not abstract or arbitrary. They are very dependable, and many huge insurance companies risk billions of dollars on well-established calculations of mathematical probability. For example, an insurance company will issue a million dollar life insurance policy on a thirty-five year old family man for only $30.00 to $40.00 per month. You may wonder how the company can take such a large risk in return for such a small monthly premium. Insurance companies depend on the Laws of Probability to work in their favor. After careful analysis of ***mortality tables***, insurance professionals know that only a fraction of the insured thirty-five year old clients will actually die within a certain time period (causing the insurance company to have to pay the family involved).

If the macroevolutionary model is correct, then highly complex systems arise by chance. Proponents of evolution assert the argument that given enough time, the right amino

VOCABULARY

Probability: the mathematical calculation of the likelihood of an event occurring; provides the basis or foundation of statistics

Mortality Tables: charts showing the number of deaths recorded of various age groups during certain time periods

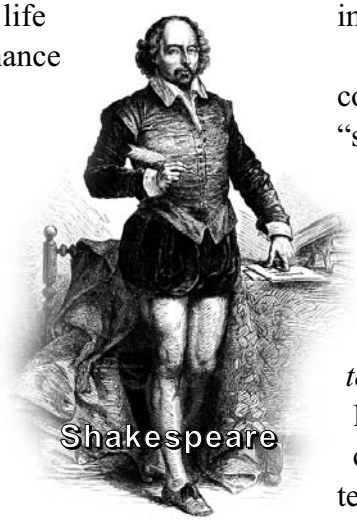
Shakespeare: (1564-1616) considered to be one of the greatest of authors; he was a poet, an actor and playwright of comedies, histories and tragedies

Hamlet: one of Shakespeare's most famous tragedy-type plays

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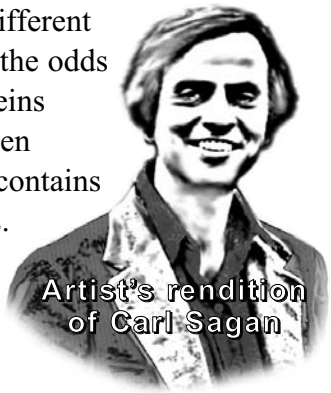
acids could have assembled together, by chance, and formed proteins which, in time, assembled life as we know it. Researchers who understand the laws of probability question the assertion that, if given enough time, even the simplest life could have arisen by chance events.


Shakespeare

One case for chance origins asserted that a number of monkeys, poking randomly at typewriters for millions of years, could eventually write all the books in the British Museum. Variations on this scenario have been proposed, such as monkeys could bang randomly on typewriters and recreate the works of ***Shakespeare***. This may seem possible until mathematical Laws of Probability are applied to the "monkey business", yielding far different conclusions. To illustrate, consider the likelihood of these monkeys spelling the word *evolution* correctly by randomly selecting nine letters from the alphabet. Using the Laws of Probability, one monkey would need more than 5 trillion attempts just to write *evolution* correctly. Typing ten letters per minute, one monkey would need over a million years to "happen upon" the word *evolution*. If one word is that difficult, the improbability of randomly producing a paragraph from ***Hamlet*** would be far greater.

Using similar logic, proponents of evolution apply the argument that, given enough time, the right amino acids could have assembled themselves together to form proteins. Imagine a simple protein of 200 amino acids. The probability of forming an ordered system of 200 amino acids is 10^{375}. (That translates to 1 chance in 10 followed by 375 zeros—a rather large number.) Anything with odds greater than one in 10^{50} is considered by mathematicians to be impossible.

