TEACHING SCIENCE OF ORIGINS

TEACHING ORIGINS IN HIGH SCHOOL SCIENCE:

RATIONALE AND CURRICULUM UNIT

By

JACK D. WESTERINK, B.Sc.

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AUTHOR: Jack D. Westerink, B.Sc. (University of Guelph)

SUPERVISORS: Dr. D.A. Humphreys and Dr. S. Najm

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ABSTRACT

Teaching science involves more than teaching facts, concepts, principles and theories. Science educators also have a professional obligation to expose students to the values associated with those theories. People make decisions on value-laden, scientific questions from the perspective of their own world view. There should be room in our science curriculum to allow the student to form a personal position on the issues of our day after a fair presentation of the full range of alternatives. Even though the student may already have a firm position on the issue in question, the exercise will foster an understanding of the views of others and promote tolerance for those who differ. One of these issues is that of the origin of life.

The objective of this project is to develop a rationale for teaching the full range of alternatives in the science classroom, and to provide a curriculum unit as a resource for teachers who want to give a balanced treatment of the issue in question.

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TABLE OF CONTENTS

Introductory Statement

This project attempts to explore different ways in which the world of life may be perceived in terms of origins. Although the course unit provided was developed for inclusion in a high school science course, those aspects which are of a sociological nature, e.g. "scientific creationism", should be identified as such and are better included in courses other than science courses. The project presents conflicting opinions about origins derived from philosophies emanating from different segments of society. To the professional biologist, it may be instructive in its presentation of alternative viewpoints, some of which are clearly in opposition to those generally held by professional biologists, and some of which are outside the realms of science.

CHAPTER 1

Theories of Origins and World-views

When we begin to consider teaching a unit of study in the high school science program in the public school system on the origin of life, we must determine what constitutes an acceptable theory of origins that merits our attention. What characteristics must a theory of origins possess in order to be considered adequate for presentation to the science student?

Karl Popper contends that a valid scientific theory must be testable by experiment against observable, repeatable phenomena. A scientific theory must be rejected as soon as it has encountered a falsifying instance. He says, "I shall admit a system as empirical or scientific only if it is capable of being tested by experience. These considerations suggest that not the verifiability but the falsifiability of a system is to be taken as a criterion of demarcation" (Popper, 1968, p. 40). Observations which agree with the predictions of a theory do not establish the theory, but they serve as corroborating instances. A theory is corroborated whenever it passes a test. The degree of corroboration depends on the severity of the test.

The problem with Popper's criterion is threefold. Firstly, theories of origins rarely stand alone, but are part of a complex web of other theories. Seldom will there be a direct contradiction between a theory and observations. At best there may be a contradiction between an observation and the whole web of the scientist's beliefs. "It is then up to him (the scientist) to decide which of his beliefs to surrender. But for answering that question, the falsification rule does not apply" (Wolterstorff, 1984, p. 43). Secondly, theories of origins are not experimental theories, and thus falsification does not apply. On Popper's demarcation criterion, origin theories are not scientific. It is possible to test parts of a theory of origins, but we do not know if the results from these experiments tell anything about the way life originated. Thirdly, theories of origins are so broad that almost any data can be accommodated. Therefore, these theories are difficult to refute. Popper even goes so far as to say that no strict disproof of a scientific theory is possible anyway, because experimental results can always be challenged. Popper's demarcation criterion does not help us decide which of the origin theories we should consider.

Charles Thaxton states that an acceptable scientific theory must be able to pass the following three tests: (1) its ability to explain what has been observed; (2) its ability to explain what has not been observed; and (3) its ability to be tested by further experimentation and to

be modified as required by new data. These tests are valid only if there is some pattern of recurring events against which the theory can be checked and falsified. For this reason, Thaxton makes a distinction between operation science and origin science. Theories that are concerned with the recurring phenomena of nature he calls operation theories. Origin science is concerned with a single particular event in the past. Origins cannot be repeated for experimental tests. "In the customary language of science, theories of origins cannot be falsified by empirical test if they are false, as can theories of operation science. The best we can ever hope to achieve with wrong ideas about origins is to render them implausible" (Thaxton, 1986, p. 204). Thaxton suggests the principles of causality and uniformity be used to judge the plausibility of origins science. Causality is the means that explain the occurrence of a given event. Uniformity is the cause-effect relationships that we can observe today and extrapolate with some measure of plausibility into the past or future. "What makes views of abiogenesis legitimate as origin science then is the legitimacy of the cause-effect reasoning and the principle of uniformity" (Thaxton, 1986, p. 211).

John N. Moore has three criteria for recognizing acceptable scientific theories which are very similar to Thaxton's, with the exception that he uses different labels (Moore, 1983, p. 81).

Phillip Kitcher highlights three characteristics of good science as follows: (1) independent testability--testing auxiliary hypotheses

independently of the particular causes for which they are introduced; (2) unification--applying a small family of problem-solving strategies to a broad class of cases; and (3) fecundity--the theory opens up new and profitable lines of investigation. "In general, theories earn their laurels by solving problems--providing answers that are independently recognized as being correct--and by their fruitfulness" (Kitcher, 1982, p. 48,49). Kitcher recommends that a battery of tests be administered to theories to qualify them as being scientific. If a theory fails these tests, then it is pseudoscience. The tests are as follows: (a) do the theory's problem-solving strategies encounter recurrent difficulties in a significant range of cases, (b) are the problem-solving strategies an opportunistic collection of unrelated methods, (c) does the theory have close connections to auxiliary hypotheses that can be tested only in their applications, (d) is the theory unable to follow up on unresolved problems, and (e) does the theory restrict the domain of its methods from new areas of investigation. "If many or all of these tests are positive, then the doctrine (theory) is not a poor scientific theory. It is not a scientific theory at all" (Kitcher, 1982, p. 48, 49).

Thomas Khun, another historian of science, criticized Popper by showing that theories are often modified without being refuted, and that even refutations are often explained away (Khun, 1972, p. 124, 231-278). Alternative conceptions of science have been developed in the collected

writings of Toulmin (1953), Kuhn (1970), Hanson (1958) and Feyerbend (1975).

The federal district court in the Arkansas trial of McLean vs Arkansas Board of Education described the essential features of science as follows: (1) it is guided by natural law, (2) it has to be explanatory by reference to natural law, (3) it is testable against the empirical world, (4) its conclusions are tentative, i.e., are not the final word, and (4) it is falsifiable (Caudill, 1985, p. 13).

Notice that there is some agreement between what is an acceptable scientific theory and what is not. One common denominator seems to be testability or falsifiability.

History shows us that science owes its birth, at least in part, to religious faith--a faith that the world was a created, orderly entity and could be understood by rational minds. "It is surely one of the curious paradoxes of history that science, which professionally has little to do with faith, owes its origins to an act of faith that the universe can be rationally interpreted, and that science today is sustained by that assumption" (Eisley, 1961, p. 62). The foundation and purpose of the work of many scientists was the search for God in nature. Men like Nicolas Copernicus (1473 - 1543), Johan Kepler (1571 - 1630), and Galileo Galilei (1564 - 1642), were scientists who were Christians. "Their beliefs were an integral and fundamental part of their mental character" (Jaki, 1976, p. 47). Galileo

endorsed the idea that God could be seen in studying the book of nature, and this gave purpose to his scientific methodology. Christian scientists were guided by their belief that "nature bespeaks an intelligibility that derives from a transcendental source" (Jaki, 1974, p. 48).

Although science and religion are fundamentally different interpretations of the universe, each is valid in its own way. The intellectual revolution of the nineteenth century destroyed several fundamental principles upon which the theistic world-view rested for many people. "Everything, including religion itself, could be explained by reducing it to natural causes in the process of development. Appeals to the supernatural were hence a priori written out of the fields of scientific knowledge. By this standard, of course, the Bible had to go" (Marsden in Science and Creationism, Montagu, ed., 1984, p. 110).

The spiritual realm was methodically ignored by science. However, "science has not freed itself from religion and philosophy, it has only succeeded in ignoring the religious and philosophical foundation on which it stands" (Ream, 1972, p.75). Only the physical realm was considered because "scientific thought soon parted from theology, because no assumption is made concerning any force outside of or beyond natural measurable forces..." (Stanley, Beck, 1982, p.739). The connection between science and religion is not just historical, but also organic. "Scientific

theories of a period of time reflect the thinking and spiritual climate of that period of history" (Shute, 1961, p. 34).

R. Hooykaas suggests that modern science is to a large degree a product of the Judaeo-Christian influence. Hooykaas states that religion has exerted a healthy influence on the development of scientific thought. "What people thought about God (or the gods) influenced their conception of nature, and this in turn influenced their method of investigating nature, that is, their science" (Hooykaas, 1972, p.xiii).

Science often encounters questions that go beyond its purview. Origin theories very often lead the scientist into metaphysics, philosophy, and theology. Questions such as, "Did the universe have a beginning?"; "Did life arise on the earth by chance?"; and, "Where did the first animals come from?", are in fact very important to man, and the answers to these questions form his world-view.

Let me cite two examples to suggest that our metaphysical views influence our scientific views. Louis Pasteur refuted spontaneous generation of life in 1864 with his well-known experiments. He proved that bacteria arise from other bacteria carried in the air, and do not arise spontaneously from broth. Teachers often cite this example to their students to illustrate the triumph of scientific reasoning over mysticism. In fact, it was a refutation of the naturalistic view of the spontaneous generation of life as opposed to the alternative of special creation. "We

had a metaphysical commitment to naturalism in the face of contradictory evidence" (Wald, 1979, p.47).

Another example is the well-known fact that the sequence of haemoglobin genes on chromosomes 11 and 16 is shared by all primates. To the atheist, as well as the theistic evolutionist, this points to a common ancestor. To both the progressive and scientific creationist, the comparison is unacceptable because of the underlying metaphysical assumption that man is nothing but a biological phenomenon. Their metaphysical assumption is that man is also a moral and religious being. When these attributes enter into the comparison, common ancestry is no longer an obvious conclusion (van der Meer, 1987, personal communication).

