FORENSIC SCIENCE COURSE: Student Review & Assignment

The goal of these sessions was to get students to learn how to test any theory of origins by using scientific laws, principles and methodologies (basic and forensic). Since I have worked with the State standards and am familiar with them, I used them as a basis for determining the "facts" of the case. I suggested that we view this "case study" (the origin of life) as we would any past singularity (unrepeatable event) in forensic science. The murder only happened once and if no one was there, it was not observed. The origin of life only happened once and it was not observed. So, in principle we have the same kind of problem—who or what caused the effect?

Students were taught the following in these sessions:

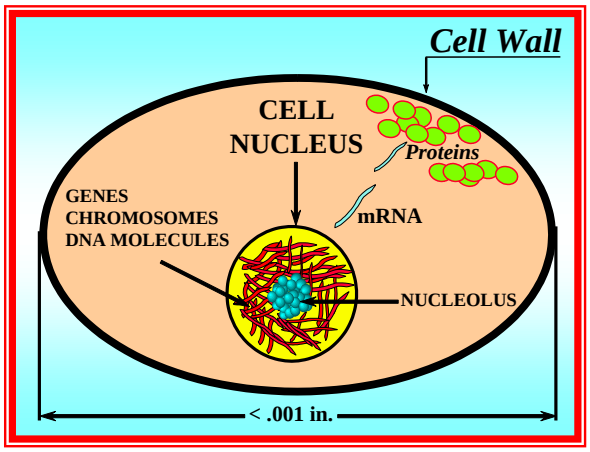
1. All relevant data (facts) must be gathered apart from opinion.
2. Applicable principles and laws are identified with respect to the fields of knowledge.
3. Interpret the data within the boundaries of applicable scientific laws.
4. Formulate a hypothesis, guided by the principles involved in the scientific method.
5. Test the hypothesis to see if it is a valid explanation of the phenomenon being studied.
6. Check any given theory to see which one best fits the hypothesis you have developed.

Student Study Guide:

1. All Relevant Data (Facts) Must Be Gathered

Data from the following courses of study will be included in this investigation:

Course: Biology & Applied Biology/Chemistry II
Topic: Biochemistry / **Standard:** Explains the structure of DNA
8.1 Describes the double-helix model.



Looking inside the cell wall we can see *proteins*, which are the fundamental components of all living cells and include many substances, such as enzymes, hormones, and antibodies. These components are necessary for the proper functioning of an organism. Next, notice that the cell nucleus contains the nucleolus and an essential molecule called *deoxyribonucleic acid* (DNA). The *nucleolus* is a small, typically round, granular body composed of protein and ribonucleic acid (RNA). DNA, combined with protein, is organized into structural units called *chromosomes*, which usually occur in identical pairs. The DNA molecule forms the infrastructure in each chromosome and is a single, very long, highly coiled molecule subdivided into functional subunits called *genes*.

The sub-discipline of molecular biology is referred to as *Information Theory* (IF). IF concerns itself with the sum and substance of biology in that it seeks to describe the data storage and retrieval systems in biological entities. With respect to the kind of information that was discovered in DNA, molecular biologists classify it as mathematically equivalent to that of a written language. Information scientist Herbert P. Yockey explains:

> The statistical structure of any printed language ranges through letter frequencies, digrams, trigrams, word frequencies, etc., spelling rules, grammar and so forth. . . . It is important to understand that we

are not reasoning by analogy. The sequence hypothesis applies directly to the protein and the genetic text as well as to written language and therefore the treatment is mathematically identical.[1]

Topic: Continuity of Life / **Standard:** Relates the continuation of life to the cell's chemical code.
9.2 Evaluates the diversity of life: a. mutations in DNA, b. natural selection

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The following information is cited from the National Academy of Science website:

Natural Selection: Darwin proposed that evolution could be explained by the differential survival of organisms following their naturally occurring variation—a process he termed "natural selection." Organisms in nature typically produce more offspring than can survive and reproduce given the constraints of food, space, and other environmental resources. If a particular off spring has traits that give it an advantage in a particular environment, that organism will be more likely to survive and pass on those traits.

Mutations in DNA: Genetic variations result from changes, or mutations, in the nucleotide sequence of DNA. Such changes in DNA now can be detected and described with great precision. Genetic mutations arise by chance. They may or may not equip the organism with better means for surviving in its environment. But if a gene variant improves adaptation to the environment, the organisms carrying that gene are more likely to survive than those without it. Although the genetic variation on which natural selection works is based on random or chance elements, natural selection itself produces "adaptive" change.

Species: Scientists have gained an understanding of the processes by which new species originate. A new species is one in which the individuals cannot produce viable descendants with individuals of a preexisting species. The split of one species into two often starts because a group of individuals becomes geographically separated from the rest. Once isolated, geographically separated groups of individuals become genetically differentiated as a consequence of mutation and other processes, including natural selection.