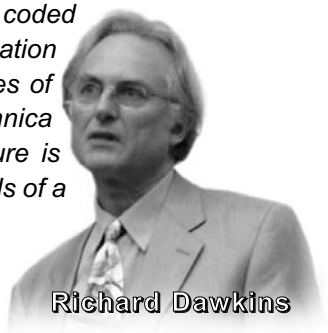
Using the Laws of Probability, chance could not produce even one protein. A "simple", single-celled bacterium contains thousands of different proteins. That means the odds of assembling all proteins necessary for life is even greater. A typical *cell* contains *ten million million* atoms. If a scale model of a cell were built using tennis balls as atoms, at the rate of one atom per minute, the project would require 50 million years. Carl Sagan, evolutionary anthropologist, astronomer and biologist said:


Artist's rendition of Carl Sagan

> *The information of a simple cell has been established as around 10^{12} bits, comparable to about a hundred million pages of the Encyclopaedia Britannica.*

Richard Dawkins, an outspoken evolutionary biologist, acknowledges that a cell nucleus:

> *. . .contains a digitally coded database larger in information content than all 30 volumes of the Encyclopaedia Britannica put together. And this figure is for each cell, not all the cells of a body put together.*


Richard Dawkins

Each living cell is composed of machinery more intricate than any man-made machine. It is inconceivable to think of a man-made machine as ever having arisen spontaneously. British philosopher and theologian William

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Paley (1743-1805) wrote a most famous essay called "The Watchmaker Argument." He reasoned that if his foot struck a rock during a stroll, he might assume the rock had lain there forever, (and may have arisen by chance). However, if he stumbled upon a watch, it would be clear that someone had designed it and made it. Paley concluded:

> . . . . Every indication of contrivance, every manifestation of design, which existed in the watch, exists in the works of nature; with the difference, on the side of nature, of being greater or more, and that in a degree which exceeds all computation.

Following Paley's logic, we could assume that if a wrist-watch had a designer and creator, we would have to assume that the *wrist* on which a watch is worn would also have a designer and creator. After all, the wrist is a much more complex "machine" than the watch.

Furthermore, cells are "irreducibly complex" as we learned in previous lessons. Each cellular structure functions only in coordination with other structures. Scientists have difficulty explaining how the complex coordination of the cell arose by chance. For example, cell membranes depend on proteins, yet proteins cannot function without cell membranes. John Horgan wrote in *Scientific American:*

> *DNA cannot do its work, including forming more DNA, without the help of catalytic proteins, or enzymes. In short, protein cannot form without DNA, but neither can DNA form without protein.*

As we examine the evolution hypothesis mathematically, we find that it appears to be statistically impossible for even the most elementary form of life to have arisen by mere chance. The bewildering complexity of even the most basic organic molecules is simply too great to be explained by random chance events. British astronomer Sir Fred Hoyle once remarked that the probability of higher life forms emerging by random, unaided chance is comparable to the odds that "a tornado sweeping though a junk-yard might assemble a Boeing 747 from the materials therein."

In the next section, we will examine the alternative hypotheses to evolution: punctuated equilibrium and intelligent design.

LIFE PRINCIPLE

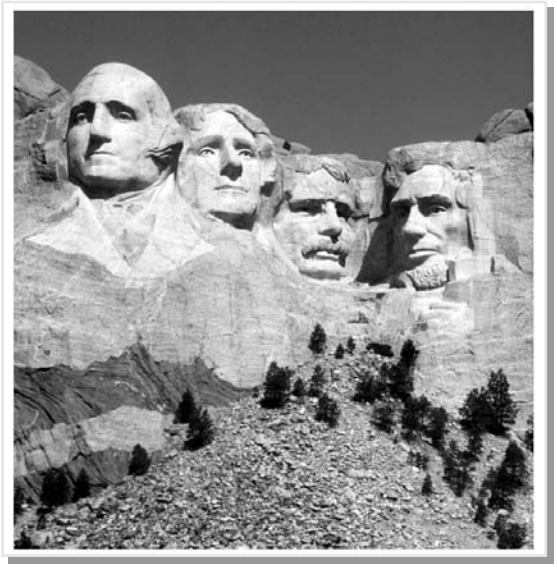


"He that answers a matter before he hears it is foolish."