In the science of palaeoanthropology, data have often been so sparse that theory heavily influenced the interpretations of these data. "Theories have, in the past, clearly reflected our current ideologies instead of the actual data" (Pilbeam, 1978, p.45). "Fossils have often been described in terms of how they seem to fit a preconceived gradualistic scheme rather than in terms of their fundamental attributes" (Stanley, 1981, p.139).

It is the duty of the instructor to introduce students to the above-mentioned scientific criteria for the acceptability of origin theories. But, it is also important to point out the wider historical, cultural, and metaphysical factors that have played a role in the development of

scientific criteria and the process of judging the acceptability of scientific theories.

To develop my curriculum strategy for teaching acceptable origin theories, it is helpful to classify various world-views and their connection to origin theories. Canadian society is a mixture of many nationalities, religious groups, and cultures. It is a multicultural society. Therefore, we can expect to find different world-views represented in the classroom. It would be beneficial for students to be exposed to the world-views of others, because it should help them become aware of their own positions and why they hold them, and of the need for tolerance of the positions of others. "I am now convinced that for a person to be fully conscious intellectually, he should not only be able to detect the world-views of others, but be aware of his own, why it is his, and why in the light of so many options he thinks it is true" (Sire, 1976, preface).

What is a world-view? It is a set of presuppositions a person has about the basic make up of the world. Wolters defines it as "the comprehensive framework of one's basic beliefs about things" (Wolters, 1985, p.2). Everyone has a world-view, even though one cannot always articulate it clearly to others. Basic beliefs emerge quickly when current issues raise practical questions that demand a positional response. A world-view provides answers or responses to these questions. Our world-view functions as a guide or compass for our life.

In our pluralistic world, there are many different world-views. They fall into six basic categories:

(1) Christian theism
(2) Deism
(3) Naturalism
(4) Existentialism
(5) Eastern pantheistic monism
(6) New consciousness

There are variations of these seven positions, but they can be classified under one of these broad categories. What we are interested in are the origins positions these world-views take.

Christian theism teaches that God created the universe out of nothing to operate with a uniformity of cause and effect in an open system (Sire, 1976, p.26, 27). God spoke the universe into existence without any prior matter. The universe has meaning and purpose, and reflects the order of the creator. God controls the operations in the universe as it unfolds in a directed pattern. The theistic world-view was the predominant view in the western world until the end of the seventeenth century. Today there are still scholars in every academic discipline who hold the theistic world-view.

Deism proposes "a transcendent God, as a first cause, who created the universe but then let it run on its own. The cosmos God created is in a closed system...no miracle is possible" (Sire, 1976, p.49). The deistic God does not interact with His creation through special events

or miracles. The deistic philosophy arose in the late seventeenth century, and still enjoys some popularity today. The deist asserts that God does not need to tinker with His creation; it is self-sustaining. The natural laws God set into motion are an independent force in maintaining creation.

Naturalism developed out of deism in the eighteenth century and grew to maturity in the twentieth century. The naturalistic world-view dominates in many educational institutions today. Naturalism is the basic philosophy from which most modern scientific research proceeds today. One of the tenets of naturalism is that matter exists eternally. God does not exist. "The cosmos exists as a uniformity of cause and effect in a closed system" (Sire, 1976, p.72). The cosmos itself is eternal because it is composed of matter. The universe is not open to reordering from the outside. The unique difference of naturalism from theism and deism is in its denial of the existence of a God.

Existentialism developed as a response to nihilism. Two forms of existentialism are popular today--atheistic existentialism and theistic existentialism. Atheistic existentialism affirms all of the propositions of naturalism except those relating man to the cosmos. Reality for man exists in two forms--subjective and objective. The subjective world of man viz the mind, consciousness, awareness, etc. cannot be penetrated by science and logic. The objective world can be known through empirical scientific investigation. "Existentialism emphasizes the

disunity of the two worlds and opts strongly in favour of the subjective world" (Sire, 1976, p.103). Man is the only being in the universe that is believed to be self-conscious and self-determinate. Naturalism differs from existentialism in that it unites the subjective and objective worlds. In this way human beings are objects or parts of the universe. The existentialist does not limit a person's significance to the objective world, but stresses the consciousness of the subjective world over which one has complete control.

Theistic existentialism accepts all of the presuppositions of theism except that it is human-oriented. "Man is a personal being who, when he comes to full consciousness, finds himself in an alien universe; whether or not God exists is a tough question to be solved not by reason but by faith" (Sire, 1976, p.115). This view emphasizes the place in which man finds himself when he first comes to self-awareness. The theistic existentialist believes that the data will never be available to prove that God exists. Therefore, it is up to man to step forth and choose to believe or not to believe. The existential version of theism is much more a special set of emphases within theism than it is a separate world-view. One major difference is that theistic existentialism holds that the Bible is historically untrustworthy. "Meaning is created in the subjective world, but it has no objective referent" (Sire, 1976, p.125). A theist challenges the theistic

existentialist to take the implications of abandoning historical fasticity as being religiously important more seriously.

Eastern pantheistic monism is the root world-view which underlies Hinduism, Buddhism, Transcendental Meditation, the Upanishads, and the Divine Light Mission. It holds that "Atman is Brahman", that is, "the soul of man is the soul of the cosmos" (Sire, 1976, p.132). Man is God, and God is the cosmos or ultimate reality. In the East, to know reality is to pass beyond distinction, to realize "the oneness of being one with the all". The pantheistic view of God is that He is impersonal, and therefore man is impersonal also. In theism, personality is one of the chief attributes of God and man, separating them from the rest of the creation.

Finally, the new consciousness world-view or "New Age thinking" is one of the most recent developments. It borrows from all other world-views. Almost all postulates are valid. "They accept the languages of all systems of reality: sorcery and science, witchcraft and philosophy, drug experience and waking reality, psychosis and normality, and they understand them all to be equally valid descriptions of reality" (Sire, 1976, p.202). Reality is some type of personal experience. There is no such thing as one true type of experience. Every experience is valid. The new consciousness view denies the existence of a transcendental God;

therefore, it is atheistic. It has much hope for the evolutionary development of man to bring about transformation.

Basically, views on origins can be categorized into five groups:

1. atheistic evolution
2. theistic evolution
3. progressive creation
4. scientific creation
5. panspermia

Although there may be many variations of these five groups--atheistic evolution can be divided into neo-Darwinism and punctuated equilibrium theory, and creationism can be divided into young earth creationism and old earth creationism--these five categories cover all the basic views.

Atheistic evolution holds that all life, including all the living flora and fauna upon the earth, has arisen spontaneously from non-living matter through a series of increasingly complex chemical reactions. The simple life forms changed to complex forms through natural processes, finally pinnacling in man. Living things are slowly, inevitably continuing to evolve. Matter is the only eternal thing in the universe. There is no God or supreme being. Evolutionary science includes the scientific evidences and related inferences that indicate:

1. emergence of the universe from disordered matter by naturalistic processes, and emergence of life from non-life
2. the sufficiency of mutation and natural selection in bringing about development of present living kinds from simple earlier kinds

3. emergence of present living kinds from simple earlier kinds by mutation and natural selection

4. emergence of man and apes from a common ancestor

5. uniformitarian geology and evolutionary sequence

6. an inception several billion years ago of the earth and somewhat later of life (Caudill, 1985, p.1)

Theistic evolution is the view that abiogenesis occurred through evolution, but that a creator God or supreme being was instrumental in forming the initial matter and the laws of nature. Those who hold this view accept the processes of organic evolution as the method God used to create humans. They are the "Christian Darwinists". They see God's providential hand behind the process of mutations selected by the favourable environment which gives living things the ability to leave more offspring and become the dominant variety (Pun, 1987, p.17). This view is a compromise between Christian theism and atheistic evolutionism. There are many variations in this view, but the common principles are the evolutionary process, and a supreme being.

The term progressive creationism was coined by Bernard Ramm in 1954. This view states that God is involved in His creation in a dynamic way by shaping the variation of the biological world through mechanisms such as natural selection. It stresses the historicity of Adam and Eve as an extraordinary act of God not explainable by natural causes.

It focuses on the unity of God's revelation in nature as well as in Scripture. Progressive creationism is somewhere in the middle of the spectrum between theistic evolutionism and recent creationism (Pun, 1987, p.17). Therefore we have evolution with a purpose, being controlled and directed by God through periodic creative acts and interventions.

The term scientific creationism refers not to the Genesis account of creation, which is a religious text, but rather to research resulting in scientific evidence in support of the theory of created matter and life, evidence for the sudden appearance of complex life forms, evidence of a young earth. Perhaps the leading creationist organization is the Institute for Creation Research (ICR) in San Diego. Other organizations include the Creation Science Research Center (CSRC) in San Diego, and the Bible Science Association of Canada. Creation science is the scientific evidence and related inferences that indicate:

1. sudden creation of the universe, energy, and all of life from nothing (ex nihilo)
2. the insufficiency of mutation and natural selection in bringing about development of all living kinds from a single organism
3. changes only within fixed limits of originally created kinds of plants and animals
4. separate ancestry of man and apes
5. explanation of earth's geology by catastrophism, including the occurrence of a worldwide flood
6. a relatively recent inception of the earth and living kinds (Caudill, 1985, p.9)

The literature of the scientific creationists is often dualistic with respect to explaining the origin of life; creation and worldwide flood, and atheistic evolution. Scientific creationists maintain that the original kinds of plants and animals have been stable, resulting in gaps in the fossil record between different kinds of organisms. The sudden appearance of plants and animals in the fossil record, as well as the existence of genetic barriers to speciation, are taken to support this view. The second law of thermodynamics is used to deny the evolution of the earth from a disordered universe and the evolution of life from non-living molecules (Bird, 1979, Impact Series 69).

Panspermia is the view that life came from somewhere else in the cosmos. Germs of life dropped to the earth from interplanetary space in the form of viable spores or microorganisms. Perhaps the spores were brought to the earth from outer space on the surface of meteorites that crashed into the earth. This view, however, does not really answer the question of first origins, but moves the answer into outer space. "In recognition of the fact that panspermia offers no theory of origins, it must implicitly assume chemical evolution on some other locale in the cosmos where conditions are more favourable than on earth" (Thaxton, 1986, p.193). The failure, so far, to find viable life spores on the moon or traces of life on other planets has been a severe blow to the theory of

panspermia. "So far, each successive planetary space probe has pushed us closer to the conclusion that life on the planet Earth is a unique occurrence within the planetary system of our sun" (England, 1972, p.47).