Topic: The Theory of Evolution: Origins of Life / **Standard:** Describes and applies concepts of origins.
12.2 Compares micro and macro-evolution. 12.3 Explains environmental changes effect on natural selection.

Micro and Macroevolution: Two phases of the same theory of origins that explains all varieties of life forms as emanating from a single cell or "common ancestor" through chance mutations (microevolution) of the genetic information system and natural selection.[2] These small successive microevolutionary changes came about by random genetic variations initiated by a changing environment. These changes exerted various pressures on the organisms, which in turn prompted them to mutate in order to survive.

Gradualism: Over very long periods of time (millions of years) the most adaptable organisms would evolve and survive (survival of the fittest). Survival was accomplished in certain organisms by surpassing the natural biological limits with respect to their species and giving rise to a new species[3] (macroevolution). According to gradualism, all life forms resulted from a series of accumulated microevolutionary changes.

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[1] Herbert P. Yockey, "Self Organization, Origin-of-life Scenarios and Information Theory," *Journal of Theoretical Biology*, Volume 91, 1981, 16. [A *Markov process* is a phrase used in the discipline of Statistics. It concerns itself with analyzing a succession of events within certain parameters, each of which is determined by the event immediately preceding it. This process was named after the Russian mathematician, Andrei Markov (1856-1922)].

[2] Natural selection, according to Darwin, is the process by which plants and animals adapt to a changing environment over a long period of time and that eventually this process gives rise to organisms so different from the original population that new species (see next footnote) are formed (*Oxford Dictionary of Biology* (New York: Oxford University Press, 1996) 338).

[3] The term *species* in biology means, "A category used in the classification of organisms that consist of a group of similar individuals that can usually breed among themselves and produce fertile offspring" (*Oxford Dictionary of Biology* (New York: Oxford University Press, 1996) 477).

Punctuated Equilibrium: The most recent variation of the theory of evolution was proposed by Stephen Jay Gould (paleontologist and former professor of biology at Harvard University). Gould's colleague, Niles Eldredge (paleontologist at the American Museum of Natural History in New York City), helped him to develop this alternate theory. Both men acknowledged that the observational evidence (fossil remains of a species in transition) predicted by the theory of gradualism was not evident. Gould said, "The extreme rarity of transitional forms in the fossil record persists as the trade secret of paleontology. The evolutionary trees that adorn our textbooks have data only at the tips and nodes of their branches; the rest is inference, however reasonable, not the evidence of fossils.[4] This fact prompted Gould and Eldredge to an alternative explanation of macroevolution called *punctuated equilibrium* (PE).

Gould and Eldredge have suggested that macroevolution happened over very short periods of geological time (usually hundreds to thousands of years) as opposed to millions of years. Gould said,

> Paleontologists have paid an exorbitant price for Darwin's argument. We fancy ourselves as the only true students of life's history; yet to preserve our favored account of evolution by natural selection we view our data as so bad that we almost never see the very process we profess to study. . . . The history of most fossil species includes two features particularly inconsistent with gradualism:
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> 1. *Stasis.* Most species exhibit no directional change during their tenure on earth. They appear in the fossil record looking much the same as when they disappear; morphological change is usually limited and directionless.
>
> 2. *Sudden appearance.* In any local area, a species does not gradually appear by the steady transformation of its ancestors; it appears all at once and "fully formed" . . .
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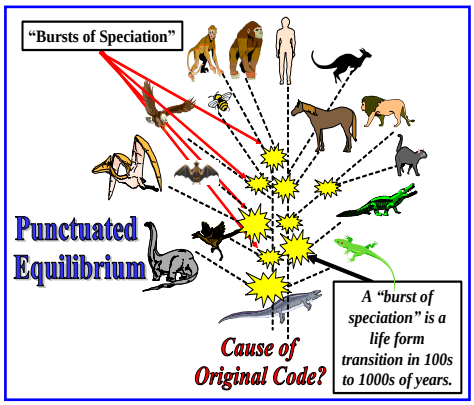
> Lineages change little during most of their history, but events of rapid speciation occasionally punctuate this tranquility. Evolution is the differential survival and deployment of these punctuations. (In describing the speciation of peripheral isolates as very rapid, I speak as a geologist. The process may take hundreds, even thousands of years; you might see nothing if you stared at speciating bees on a tree for your entire lifetime. But a thousand years is a tiny fraction of one percent of the average duration for most fossil invertebrate species—5 to 10 million years. Geologists can rarely resolve so short an interval at all; we tend to treat it as a moment). [5]



Course: Earth Science
Topic: The earth's history / **Standard**: Distinguishes the principles of uniformitarianism [in geology, a deduction based upon the principle of analogy], superposition and fossil correlation.
21.5 Models the Geologic Time Scale. 21.6 Cites the Geologic Time Scale from Cambrian to the present.