—Ancient Hebrew Proverb

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Evolution—
Special Topics

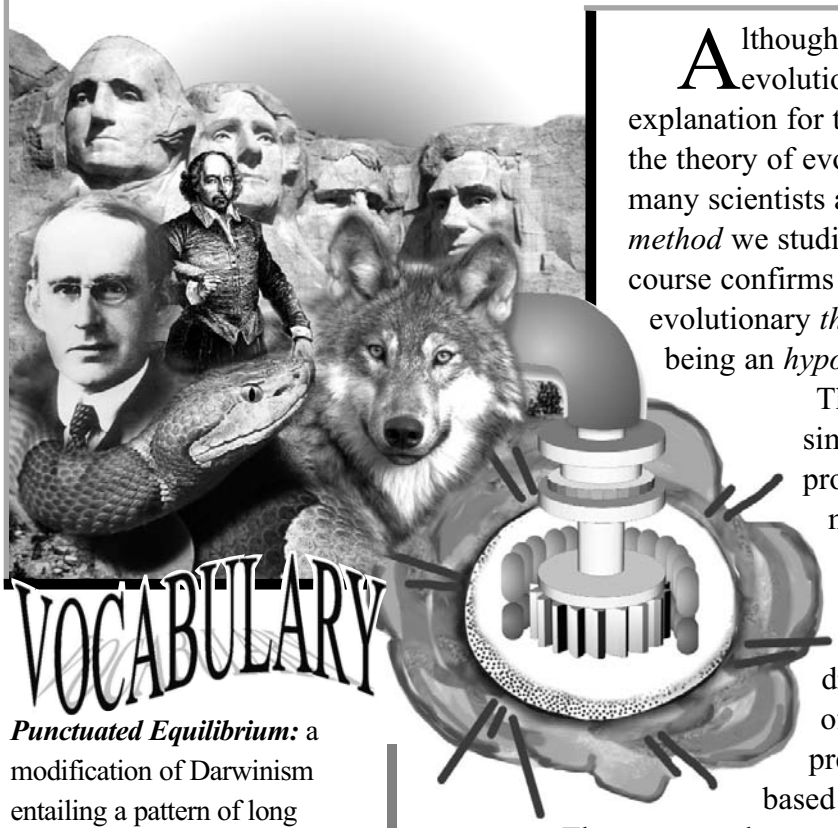
Lesson 15

Chapter 4

Section 3

Lessons 11-15

EVOLUTION TODAY



VOCABULARY

Punctuated Equilibrium: a modification of Darwinism entailing a pattern of long periods of stability interrupted by episodes of rapid change in which new forms of species evolved

Intelligent Design: the theory that an intelligent force was responsible for the creation of all life forms

Mt. Rushmore: a mountain in South Dakota with 60 ft. likenesses of four United States presidents sculpted into its granite face over a 14 year period by American sculptor Gutzon Borglum

Although many textbooks set forth evolution as the standard and accepted explanation for the origin of life on this planet, the theory of evolution has not been accepted by many scientists as *scientific law*. The *scientific method* we studied in the first chapter of this course confirms that significant parts of evolutionary *theory* never left the stage of being an *hypothesis*.

The scientific method is quite simple and is a logical, systematic procedure that we all use daily to make decisions. Very simply stated, we use observations in the natural world, as well as in the experimental world, to draw conclusions. In the world of science, we begin with a given premise, called an *hypothesis*, based on some initial observations.

Then, we go about trying to prove or test the hypothesis by collecting data. In order to do this, experiments are designed and performed. Once enough test evidence is collected to validate the hypothesis, a theory is established. Over time, the theory gains enough acceptance from the scientific community to become a scientific law because no exceptions to the theory have been found.

During the process of collecting data, the scientist must be willing to alter, or even abandon, his most cherished generalizations when they are contradicted by new facts. The scientist's question must always be: "What is the evidence?"

As we have studied in this chapter, virtually no solid evidence exists to support the hypothesis of macroevolution. The fossil record offers no positive proofs and neither does the field of molecular biology. In fact, certain basic laws of science such as the Laws of Thermodynamics are in direct

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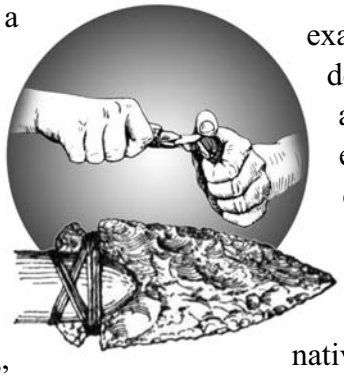
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opposition to macroevolution. The Laws of Probability show clearly the statistical improbability of macroevolution as currently proposed in many textbooks.