As we have briefly examined the fundamental world-views and theories of origins, we can analyze them to make correlations between them. First of all, we notice that Christian theism and scientific creationism both require a creator. Some theists hold to progressive creation, others support theistic evolution. Deism complies with the theory of theistic evolution as well. God is needed for the creation of the universe and all of life, but He has left it to progress on evolutionary principles and mechanisms. Since deists believe that God made this system perfectly, there is no need for interference from time to time.

Atheistic evolution holds the same fundamental principles on origins as the naturalistic world-view. God's existence is denied, and matter is the only thing that is eternal. Atheistic existentialism and atheistic evolution compare closely. All of the evolutionary principles are accepted and recognized in this world-view. Theistic existentialism agrees with either theistic evolution or progressive creation. Both views hold to the existence of God or a supreme being. God's existence cannot be proved, but is accepted by faith. Whether or not God is responsible for creation is not known, nor can it ever be known.

Eastern pantheistic monism could accept the principles of atheistic evolution. There is no separate being called God. God is everything. Since the theory of evolution proposes that all living things have a common ancestry in the primordial soup of the earth, then all are part of the one same reality. All things are one. Theistic evolution is not acceptable to the pantheist because the theist separates God from creation. Finally, the new consciousness view conforms to the atheistic evolution principles as well because both views deny the existence of God. For the new consciousness follower, evolution is the hope for better things tomorrow in a more highly developed earth and a more advanced man.

In summary, science teachers have an obligation to expose students to the basic metaphysical commitments that people have because it greatly affects the manner in which these people judge origin theories. "The answers that scientists give, implicitly or explicitly, to such issues depend upon philosophical categories that are themselves decisively shaped by a deeper-lying world-view" (Wolters, 1985, p.97). The question is, does the science education we provide for students today prepare them for making a value decision on origins? Can our students differentiate between plausible and implausible theories of origins? Exclusive presentation of any one theory at the expense of other plausible theories violates the principle of neutrality.

MATCH BETWEEN WORLD-VIEW AND ORIGIN THEORY*

WORLD-VIEW	ORIGIN THEORY
Christian Theism 1)	Scientific Creation 1)
Theistic Existentialism 1)	Progressive Creation 2) 3)
Deism 1) 3)	Theistic Evolution 2)
Naturalism 2)	
New Consciousness 2)	
Eastern Pantheistic Monism 2)	
Atheistic Existentialism 2)	Atheistic Evolution 1)

*Mutually exclusive world-views and origins theories are labelled with common numbers.

The question of origins is part of every world-view. One's world-view is a plumb line, guiding the choice of one's view of origins. The correlation between the two is quite varied. The key point is that each student should be able to place himself somewhere in the matrix, and perhaps gain a better understanding as to why he holds to a particular view and gain an appreciation for the views of others. The Ministry of Education for Ontario has prepared a curriculum guideline for science teachers that states, "The Province of Ontario has a tradition of providing opportunities for people of various cultural, linguistic, racial, and religious

origins to build a life together as Canadians. Schools are to demonstrate their commitment to this principle at all times" (MOE, 1987, p.34). The Values Clarification or Cognitive Developmental methods of teaching values (presented in Chapter 2) will aid the science teacher in presenting "all topics in a sensitive and scientific manner and do whatever they can to ensure that all students are both respected and respectful" (MOE, 1987, p.34).

CHAPTER 2

Moral Education and Teaching Origins

Moral education has been a part of education since the time of the Greek philosophers. North American schools were built around philosophies of educators such as John Dewey, who saw moral education as being central to the school's mission. "The child's moral character must develop in a natural, just, and social atmosphere. The school should provide this environment for the child's moral development" (Dewey, 1934, p.85). Over the years, there has been an erosion of the school's efforts to promote certain values and to aid the student in thinking about moral issues. The immigration of many Jews and Catholics from Europe to North America resulted in conflicts regarding the Protestant moral theology in the public school system. "The actual pluralism of American society made it, as a matter of equity, inappropriate to promote sectarian religious views in public institutions. The alleged neutrality of the new sciences was a theoretical model that better fit the demands of a pluralistic society than did approaches based on religious commitments" (Marsden in

Science and Creationism, Montagu, editor, 1984, p.103). Teachers began to deal with moral issues very carefully, so as not to offend anyone, and tried to simply present the facts, letting the students make their own moral decisions.

The public school's pluralistic character of religious, ethnic, and racial groups presents the teacher with a varied set of values, world-views, and types of moral behaviour. Private and parochial schools have a much clearer role in providing moral education, because parents often choose these schools for the particular values they advocate. Whatever role the public school takes in moral education, it must be free of indoctrination. It is a fact that the school cannot avoid being involved in the moral life of the students. It is not possible for the school to instruct children six hours a day, 185 days a year, from the sixth to the eighteenth year of age, and not affect their moral thinking and behaviour. "Moral education is an inevitable role of the schools. For the educator, it comes with the territory" (Purpel, 1979, p.9). Whenever we succeed in teaching new knowledge, we influence students' values.

A major purpose of education is to help students become effective citizens who can intelligently assess some of the issues in today's society. Many of these issues relate to the use of scientific technology to modify our present life. "Studying issues in the science classroom provides

students with opportunities to think clearly and logically and to deliberate in an open and honest manner" (MOE, 1987, p.51). Due to the fact that many issues contain important moral components, students have the opportunity to consider the ethical implications of various points of view. Science as a subject often involves issues, morals, and beliefs. Although many issues, morals and beliefs cannot be tested empirically, they often relate closely to science applications. "Issues in science should not be avoided solely because they are issues. They should be included in science education in order to raise student awareness and to search for solutions" (MOE, 1987, p.52). Issues result from differences of opinion about what is true, or what action should be taken. The following are examples of issues that are met in the science classroom:

> If population is not controlled, what problems are likely to arise? How should population be controlled?
>
> How should energy conservation be accomplished?
>
> How should we deal with the increasing problem of waste disposal?
>
> Should we be building more nuclear power plants? Why or why not?
>
> To what extent should pesticide use be regulated?
>
> How valid is the theory of biological evolution? What other explanations are there for the origin of life?
>
> How does one define life and when does death occur?
>
> What determines whether drugs or alcohol should be legal or illegal?

Should genetic engineering be supported or opposed?

What ethics should govern the distribution of food supplies in the world?

The Ontario Ministry of Education gives some guidelines to teachers in handling sensitive issues such as origins in the classroom. In the Program Outline and Policy for Intermediate and Senior divisions, 1987, it suggests the following principles:

1. Introduce sensitive issues only at times when the maturity level of the students is appropriate;

2. Discuss the strengths, limitations and tentative nature of theories;

3. Introduction of two opposing views often heightens the interest of students and results in a more open-ended approach to the topic;

4. There should be a sound rationale for including a sensitive issue in the science program;

5. The teacher should ensure a sensitive and rational treatment of the issue;

6. Background information on an issue should reflect the different perspectives held by religious, racial, national or cultural groups;

7. The teacher and the students must learn to respect religious beliefs or cultural practices for their intrinsic value;

8. In evaluation of student achievement, the basis must be on organization, factual knowledge, reasoning, readability, and overall presentation and not on belief or opinion, particularly if it differs from that of the teacher.

The question is, "What are the criteria for acceptance of a scientific theory? In Chapter 1, I outlined some of the criteria for plausibility of scientific theories of origins. I also discussed the historical evidence that shows that metaphysical or religious considerations play a role in decision-making. This role is not recognized by many practising scientists, but it is recognized by historians and philosophers of science. My suggestion is that theories of origins be taught with special emphasis on the specific criteria for plausibility outlined in Chapter 1 and the organic connection with a world-view. Let the student form his own opinion, using the critical thinking skills he has been taught. "In training students to reason, we train them to be critical. We encourage them to ask questions, to look for evidence, to seek and scrutinize alternatives, to be critical of their own ideas as well as those of others" (Purpel, 1976, p.27).

We need to make our science students aware that scientists are influenced by their metaphysical presuppositions when they theorize on origins. Concepts of origins are developed on the basis of both scientific observations and metaphysical views. Once a metaphysical presupposition is adopted, it will shape--rather than be shaped by--our scientific observations. "On the whole, our metaphysical commitment has priority over our scientific common-sense beliefs such that if challenged, they yield to it rather than the reverse" (Hein, 1971, p.93).

Science teachers need to make students aware of the distinction between observed facts and the theories into which these facts are fit. One particular set of observations may agree with more than one theory. Observations take on different meanings when subjected to different interpretations.

It is difficult for science teachers to avoid the value-laden issue of origins because it is such a foundational premise in biology, geography, and other sciences. The books the student reads, the films shown in the classroom, the magazines, newspapers and journals available in the library, discussions with fellow students and teachers, all influence a student's viewpoint on origins. The student will be better equipped to recognize and distance himself from bias as he matures and develops higher levels of reasoning. It is therefore important to introduce this issue at an appropriate age level.

One approach is to provide opportunities for the student to discover what his own opinions are on origins. No attempt is made to influence a student's point of view, but all of the evidence is given, the varying interpretations of the evidence are presented, and the student is allowed to make up his own mind. This has become the most popular method for conducting moral instruction. It was developed by Raths, Harmin and Simon in 1966, and is called the Values Clarification method

(VC). All of the plausible theories of origins would be examined, provided they fulfilled the criteria for plausibility outlined in Chapter 1.

A second approach is to teach a specific process that a student should go through when making value decisions. The goal is to prevent the student from making irrational or emotional value decisions, and to encourage a reasonable and objective approach to value situations. This method resembles the Cognitive-Developmental method (CD) developed by Lawrence Kohlberg in 1975. First, the teacher presents all of the facts to the students in a fair and impartial manner. After critically examining the data and discussing them, the student makes up his own mind as to which theory of origins he chooses to value as his personal view.

The difference between VC and CD methodology is that CD attempts to expose the student to higher levels of moral reasoning than he has already attained, and encourages him to make his value decisions at that level.