The Precambrian time period, in geology, is the earliest and largest division of time for which rock strata are recognized. This era is taken to include the entire time interval beginning with the formation of the solid crust of the earth and ending when life in the seas had begun to flourish. It is the span of time preceding the *Cambrian* period and characterized by the appearance of primitive forms of life. The first evidence of invertebrate[6] animal life appears with startling suddenness in the Cambrian period. The general public became aware of this event primarily through a *Time* magazine cover story,

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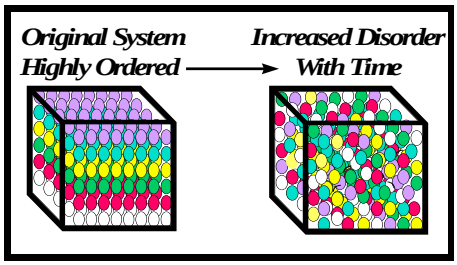
[4] Stephen Jay Gould, *The Panda's Thumb* (New York: W. W. Norton & Company, 1982), 181 (emphasis added).
[5] Stephen Jay Gould, *The Panda's Thumb* (New York: W. W. Norton & Company, 1982), 181-184.
[6] An animal, such as an insect or a mollusk, that lacks a backbone or spinal column; not a vertebrate. A vertebrate has a backbone or spinal column and includes fishes, amphibians, reptiles, birds, and mammals.

543 million years ago, in the early Cambrian, within the span of no more than a million years, creatures with teeth and tentacles and claws and jaws materialized with the suddenness of apparitions. *In a burst of creativity like nothing before or since*, nature appear to have sketched out the blueprints for virtually the whole of the animal kingdom. This explosion of biological diversity is described by scientists as biology's *Big Bang*.

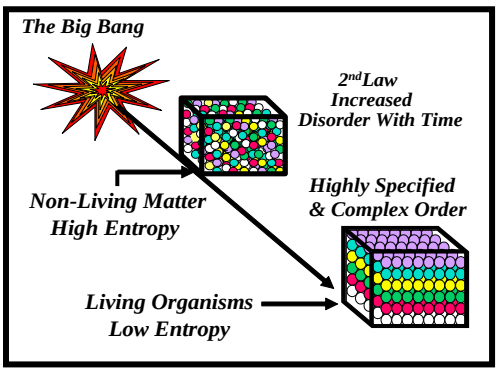
Over the decades, evolutionary theorists beginning with Charles Darwin have tried to argue that the appearance of multi-celled animals during the Cambrian [period] merely seemed sudden, and in fact had been preceded by a lengthy period of evolution for which the geological record was missing. But this explanation, while it patched over a hole in an otherwise masterly theory, now seems increasingly unsatisfactory. Since 1987, discoveries of major fossil beds in Greenland, in China, in Siberia, and now in Namibia have shown that the period of biological innovation occurred at virtually the same instant in geological time all around the world. . . . It was during the Cambrian (and perhaps only during the Cambrian) that nature invented the animal body plans that define the broad biological groupings known as phyla, which encompass everything from classes and orders to families, genera and species.[7]

Course: Science, Technology and Society Laws Applied
Topic: Environment / **Standard:** Analyzes ecosystem structure in thermodynamic terms
5.7 Identifies the energy loss in nature systems. 5.8 Identifies increasing entropy in natural systems.

One way to understand the effects of entropy on a closed system is to imagine finding a sealed container with rows of marbles compiled in a highly organized manner (8 across x 6 high x 5 deep as depicted by the left container in this illustration). This container is characterized by low entropy (low disorder). If we took the container and started to shake it over a long period of time, it may resemble the container portrayed on the right—characterized by high entropy (high disorder). In a similar manner, all natural systems are ultimately affected by energy loss as described by increasing entropy.



The DNA molecule is a "natural system" and we must be able to understand the effects of entropy on it. Although it is an open system with respect to energy input from the sun and the environment, we must also account for how entropy is related to the information content of the DNA molecule with respect to time, energy, and natural forces. The 2nd law of thermodynamics measures the level of disorder (entropy) in a system. The reciprocal function of the 2nd law, the law of specificity (1/entropy), is also used to measure the degree of order produced in a system (specificity).



Once the relevant facts have been gathered (step 1) and the applicable principles and laws identified, then rational inferences can be made and the data is analyzed, within the boundaries of those laws and principles. If no fallacies of thought have been committed a hypothesis can be formulated with respect to the scientific method and check against competing origin of life theories.

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[7] J. Madeleine Nash, "When Life Exploded," *Time*, December 4, 1995, 49-56 (For more information on the Cambrian Explosion, see http://www.pbs.org/wgbh/evolution/library/03/4/l_034_02.html).