In response to this seriously weak evidence, some scientists who embrace the theory of evolution have turned to one of two new hypotheses regarding the history of the Earth and the mystery of life.

Punctuated Equilibrium

A number of biologists accept an hypothesis called ***punctuated equilibrium***. This hypothesis states that a species persists unchanged (in equilibrium) for millions of years. Then, a small segment of the species becomes isolated. It rapidly evolves, taking over the place where the parent species lived; the parent species then becomes extinct. Perhaps, they suggest, a group of organisms might be suddenly exposed to high levels of toxic chemicals which would speed up the mutation rates among the offspring. Most of these offspring would die, but a few lucky ones would survive. After just a few generations, a new species would emerge. Since only a few individuals would be involved in this rapid mutation process, the fossil record would not show transitional forms. The new species itself would then live for a long time at "equilibrium" until once again "punctuated" by the arrival of another new, swiftly-evolved species.



While punctuated equilibrium does help explain the lack of transitional fossils, it still depends on mutations to add information to the genetic code of the species in order for the species to evolve. This is rather unlikely due to being contrary to the basic laws of science and to the very nature of mutations. Punctuated equilibrium is an interesting idea; however, like the original hypothesis of macroevolution, punctuated equilibrium is not validated by the scientific method of discovery. No hard evidence exists. Punctuated equilibrium happens too fast to leave evidence, whereas Darwinian evolution occurs too slowly to observe. Either way, the scientific method is averted.

Design

Many scientists are turning to the hypothesis of ***intelligent design*** to explain the origin and diversity of life.

The evidence of *design* is abundant throughout our world. You have read many examples in this course of complex systems in life that logically indicate the probability of some intelligent being having designed Earth's life systems.

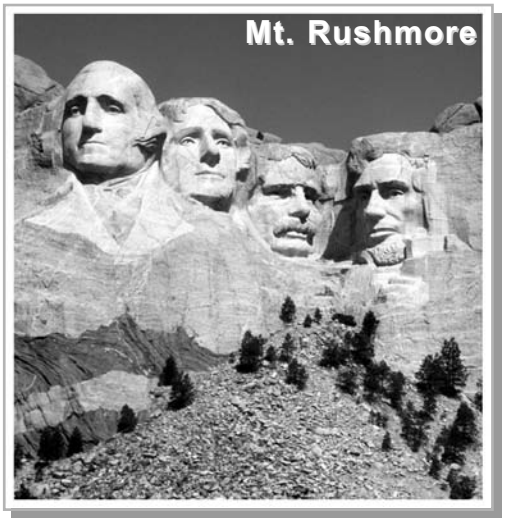
Design vs Random Selection

Design is very easily detected. For example, if we find arrowheads on a desert mesa in the Southwest, we can assume they were made by someone, even if we do not know who the designer was. We can imagine a person of Native American descent of past centuries carefully carving his arrowheads out of stone; the native would have been the *designer*.

If you look at a stream of letters such as: TEIEDSCLELTSEYDNSAIEGD, you will probably think that this is just a random assortment of letters. However, when you see these same letters placed in order to make the complete sentence, "Design is easily detected", you recognize that some kind of intelligence was behind the "message" in the sentence.

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We can detect intelligent design in *written messages*. If you were to see someone's name written in the beach sand, you would naturally assume an intelligent being wrote the letters in the sand. On the contrary, you would assume that the patterns in the sand caused by wave and wind action on the beach were the result of random, natural forces. Similarly, you would never believe that the recognizable carved heads of the four United States Presidents on ***Mt. Rushmore*** were a result of millions of years of wind and water erosion. Erosion produces irregular shapes seen in rocky cliffs or smooth, highly ordered shapes like sand dunes, but not complex, intricate sculptures of famous men's heads or legible written messages. We quickly can conclude that these things are products of a designer. Such results are not likely to be produced by random, unaided chance.



Design is evident in *function*. For example, the bacterium's flagellum is a microscopic, motor-like force that gives bacteria the ability to move from place to place. It is such an efficient motor that some engineers are trying to copy its design for industrial applications!