A third approach is to teach the student a given set of values. The goal is to persuade the student into a particular viewpoint by presenting one side of the issue, or presenting the viewpoint in such a way as to favour the position taken by the instructor. Some instructors advocate the metaphysical position of atheistic evolution as the only rational choice to anyone who claims to be scientific, and do not present other theories as equally possible alternatives. In some cases, this may

amount to indoctrination. The democratic ideal is antithetical to any form of such indoctrination. A democracy is a society which sustains itself by the reasoned choices of its citizens, in the light of critical scrutiny of alternatives. The democratic ideal consists of free choice by free, informed persons. "The function of education in a democracy is rather to liberate the mind, strengthen its critical powers, inform it with knowledge and the capacity for independent inquiry, engage it in human sympathies, and illuminate its moral and practical choices" (Purpel, 1976, p.23). In traditional authoritarian societies, education is a process which embodies central doctrines which are not to be questioned. Education then deteriorates into an instrument for shaping the minds of the ruled in accordance with the favoured dogma of the rulers.

The values clarification (VC) approach to teaching life issues has become one of the most widely accepted methods in North American schools because the principles are easy to learn and do not require any special training or curricular materials. VC deals with life issues in an open and honest way so that teachers do not need to impose their personal views on students. The purpose of VC is simply to clarify one's values. No particular set of values is advocated, but the student is gently encouraged to form his own values and reflect on them. Values are very personal, because they are developed out of life experiences. These life experiences form guidelines for behaviour, and give direction to life. Since a person's

relationship to the world is not static, his values are always changing as a result of new experiences, and of a more mature way of interpreting those experiences.

VC asserts that values are established by a process called valuing. Seven basic criteria are proposed in order for a principle to be considered as a value. A value is a goal which is chosen freely, from a list of alternatives, after due consideration has been given to the consequences of holding that value. The student should prize, or be happy with the value choice he has made, and be willing to affirm his choice publicly. Finally, a value must be acted upon repeatedly so that it becomes entrenched.

There are eight or more categories of behaviour that a teacher should be aware of in order to help a student clarify his values. When a student expresses his goals or purposes, aspirations, interests, beliefs, convictions, attitudes, activities, and worries, there is an opportunity to guide the student into forming values out of them. It is important to avoid indoctrination in helping a student form values. If a student is coerced into making a choice, then what is chosen is not a value at all. It is important to the student that the choices which he makes are meaningful to him. Alternatives may require explanation in order to be understood by the student, but he should still be exposed to the full range of alternatives.

The VC strategy is to question the student in a way that causes him to reflect on the reasons for his goals, purposes, interests, etc.

He in effect considers what he has chosen to value and why. By verbalizing his views, the student is stimulated to clarify his thinking and behaviour, and thus clarify his views. This method places the responsibility for making decisions upon the student.

In order for the student to feel free to express himself, there must be a positive, accepting atmosphere. The teacher's role at this point in the discussion is to listen to what the student says, feels, or thinks. Strongly evaluative questions or critical comments by the teacher may destroy the open, trusting atmosphere, and will add the teacher's own views or judgments upon the student's choices.

If one is to employ the VC method in the science classroom in relation to origins, then all the plausible theories of origins should be presented, discussed, criticized and compared. The final choice is to be made by the student, not the instructor. The atmosphere in which the student makes his choice must be free from ridicule or criticism; otherwise factors such as peer pressure, or the instructor's personal bias will influence the choices made. The crucial criterion of VC is the idea of forming a personal view from alternatives. If there is only one view, one cannot make a choice. In order for the student to make a proper choice, the teacher should see to it that the alternatives have meaning for him. Therefore, the science teacher has to be knowledgeable in all plausible

theories of origins, so that he can make a proper and fair presentation to the students.

One disadvantage of the VC strategy is that it works best in one-on-one situations between teacher and student. Most of the VC situations arise without prior planning. VC is basically a technique that a teacher can use whenever the situation happens to arise. "The clarifying response is usually aimed at one student at a time, often in brief, informal conversations held in class, in hallways, on the playground, or any place else where the teacher comes into contact with a student who does or says something to trigger such a response" (Purpel, 1979, p.112). This fact makes it difficult to use VC in the planning of a curriculum unit on origins. But, it will be useful to employ VC as a method of evaluating the student's view on origins (see 7.3 in the Curriculum Unit).

The Cognitive-Developmental method (CD) was, according to Lawrence Kohlberg, first proposed by John Dewey. Jean Piaget also recognized four levels of cognitive development that correspond to Kohlberg's three levels of moral reasoning. Piaget called the first level of cognition the sensori-motor stage. From birth to about two years of age, children approach their environment by means of non-verbal thought. The second level, or pre-operational stage, is from two to about seven years of age, during which time children develop in their use and understanding of language. At stage three, approximately seven to eleven years of age,

children are moving toward more logical thought, however, they are limited only to logical operations related to their own personal experience. At the fourth and highest level of cognition, from age twelve to maturity, children learn to think abstractly. Kohlberg redefined and validated these Piaget stages empirically.

According to Kohlberg, the levels of moral reasoning are structural wholes that are arranged in an invariant sequence. Each level in the sequence includes the level below it and supersedes it. The first level, called the preconventional level, describes a type of behaviour that is motivated by biological or social impulses. Good and bad are identified with rewards and punishments. The second level, being the conventional, outlines behaviour which will usually fall into line with the accepted norm of the group. The attitude is one of conformity and loyalty to the group without any critical reflection on the group's values. The third and highest level of moral reasoning is the autonomous, postconventional or principled level. This type of behaviour is guided by individual thinking and reflection on morals that have validity. The person makes moral judgments in terms of universal principles that are applicable to all mankind.

It has been empirically proven by Kohlberg and others that students reject levels of moral reasoning below theirs, and can only comprehend messages one stage beyond their own level. The basic goal of CD is to promote movement to higher levels of moral reasoning. The

technique of CD is to employ the exposure to a higher level of reasoning than that of the student, and to discuss dilemmas which involve moral implications so as to disrupt the moral structure currently held by the student, and encourage movement to a higher level. In order for this to occur, the atmosphere of discussion of moral dilemmas must be free and open. Role playing may also be employed to encourage empathy or a change in viewpoint.

Pilot programs using the CD methodology have been developed for both elementary and high school levels (Clive Beck, 1976, pp.697-700). Usually the topics to be studied are selected by the teacher so that they will reflect student interests, backgrounds, stage of cognitive development, and relevance to the student's life situation. The reason for developing some basic ground rules and core content is to avoid free-wheeling and non-directive discussions. This method allows for freedom within a broad framework, and provides purpose and direction to the class.

Kohlberg has developed some evaluation techniques for the CD method. A pretest, post test, and one year after post test have been developed. In the test, an interview is held with the student in which a moral dilemma is proposed. The student's response to this dilemma will fall into one of three general areas of moral reasoning. If the student has moved up to a higher level of moral reasoning because of the efforts of the program, then the goal has been achieved.

The CD method involves a choice between two or more conflicting alternatives in a moral dilemma. Like VC, the CD approach to moral education stresses open Socratic peer discussions of value dilemmas. The CD approach opposes indoctrination of any type. To relate this to origins, it is important that the student has a choice in all of the relevant theories, and that an open, critical discussion of the options will help the student formulate his own choice. The teacher's own opinion or personal bias is neither stressed nor evoked as being authoritative.

The CD approach lends itself better to the planning of a curriculum unit on origins than the VC strategy. The difficulty with the CD method is that the instructor needs to be well trained to be able to identify the level of moral reasoning of the students, and has to plan curriculum that will encourage movement up to a higher level. In spite of the differences between VC and CD methods for moral development, both aim to sensitize people to values or moral issues, encourage critical thinking about these issues, and try to develop personal consistency and self-confidence in the judgments taken.

CHAPTER 3

Educational Theory and the Teaching of Origins

As we attempt to develop and teach a unit of study for high school biology courses on the topic of origins, we should examine educational theory to see how this unit might fit in. Every culture has certain concepts, principles and practices. It is the task of education to expose this cultural heritage to the students in order for them to function well. It is the task of curriculum planners to examine what knowledge is most important or essential, and which instructional methods to employ, in order to be successful.

Many have studied and written about cognitive learning. Some of the well-known learning theorists are Robert Gagne, Jean Piaget and Jerome Bruner. However important they have been in forming our approach to education, they lack significant empirical data from classroom learning. Many of the theories are based on stimulus-response (S-R) or operation-response (O-R) and have data from rats and pigeons to support them. "Much empirical data from classroom learning does not support S-R

or O-R theories, nor in fact have any substantial efforts been made to link S-R theories with learning theory" (Novak, 1977, p.69).

The educational theory that I wish to examine was developed by David Ausubel in his book Educational Psychology: A Cognitive View, 1988. There are several reasons why I have chosen this educational theory. Firstly, Ausubel himself was a science teacher, and he felt that the educational theory one uses has to be closely connected to the curriculum design if it is to be effective. Ausubel's theory explains how a student learns, what type of material is most fitting, and the most effective methodology to use. Many educational theories have little bearing on the type of material and the methodology by which it is taught. In other words, the theory may be fine, but it is never put into practice.

The second reason for choosing this theory is the specific order in which topics should be taught in a given course of study. Ausubel states that, "The most important factor influencing learning is what the learner already knows" (Ausubel, 1968, p.vi). It is important to identify the knowledge store that a student has that is relevant to what one hopes to teach. Ausubel calls this knowledge the subsuming concepts in the learner's cognitive structure. Storage of information in the brain is highly organized. Minor elements of knowledge (facts and records of events) are linked to larger more inclusive categories of knowledge (concepts or theories that describe relationships among the facts). As new experiences

and facts are obtained, they are linked to these all-inclusive concepts in a hierarchical framework. Each new fact or experience confirms or further develops these concepts, so that knowledge in subsequent learning is easier to relate to. Ausubel claims that concept development proceeds best when the most general and all-inclusive concepts are taught first, and then gradually more detailed and factual knowledge is presented. The larger concepts are then broadened and differentiated as one progresses downward through the curriculum. It is therefore very important for curriculum planners to identify the fundamental concepts and order them in hierarchical fashion. In a biology course, one of the broadest and all-inclusive concepts we could think of is the topic of origins. If this concept is dealt with first, more detailed concepts could follow. "One reason school instruction has been so ineffective is that curriculum planners rarely sort out the concepts they hope to teach and even more rarely do they try to search for possible hierarchical relationships among these concepts (Novak, 1977, p.86).

Rote learning is the acquisition of knowledge without any association to other knowledge in the existing framework of concepts. Hence it is essentially not really relevant to any previous experience or knowledge. Sometimes rote learning is necessary, e.g. telephone numbers, bank account numbers, license plate numbers, social insurance number, lock combinations. Rote learning is usually needed when an individual

acquires new information in an area of knowledge that he has never been previously exposed to, or which is unrelated to anything he knows. There is no connection to any existing concepts already in the cognitive structure.

Young children learn about the world around them through exploration and repeated testing of everything they see. They begin to form associations between experiences. "By school age, most children have an adequate framework of concepts to allow for meaningful learning to proceed (Novak, 1977, p.78). Most learning results from the visual or auditory input a child receives. The learning is meaningful if the incoming information can be related to something already experienced. Depending upon the history of experiences of the individual, concepts may be large and well developed, or they may be limited. The larger the concepts are, the more meaningful learning becomes. The smaller the concepts are, the more the learning approaches the rote style. "Rote learning and meaningful learning then is a continuum, not a dichotomy" (Novak, 1977, p.78). The primary concern of all curricula and teaching methodology should be to make the learning as meaningful as possible. "It is this interaction between newly learned material and existing concepts that is the core of Ausubel's learning theory" (Novak, 1977, p.82).

One important question in educational research has been, "When are children ready to learn a particular subject matter?" Ausubel's theory of learning suggests a reformulation of this question. His theory

centres on the process of meaningful learning. He recommends that curriculum planners find out what the learner already knows, and teach him accordingly. In other words, a student is ready for meaningful learning when he has the specific, relevant, subsuming concepts for the topic. Older children tend to have better developed concepts than younger children. "We must organize the curriculum to assure that all the necessary motor skills and the primary and secondary abstractions needed at any stage of the learning sequence are available" (Novak, 1977, p.140). This principle applies especially to the teaching of origins in high school biology. Some of the concepts dealt with in origins are best placed in later courses of biology to avoid undue difficulties in executing the instruction. Some of the arguments in favour of origin theories (e.g., radioactive decay dating methods) require a detailed background in chemistry or molecular biology. These concepts should be left until the student has the necessary background knowledge.

Traditional science education programs are largely dominated by the teacher in teacher-directed lessons. The teacher selects the material to be learned by the student. An improvement in the approach can be made when the teacher makes a wide use of learning resource materials and strategy to make the learning more individualized. In this scheme, the teacher is more of a learning counsellor--guiding, advising, tutoring and providing emotional support.

Some of the different teaching strategies that can be effectively used in consideration of Ausubel's theory are: lecturing, discussion groups, laboratory work, tutorial instruction, individualized instruction, and mastery learning. Each method can be effective in making learning meaningful if the important principles are kept in mind. Lecturing is good only if the students have a sufficient framework of concepts relevant to the lecture material. This may cause problems for classes where the conceptual frameworks of students differ greatly. The lowest common denominator may be too low for some, and an average may be too high for others. Duplicated notes are very helpful, especially for the students who assimilate the material more slowly. More time can then be spent on learning and understanding than on note taking. One danger with this method is that lectures may be poorly attended if the notes are too comprehensive. Lectures are very good media for presenting illustrations and examples of concepts that are poorly understood. The lecturer can also generate enthusiasm and interest in the subject material by demonstrations and anecdotes whenever possible.

Discussion groups are also excellent for providing help to students in identifying gaps or deficiencies in their conceptual frameworks. These sessions are excellent vehicles for promoting closer human relationships among the students. The student has an opportunity for self-expression, to defend his views and see the merits in the viewpoints of

others. Labs provide direct and concrete experience needed to develop primary abstractions of the material. Labs are not always possible, and may be costly, but concepts can be modified or differentiated very well when example and correction are provided in close proximity. It is important that the student have the motor skills required to perform the experiment. Therefore, the labs must be sequenced so that the student has the necessary skills to make the learning experience successful.

Tutorial instruction is performed on a one-on-one basis. This type of teaching is ideal because it can be tailored to the student's conceptual framework. Examples to illustrate concepts can be matched to the student's previous experiences. The pace of instruction can be geared to the individual. One disadvantage with this method is the cost, because the student-teacher ratios need to be low enough to provide sufficient interaction.

Individualized instruction is a program of learning that is set up so that each student follows an outlined program at his own rate, at the times most convenient, and using teaching aids that are most effective to him. The course is divided into blocks or modules that the student must complete within a certain time constraint. Proper sequencing of material would be an important consideration if we follow Ausubel's theory of learning. Meaningful learning is retained for longer periods of time. In this system, student-to-student interaction and co-operative learning are

encouraged. The instructor serves as a counsellor to those who are having problems. Some course styles that instructors can choose from are: (a) Keller Plan courses, (b) Modular courses, (c) Audio-Tutorial courses, and (d) Computer-Assisted instruction.

Another method that can be employed is mastery learning. Achievement is based on an individual's successful completion of study units. All competition between students is removed in this approach. The student is in competition with himself. As soon as the student has mastered a topic or unit, he can progress on to further units. One disadvantage is that the student who is poorly motivated could get far behind before it is noticed, and perhaps lose interest in the course. Highly motivated students will have the opportunity to complete assignments early. Close supervision over the student's progress would be important in the success of this program. Proper sequential arrangement of the curricular material would be very significant if learning is to be relevant to the student.

To apply Ausubel's learning theory to the teaching of origins requires that the instructor should solicit from the students all the pertinent information--ideas on origins already in the student's cognitive framework. As students share this information, it can be fitted into an already existing hierarchical framework. When the existing knowledge has been uncovered, the instructor can expose the students to all of the theories of origins

currently held by members of our society. These overall concepts can be interrelated to the student's own personal experiences and values. The method of instruction can be varied according to the needs of the students and the resources available to the instructor.

The class can then discuss, debate or further research the various origin theories. Care must be taken to maintain an open atmosphere, free of ridicule and personal bias. Each student should be allowed to form his own opinions as to which theory best fits his value system.

Two important conclusions can be drawn from this overview of Ausubel's learning theory. One is that since the theory of origins is a foundational premise upon which much of the study of biology hangs, this topic must then be discussed early in the biology course so that all subsequent learning will be relevant to the student's conceptual framework. The second conclusion is that the teacher must be familiar with all of the plausible theories of origins and have some understanding as to how a set of facts can be interpreted differently by people with different sets of presuppositions. The instructor needs to have access to a broad selection of books, magazine articles, tapes, filmstrips, films and videotapes that represent the different positions held. These resources are listed in the curriculum unit which follows.

SUMMARY

My rationale for teaching all of the plausible theories of origins in the science classroom is derived from the following observations:

1. Theories of origins need to fulfil the minimum specific criteria of causality and uniformity in order to merit a place for discussion in the science classroom.
2. Origin theories have an organic relationship to the basic world-views. Exposure to all origin theories will enable the students to understand their own positions better and appreciate the positions of others.
3. Scientific theories are influenced by the religious climate in which they were developed, as well as the metaphysical presuppositions of the investigator. Students need to be made aware of the distinction between the facts and the presuppositions from which these facts are interpreted.
4. Two ways of dealing with morals in education are Values Clarification and Cognitive Development. The instructor can utilize the strengths of both methods to aid the student in developing his own view with consistency and confidence.

5. The proper place in the curriculum for a unit on origins would be at the beginning of a course of study because it is such a broad, all-inclusive topic. All subsequent learning will be more meaningful if this concept is well founded in the student's conceptual framework.

CURRICULUM UNIT - ORIGINS

GOALS AND AIMS

The purpose of this unit of study is to provide educators with suggested resources and lesson outlines to facilitate the teaching of an "origins" unit in high school science courses. The suggested lesson plan lay-out is by no means a comprehensive study of the topic of origins, but the purpose is to introduce the topic to the student, allow him to be exposed to the full range of theories for interpreting the facts on origins, and give him an opportunity to further develop his own view and an appreciation of the views of others.

The science teacher is always faced with the problem of combining the required content of the course with the implied environmental, social, ethical and moral issues. Unfortunately, too often content assumes pre-eminence in the curriculum while the implied issues are not dealt with. This unit of study forces the student to connect the data and theories to the issues.

A unit of study on origins agrees with the goals and aims for science education in Ontario as set forth by the Ontario Ministry of

Education in Part 1 of its curriculum guideline produced in 1987 for science at the intermediate and senior levels. Some of these goals and aims are as follows:

1. to develop a responsiveness to the dynamic process of learning;

2. to develop resourcefulness, adaptability, and creativity in learning and living;

3. to acquire the basic knowledge and skills needed to comprehend and express ideas through words, numbers, and other symbols;

4. to gain satisfaction from participating and from sharing the participation of others in various forms of artistic expression;

5. to develop a feeling of self worth;

6. to develop a sense of personal responsibility in society at the local, national and international levels;

7. to develop esteem for the customs, cultures and beliefs of a wide variety of societal groups;

8. to develop values related to personal, ethical, or religious beliefs and to the common welfare of society, and

9. to develop a sensitivity about science and its influence on societal issues and values;

* underlining mine

The above-mentioned goals and aims can be realized in a study of the unit on origins because the student will be:

(a) exposed to the different views on origins held by the various religious, cultural, and societal groups found in Ontario. This will help develop goals 3 and 7.

(b) given opportunities to express his own personal opinions and views on the issue of origins and gain an appreciation as he listens to the positions of others. This will help fulfil goals 1, 4, 5, 6 and 8.

(c) given an opportunity to formulate his own values and world-view on origins. This will help develop goals 5 and 8.

(d) exposed to the historical development of theories of origins and the climate in which they were formed. This will help develop goals 2, 3 and 7.

(e) gain an appreciation for the influence of origins and world-views on the field of science. This will help develop goals 1, 3, 7 and 8.