Design might also be detected in terms of *information*. The information content of living things is staggering, as we have learned in previous lessons. Within the DNA and RNA coding system, living things have by far the most compact information storage and retrieval system known to man. The amount of DNA information that could be stored in an object the size of a *pinhead* is beyond amazing. It would be the equivalent of the information content contained in paperback books piled 500 times as high as the distance from Earth to the Moon. This information is what is used to "program" all characteristics in life, such as hair, skin, eyes and height. DNA determines the arrangement for 206 bones, 600 muscles, some 10,000 auditory nerve fibers, 2 million optic nerve fibers, 100 billion nerve cells, about 75,000 miles of blood vessels and capillaries and much more.

Scientists have demonstrated conclusively that information does not and cannot arise spontaneously. Information results only from the expenditure of energy to arrange various elements of communication, such as letters and

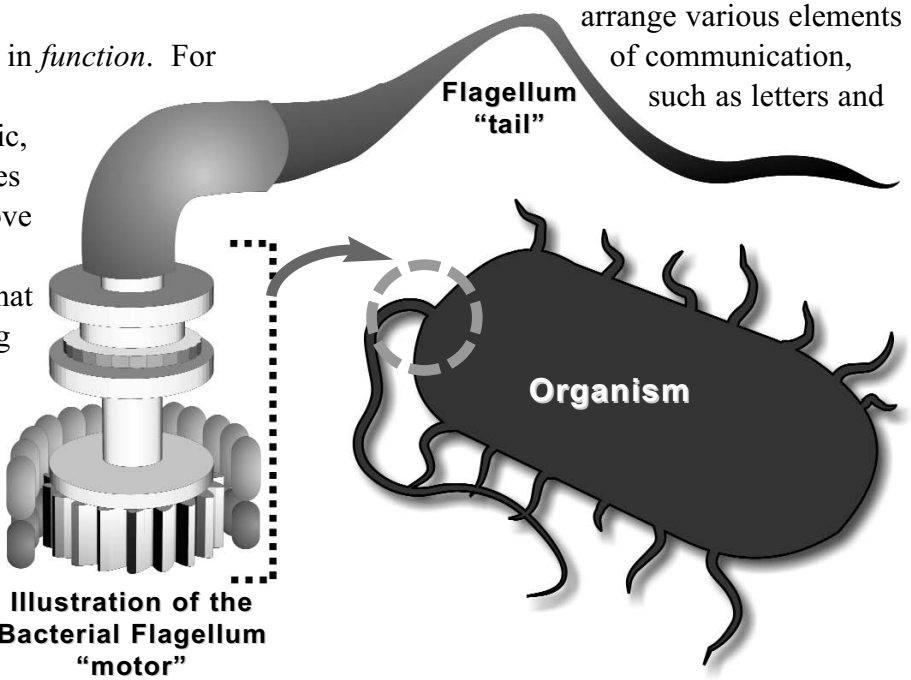


Illustration of the Bacterial Flagellum "motor"

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words, and only under the direction of intelligence. DNA is a highly complex, ordered, specific information system within the living cell. Therefore, since DNA is information, the only logical and reasonable conclusion is that DNA was designed on purpose. If DNA arose by purposeful design, then the living system with which it communicates must also have been a result of purposeful design.

As physicist Paul Davis stated:

> *The temptation to believe that the Universe is the product of some sort of design, a manifestation of subtle aesthetic and mathematical judgment, is overwhelming. The belief that 'there is something behind it all' is one that I personally share with, I suspect, a majority of physicists.*

We have looked closely at the hypothesis of macroevolution and the evidence that is currently available. We have seen that solid evidence is lacking to support the idea that life began and evolved by mere chance. The purpose of this chapter has been to present scientific data so that the student can draw his own conclusions about the subject of origins. Students are encouraged to study further the many books published about the origin of life.

In the next chapter, we will begin our study of the Earth and the kingdoms of biology.

LIFE PRINCIPLE



"Facts do not cease to exist because they are ignored."

—Aldous Huxley (1894-1963)
English novelist and essayist

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