SCIENCE COURSES

An origins unit would fit very well into the science curriculum because questions such as, "Where did life originate?" and, "How did life begin?" naturally arise when studying biology. In order to give the student a proper perspective and framework from which these and other questions could be answered, it would be best to deal with origins questions early in the course. I have already discussed in my rationale that it is good learning theory (Ausubel, 1968) to deal with the broader, all-encompassing issues first, and then to proceed to the more specific topics. As the course proceeds, continual reference can be made by the student to his own personal framework of origins.

The following chart shows how a curriculum unit on origins could be included in the course, with all other content requirements for

that course still being fulfilled. The suggested courses in which this unit could be taught are Grade 10 Science, and Grade 11 Biology.

GRADE 10 SCIENCE - SNC2A 1 CREDIT

UNIT	TITLE	TIME wks/hrs
1	Origins	2 / 6
2	Interactions	5 /16
3	Organisms and External Environment	5 /16
4	Organisms and Internal Environment	5 /16
MIDTERM EXAMINATION		
5	Heat	5 /16
6	Science Project	3 / 9
7	Applied Chemistry	5 /16
8	Magnetism and Electricity	5 /16
FINAL EXAMINATION		35/110

GRADE 11 BIOLOGY - SB13A 1 CREDIT

UNIT	TITLE	TIME wks/hrs
1	Origins	3 / 9
2	Cell Structure and Processes	4 /14
3	Vascular Plants: Growth and Structure	7 /20
4	Genetic Continuity	5 /16
5	Bacteria and Viruses	4 /12
MIDTERM EXAMINATION		
6	Vertebrate Skeletal and Support Systems	3 / 9
7	Vertebrate Digestive Systems	2/7.5
8	Vertebrate Gas Exchange Systems	2/7.5
9	Vertebrate Transport Systems	2/7.5
10	Vertebrate Reproduction and Development	2/7.5
FINAL EXAMINATION		34/110

SUGGESTED LESSON PLANS

Following you will find seven suggested lessons, each 45 minutes in length. There is much more material available than can be possibly taught in this 6-hour schedule, however, each teacher can expand

or revise the outline as required. It is expected that the teacher will tailor the material to the maturity level, scientific ability and level of moral reasoning (Kohlberg, 1976) of the student.

LESSON	TITLE	TIME
1	What is origin science?	45
2	Development of evolution theory	45
3	Evidence for evolution	45
4	Scientific creationism	45
5	Other origin theories	45
6	Sharing session	45
7	Evaluation session	45

LESSON 1 - What is Origin Science?

OBJECTIVES

At the end of this lesson the student will be able to:

1. differentiate between the different types of knowledge available to man;
2. outline some of the process skills involved in science;
3. trace the steps in the scientific method;
4. recognize the difference between scientific theories and religious beliefs, and
5. explain the five basic views of abiogenesis.

TOPIC	CONTENT	REFERENCES
Types of knowledge	Explain the difference between: a) empirical knowledge b) revealed knowledge c) authoritative knowledge d) rational knowledge e) intuitive knowledge	1.1
Process skills of science	a) observing b) making definitions c) classifying d) forming hypotheses e) predicting f) measuring g) experimenting h) interpreting data i) communicating j) formulating models k) re-examining	1.2
Scientific method	a) stating the problem b) collecting data c) forming hypotheses d) experimentation e) drawing conclusions f) making generalizations	1.3
Science or religion	Criteria for good scientific theories	1.4
	Scientific vs religious theories	1.5
Theories of Abiogenesis	a) macrozoic abiogenesis b) microzoic abiogenesis c) sub-microzoic abiogenesis d) cosmozoic abiogenesis e) theozoic abiogenesis	1.6

1.1 - Types of Knowledge

Knowledge can be classified under the following categories on the basis of the source of the knowledge: empirical, revealed, authoritative, rational and intuitive.

Empirical knowledge is gained by direct experience, through the senses. Scientists assume that observations give us an accurate knowledge of nature. Revealed knowledge is accepted on the basis of faith. One widely accepted source of revealed knowledge is the Bible. Bible authors are believed to have received this knowledge from God by direct revelation. Authoritative knowledge is gained from the experts by indirect experience. We accept the experiences of others which they pass on to us in books, journals, and encyclopedias. Libraries and museums are depositories of this knowledge. It is generally not realized how much the scientist relies on the authority of his predecessors. Rational knowledge is based on self-evident truths. Geometry and mathematics are fields of rational knowledge. These disciplines are based on widely accepted ideas because they have intrinsic merit. Intuitive knowledge is possessed without one really knowing its source--similar to instinct. It is often an inborn type of knowledge necessary for survival or self-defense.

If we examine all these sources of knowledge, we discover that it is only in revealed knowledge that we can find the answers to our "why" questions on the origins of life and the purpose of life here on earth.

Empirical knowledge can never tell us why we are here on this earth, nor can it provide answers about our spirituality. Science is limited.

1.2 - Process Skills of Science
(Moore, 1983, p.67)

1. **OBSERVING:** skilful direct or indirect use of the senses of sight, sound, touch, smell or taste.

2. **MAKING OPERATIONAL DEFINITIONS:** descriptions of physical features and/or processes or activities.

3. **CLASSIFYING:** ordering, arranging information in convenient categories according to similar or contrasting characteristics.

4. **FORMING QUESTIONS AND HYPOTHESES:** statement of conceivable perplexities and tentative answers that are testable.

5. **PREDICTING:** stating expected conditions based upon already known data.

6. **MEASURING:** gaining numerical dimensions.

7. **EXPERIMENTING:** careful examination of constant and variable conditions.

8. **INTERPRETING DATA:** summarizing data from use of other process skills of classifying, inferring, communicating, etc.

9. **COMMUNICATING:** charts, graphs, oral or written reports to present significant facts.

10. **FORMULATING MODELS:** conceptual organizations designed to relate ideas and classes of data.

11. **RE-EXAMINING:** further evaluation of interpretations, communications and models for the purpose of correction and improvement.

1.3 - Origins Glossary
(adapted from Moore, 1983, pp.363-368)

ASSUMPTION: A statement of a concept taken for granted and not tested during particular scientific activity.

ATHEISM: The point of view that involves denial of the existence of God and an account of existence of the universe without a self-existent and self-conscious God.

CLASSIFICATION: The process of ordering objects and/or events according to stated criteria.

COSMOGONY: A list of ideas or formulations centred on origination and generation of the universe.

COSMOLOGY: The study of the nature of the universe; use of tools or technology to describe aspects of the observable and physical universe.

CREATIONISM: The point of view that all reality came into existence initially as the consequence of creative acts of a Supreme Being such that all aspects of the universe and life are completely functional.

CREATION MODEL: An explanatory belief system based upon the existence of an eternal Creator who established a completed, finished and functional universe in all aspects.

DARWINISM: The point of view that all present variety of living things came from previously existing living things through survival of favoured varieties as a result of natural selection.

DEISM: The point of view that a personal transcendent God exists who created the universe and all therein but does not intervene in ongoing existence or affairs of men.

DETERMINISM: The point of view that involves universal application of causality such that no event is without a specific antecedent cause.

EMPIRICISM: The point of view that valid ideas can be derived from observation and experimentation.

EVOLUTIONISM: The point of view that all present variety of living things has come into existence through changes of previously existing living things; the concept has been extended back through time to include organic life coming from the inorganic and the whole universe coming from eternally existing matter; also applied to future changes of human society.

EVOLUTION MODEL: An explanatory belief system based upon eternal existence of matter from which has come an ascending series of elements by nucleogenesis, changes by stellar evolution of young stars into old stars, galaxies, planets; ideas have to do with origination of order out of disorder and integration of more complex patterns out of less complex patterns.

EXPERIMENT: A specifically designed use of equipment, tools of measurement and controlled variable components to gain observations and descriptions otherwise unattainable.

FACT: An object and/or event in space at some time.

GENERALIZATION: A statement of common aspects of similar objects and/or events; an assertion that something is true about all members of a certain class of objects and/or events.

GEOCENTRIC: The point of view attributed primarily to Ptolemy that the earth is the physical and spiritual centre of the universe.

HELIOCENTRIC: The point of view attributed primarily to Copernicus that the sun is the physical centre of the solar system.

HUMANISM: The point of view which places faith in man rather than faith in God.

HYPOTHESIS: A tentative answer to a problem; a hypothesis is most properly expressed as an assertive statement in form suitable for testing.

MYSTICISM: The point of view that knowledge can be obtained by revelation, often accompanied by intense emotional experiences which transcend time, space and morality.

NATURALISM: The point of view that God does not exist and eternal matter is all there is in a cosmos that is a closed system.

NEO-DARWINISM: The point of view that all present variety of living things came into existence through variation according to Mendelian genetics, mutation and natural selection of favoured varieties.

OBSERVATION: A written or spoken record as communication to self or another of an awareness of an object and/or event.

POSTULATE: A hypothesis advanced as an essential pre-supposition or premise not based on observations but on a line of reasoning.

PREDICTION: The projected or expected state of affairs or relationship of objects and/or events based upon known or understood conditions; often found in an "if-then" expression.

PROBLEM: An interrogation or stated perplexity for which an answer is sought; a problem is most properly expressed in question form.

RATIONALISM: The point of view that all things can be known from reason alone.

SCIENTIFIC CREATIONISM: The point of view that existing proper scientific data gained from the study of natural objects and/or events can be used validly to support the creationist viewpoint on origin questions.

SCIENTIFIC LAW: A repeatedly tested and well-supported or substantiated generalization of seemingly universal application regarding a certain set of facts; a level of scientific explanation between description and scientific theory.

SCIENTIFIC THEORY: A list of postulates or theoretical assumptions usually specifying existence, relationship and events concerning an imaginary entity whereby a meaningful system for a range of rather diverse facts is made available; the highest level of scientific explanation.

SCIENTISM: The point of view that matter and energy are the only reality with stress upon the position that the only knowledge of any real value is that gained through the scientific method.

SECULARISM: The point of view that places emphasis upon the present life according to the principles of ethics not dependent upon any religion.

THEISM: The point of view that a Supreme Being created the universe, the earth and all life.

THEOREM: A statement derived from assumptions of scientific theory more or less in the form of testable predictions or expectations.

1.4 - Criteria for a Good Scientific Theory
(Levitt, 1976, p. 94)

Rigorous criteria for identification of a proper scientific theory are provided below. Qualifications 1 and 3 are very important to

any conceptualization of first origins. It is a very critical fact that no "prior observations" are possible since no person observed first origins of the universe, life or humankind, nor is it possible to "check with experience by test" in any manner when objective considerations are given to first origins.

1. A fruitful theory correlates many separate facts, particularly the important prior observations, in a logical, preferably easily-grasped, structure of thought.

2. In the course of continued use it suggests new relations and stimulates directed research.

3. The theory permits us to deduce predictions that check with experience by test, and it is useful for clarifying puzzling difficulties and solving practical problems.

The history of science has shown that a good theory frequently has one or more of the following three attributes, in addition to the three listed above:

4. When the "smoke" of initial "battle" has lifted, the most successful of rival theories is often the theory that is simpler, i.e., the theory that invovles fewer basic assumptions or hypotheses.

5. A theory is more readily acceptable to contemporary scientists if its postulates or assumptions are plausible.

6. A successful theory is flexible enough to grow and to undergo modifications where necessary.

1.5 - Differences Between Scientific and Religious Explanations

(adapted from Robert Root-Bernstein in Science and Creationism, Montagu, editor, 1984, p.78,79)

Scientific Theories:	Religious Theories:
Comprised of contingent or tentative knowledge.	Comprised of claims of absolute knowledge (truth).
Organized to be operationally useful.	Concern morals and values.
Solve problems concerning particular aspects of nature.	Direct universal aspects of human existence.
Problems of nature exist in the here and now.	Emphasize the natural and the supernatural.
Promote sceptical consideration.	Promote faith.
Promote alternative explanations.	Promote an orthodox doctrine.
Are evaluated against one another on the basis of empirical or logical tests.	Are established by reliance upon authoritative and historical evidence.

1.6 - Ideas on the Origins of Life
(adapted from Levitt, 1976, p. 102,103)

Pro and con aspects of the five basic themes found in writings over the centuries, with respect to the origins of life, have been reduced to specific and explicit expressions.

PRO POSITION	CON POSITION
Macrozoic ideas: Ancient people believed in spontaneous generation of whole organisms, because they thought they saw mice come from mud and snakes from horses' hair, etc. (Aristotle and others).	Conclusive controlled experiments of Francisco Redi (1650) with covered and uncovered meat established "life came from life", at least flies came from maggots which came from eggs.
Microzoic ideas: People believed in spontaneous generation of microbes or bacteria because Pouchet (1860) and others thought they saw such occur in nutrient broths.	Controlled experimentation by Pasteur (1864) with swan-necked flasks established that dust may be bacteria-laden and a source of bacterial life.
Sub-Microzoic ideas: **Evolution** Belief in spontaneous generation of subvital units of matter that formed into "coacervates" or "protenoids" (Darwin, Oparin, Miller, Fox, Pannapurumma)	Instantaneous synthesis of amino acids requires human intervention; hence no man can study spontaneous generation (Blum, Thaxton).

Cosmozoic ideas:

Panspermia

Over the decades and still today people believe that life came to the earth from other planets or other parts of the universe by way of "spores" or meteorites.

These ideas "beg the question", side-step the problem of origin of life; no other planets known from space probes (Mercury, Venus, Mars, Jupiter or Saturn) seem to have life as we know it. Heat of meteorites, x-rays, UV light would have deleterious effects on life.

Theozoic ideas:

Creation

Over the centuries many scientists believed that life was a result of a supernatural creative act of a creator-God.

No scientific study possible, but a Creator of life would not be in contradiction to concepts of cause and effect, or degradation or degeneration from complex, organized order.

LESSON 2 - Development of Evolution Theory

OBJECTIVES

At the end of this lesson the student will be able to:

1. Outline the historical roots and development of evolution theory.

2. Appreciate the role the men of science had in the maturation of the theory of evolution.

3. Define the basic principles of uniformitarianism and natural selection.

4. Summarize the meaning of Neo-Darwinism and Punctuated Equilibria.

5. Recognize the implicit assumptions and difficulties of Darwinian Evolution and uniformitarianism.

TOPIC	CONTENT	REFERENCES
Early Evolutionists	Brief history of Anaximander, 610 B.C. to Stephen J. Gould, 1972.	2.1 2.2
Darwinian Evolution	HMS Beagle trip 1831-1836 Origin of Species - 1859	FILM: Darwin, CBC, 1971, 25 minutes
Neo-Darwinian Evolution	Hugo DeVries	2.3
Punctuated Equilibria	Richard Goldschmidt's macromutations - 1940, Stephen J. Gould's periodic macromutations - 1972	2.4

2.1 - Historical Development of Evolution

Anaximander 610-546 B.C.

- Greek philosopher - developed a primitive theory of evolution
- thought that the earth was formed out of condensed water
- plants and animals grew out of the primordial slime
- men were derived from fish - abandoning their scaly skin

Augustine 354-430

- theologian who did not believe in a literal six-day creation
- he felt it was beyond the power of man to know for sure

Thomas Aquinas 1225-1274

- a philosopher who seems to have blended evolutionary ideas with the Genesis account of creation

Pierre Louis Maupertuis 1698-1759

- a physical scientist who formulated a theory of natural selection and survival of the fittest
- recognized mutations as the raw material of evolution

Georges Louis Buffon 1707-1788

- French natural philosopher
- wrote about the origin of the earth and its development into an environment fit for living creatures
- in his Histoire Naturelle we find his theory of evolution

James Hutton 1726-1797

- a Scottish medical doctor who in retirement studied geology
- father of uniformitarianism - "present is the key to the past"

Erasmus Darwin 1731-1802

- grandfather of Charles Darwin and an ardent evolutionist
- believed there were similarities in all of nature
- nature is one family of one parent
- he taught an upward trend in evolution - natural selection being of prime importance

Sir Charles Lyell 1797-1875

- English geologist/biologist who popularized Hutton's uniformitarianism
- applied Darwinian evolution to the development of man

Herbert Spencer 1820-1903

- a philosopher who coined the term "survival of the fittest" and "evolution"
- applied Darwinian principles to the development of societies and cultures

Jean Baptiste Lamarck 1744-1829

- a famous French botanist and an authority in classification of invertebrates
- new species resulted from the gradual change of the previous species
- suggested four principles of evolution
  (1) organisms tend to get larger with time, (2) new wants in the organism give rise to new organs, (3) organ development proceeds according to use, and (4) new developments are passed on to offspring
- discarded the principle of fixed species and suggested variable populations

Thomas Malthus 1766-1834

- a British political economist who wrote an essay on population principles
- stated that reproductive potential exceeds resources
- population would be controlled by famine, disease or war

Alfred Russell Wallace 1823-1913

- formed his theory of evolution while working in Malaya as a naturalist
- wrote his theory of natural selection or survival of the fittest in 1855
- his ideas went out basically unnoticed

- sent his ideas to Charles Darwin in 1858 and together they gave a presentation to the Linnaean Society in 1858

Charles Darwin 1809-1882

- formed his ideas while on a five-year voyage around the world on H.M.S. Beagle from 1831-1836, working as a naturalist
- published The Origin of the Species in 1859
- proposed variation as the universal property of all organisms
- proposed the theory of survival of the fittest or natural selection

Thomas Huxley 1825-1895

- great promoter and defender of Darwinism
- debated and lectured on Darwinism

Hugo DeVries 1848-1935

- famous Dutch botanist who rediscovered Mendel's laws
- suggested that evolution occurred by series of mutations in pure lines
- natural selection occupied no place in his theory
- new species arise by sudden steps or jumps

Richard Goldschmidt 1878-1958

- departed from traditional Darwinism because mutations led nowhere
- suggested macromutations that caused large jumps in evolutionary change
- resulted in the production of "hopeful monsters"

Stephen J. Gould -1972

- professor of geology and paleontology at Harvard; recognized the failure of Darwinism (slow, gradual evolution)
- advocated the theory of punctuated equilibria (rapid evolution in small populations followed by periods of stasis)
- explained reason for gaps in the fossil record--because intermediate stages happened too quickly to leave behind fossil records

2.2 - Time Scale of the Rise of Evolution Theory

EIGHTEENTH CENTURY NINETEENTH CENTURY

17- 18-

10 20 30 40 50 60 70 80 90 00 10 20 30 40 50 60 70 80 90

Linnaeus

Buffon

Hutton

Erasmus Darwin

Lamarck

Malthus

Lyell

Spencer

Wallace

Huxley

Darwin

2.3 - Neo-Darwinism

Neo-Darwinian theory is an application of the ideas of Darwin to the scale of macroevolution. Macroevolution is the theory of evolutionary change involving relatively large and complex steps. Neo-Darwinian theory in the strict sense adds only mutations as the mechanism for creating variability. It does not concern itself with pre-biotic evolution. Neo-Darwinism can be summed up in the form of two propositions:

problem at this point

1. There has been chemical evolution from non-life to life.
2. Major groups of organisms arose from common ancestors.

The pre-biotic story of evolution began nearly 5 billion years ago and it gradually unfolded through a series of five stages. In Stage 1, we find the primitive earth surrounded by a reducing atmosphere made up mostly of gases such as methane, ammonia, hydrogen and water vapour. At Stage 2, u.v. light, electrical discharges (lightning) and high energy molecules bombarded this atmosphere. After some time, small organic molecules such as sugars, amino acids and nucleotides formed. At Stage 3, over long periods of time, combinations of these organic molecules resulted in the chance formation of long polymers such as starches, proteins and nucleic acids. At Stage 4, we find that these large molecules joined together as gel-like blobs called coacervates. These coacervates attracted smaller molecules to themselves, forming microspheres. Finally, at Stage 5,

one of the cells, by chance, absorbed the right combinations of molecules so that the cell became self-replicating. These cells first fed on molecules found in the primordial ponds. After many years of continued evolution, photosynthetic cells evolved that could produce their own food from sunlight with oxygen as a byproduct. As the oxygen began to build up in the atmosphere, it reacted with u.v. light to produce ozone, which acted as a protective screen for the developing cells. Under this protective ozone layer, cells emerged from the water and all life forms as we know them today evolved.

Neo-Darwinian theory relies on the fact that a very small percentage of the offspring is noticeably different from the parents. Their changed appearance is due to genes in the germ cells being significantly altered. These mutants, under changing environmental conditions, are better adapted than their parents and thus propagate successfully. With further mutations, it is presumed that a new species will appear.

2.4 - Development of Punctuated Equilibria Theory

Richard Goldschmidt (1878-1958), a respected geneticist from Berkeley, California, sparked a new development in evolution theory in his book The Material Basis of Evolution (1940). Goldschmidt observed that

after forty years of working with micromutations, they lead nowhere. He broke with traditional Darwinian evolution by suggesting that "mega" or "macro" mutations must produce what he termed "hopeful monsters". "Goldschmidt analogized a quantum jump or "saltation" in genetic material which might, for example, lead to a prototype bird hatching from a reptilia egg" (Pitman, 1984, p.72).

Ernst Mayr, formerly of Columbia University, first proposed the modern punctuational view into the biological sphere. In 1954, Mayr generalized that many important evolutionary transitions have taken place in small, local populations. "The point here is that if the transition was typically rapid and the population small and localized, fossil evidence of the event would never be found" (Stanley, 1981, p.77).

Harvard paleontologist, Stephen J. Gould, and his colleague, Niles Eldredge, of the American Museum of Natural History first applied the terms "punctuational" and "gradualistic" to the alternative views of evolution. "Thus our model of "punctuated equilibria" holds that evolution is concentrated in events of speciation and that successful speciation is an infrequent event punctuating the stasis of large populations that do not alter in fundamental ways during the millions of years that they endure" (Gould, 1980, p.125). They believe that macro-mutations could make evolution possible. These quantum leaps of genetic mutations called "punctuations" occur in short periods of time between long periods of

"stasis". The result is a jerky, step-like evolution. Since these changes are so rapid, very few transitional forms can expect to be fossilized. This "punctuated equilibrium" theory predicts the absence of link-fossils. Gould says, "All paleontologists know that the fossil record contains precious little in the way of intermediate forms; transitions between major groups are characteristically abrupt" (Gould, 1977, p.24).

Paleobiologist Stanley writes in his recent book,

> "The record now reveals that species typically survived for a hundred thousand generations, or even millions or more, without evolving very much. We seem forced to conclude that most evolution takes place rapidly, when species come into being by the evolutionary divergence of small populations from parent species. After their origins, most species undergo little evolution before becoming extinct" (Stanley, 1981, p.xv).

LESSON 3 - Evidence for Evolution

OBJECTIVES

At the end of this lesson the student will be able to:

1. State at least ten of the basic facts in support of the evolution theory.

2. Define the terms and conventions in the area of evolutionary science.

3. Recognize the similarities and differences between the groups of living things.

4. Outline the limitations of being able to prove evolution.

5. Explain the accepted evolutionary tree linking organisms together.

6. Describe the accepted evolutionary geologic column.

7. Discover at least two cases of fraudulent manipulation of data to support the theory of evolution.

TOPIC	CONTENT	REFERENCES
Major Lines of Evolutionary Evidence	- evidence from classification	3.1
	- evidence from comparative anatomy	
	- evidence from embryology	
	- evidence from biochemistry	
	- evidence from physiology	
	- evidence from geographical distribution	
	- evidence from vestigial organs	
	- evidence from breeding experiments	
	- evidence from mutations	
	- evidence from paleontology	3.2
	- audio/visual aids	3.3
	- annotated bibliography	3.4
False Evidence for Evolution	- stone age swindle	3.5
	- Krao Farini: the missing link	3.6
	- Piltdown man	3.7

* A good review of paleontology can be found in Roger J. Cuffey's essay, Paleontological Evidence and Organic Evolution, Journal of American and Scientific Affiliation, Volume 24, No. 4, December 1972.

3.1 - Major Lines of Evidence for Evolution

CLASSIFICATION: The fact that it is possible to arrange the various kinds of plants and animals into categories of species, genera, families, orders, etc. suggests genetic relationships.

COMPARATIVE ANATOMY: Similarities in skeletal structure imply an evolutionary relationship.

EMBRYOLOGY: Similarities in the embryos of different kinds of animals, and the growth of these embryos as they pass through analogous evolutionary development into their present forms suggest evolutionary linkage.

BIOCHEMISTRY: The fact that all organisms are composed of certain basic chemical substances (amino acids, proteins, DNA, etc.) suggests a common ancestry.

PHYSIOLOGY: Similarities in physiological factors, such as blood precipitates, and behaviour characteristics suggest genetic kinships.

GEOGRAPHICAL DISTRIBUTION: The tendency of certain kinds of plants and animals to vary in character when geographically isolated from similar populations.

VESTIGIAL ORGANS: Certain organs and structures which have no known use in man (e.g., appendix, coccyx, etc.) are thought to represent "vestiges" of traits once useful and functional in a previous evolutionary stage.

BREEDING EXPERIMENTS: The many new varieties of plants and animals that have been developed by hybridization and other breeding techniques are believed to be indicative of the evolutionary potential implicit in living organisms.

MUTATIONS: The observed fact that entirely new varieties or species suddenly appear in a particular organism is offered as the best present-day visual proof of evolution; these mutations, if favourable, will be preserved by natural selection and contribute to the long-term evolutionary process.

PALEONTOLOGY: The fossil record of former living things, as preserved in the sedimentary rocks of the earth's crust, if offered as documented history of organic evolution, with the degree of complexity of the fossils supposedly increasing with the passage of geologic time.

3.2 - Major Events in the Evolution of Multicellular Life (Ruse, 1982, p.172)

Millions Yrs Ago	Era	Period	Events
0	Cenozoic	Quaternary (Pleistocene Epoch)	Evolution of man
50		Tertiary (Epoch: Pilocene Milocene Oligocene Eocene Palaeocene)	Mammalian radiation
100	Mesozoic	Cretaceous	Last dinosaurs First primates First flowering plants
150		Jurassic	Dinosaurs First birds
200		Triassic	First mammals Therapsids dominant

250	Palaeozoic	Permian	Major marine extinction Pelycosaurs dominant
		Pennsylvanian	First reptiles
300			
		Mississippian	Scale trees, seed ferns
350		Devonian	First amphibians Jawed fishes diversify
400		Silurian	First vascular plants
450		Ordovician	Burst of diversifica-tion in Metazoan families
500		Cambrian	First fish First chordates
550			
600	Precambrian		First skeletal elements
		Ediacaran	
650			First soft-bodied metazoans First animal traces (Coelomates)

3.3 - Audio/Visual Aids Supporting the Theory of Evolution

16 mm films

TITLE	TIME	DATE	PRODUCER
Building Bodies	20	1981	BBC
Conquest of the Waters	22	1981	BBC
Darwin	25	1971	CBC
Flowers and Insects	26	1981	BBC
From Reptile to Birds	26	1981	BBC
The Hunters and the Hunted	26	1981	BBC
Invasion of the Land	23	1981	BBC
Life in the Trees	24	1981	BBC
Lords of the Air	24	1981	BBC
Mammals of the Sea	21	1981	BBC
Monkeys, Apes and Man	50	1971	Nat'l Geogr.
One Voice in the Cosmic Fugue	60	1980	KCET & Carl Sagan Producer
The Segmented Invertebrates	24	1981	BBC
The Amphibians	24	1981	BBC
The Beginning of Life	21	1981	BBC
The Bony Fishes	26	1981	BBC
The Coming of Insects	22	1981	BBC

Dinosaurs: The Terrible Lizards	22	1981	Reid Towers Pro.
The Dinosaurs & Their Descendants	22	1981	BBC
The Early Seas	22	1981	BBC
The First Forests	25	1981	BBC
The Infinite Variety	21	1981	BBC
The Leaf Eaters	22	1981	BBC
The Marsupials	24	1981	BBC
The Primates	23	1981	BBC
The Rise of Mammals	23	1981	BBC
Theme and Variations	25	1981	BBC
Upright Man	25	1981	BBC
Victors of the Dry Land	19	1981	BBC

3.4 - Annotated Bibliography - Evolution

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An easy-reading account of the evolution of vertebrates.

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McGowan, Chris. In the Beginning...A Scientist Shows Why the Creationists are Wrong. MacMillan of Canada, 1983.
A strong rebuttal to creationists' claims and arguments.

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A collection of essays by philosophers and scientists giving a strong rebuttal against creationist claims and arguments.

Ruse, Michael. Philosophy of Biology. London: Hutchison, 1974.
Discussion of some of the methodological issues in evolutionary biology.

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Contains the theory of punctuated equilibria by N. Eldredge and S.J. Gould.

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An excellent introduction to evolutionary theory.

3.5 - Stone Age Swindle

The story begins when a hunter named Dafal reported the discovery in 1971 of a Stone Age tribe of men, women and children living in the thick rain forest of Mindanao, an island of the Philippines in South-East Asia. Dafal had informed Manuel Elizalde, the Presidential Assistant on National Minorities under the then Marcos government. Elizalde had in turn contacted National Geographic magazine in Washington with an offer of exclusive rights to the "story of the century". The prospects were considered significant enough to engage the attention of NBC television, and they agreed to pay Elizalde $50,000.00 for exclusive rights.

So it was that in December, 1971, the North American television audience was treated to a unique jungle meeting between the Presidential Assistant and some naked dwellers in the Stone Age. The story was reported in the August, 1972 issue of the National Geographic magazine (142:218). Not a word was heard from the Tasady people until April, 1986.

When the Marcos government fell early in 1986, the truth about the Stone Age tribe began to leak out. A Swiss journalist, Oswald Iten, investigated the affair and reported it in the Swiss newspaper, Neue Zeurcher Zeitung (84:77), under the headline "Steinzeitschwindel" or "Stone Age Swindle". Both National Geographic and NBC television had

been tricked by Elizalde and Dafal, the hunter, who saw an opportunity to make money. The caper involved two or three families of the Manubo Blit people, "slash and burn" farmers who live a free and easy life, who were persuaded to remove their clothes and act like Stone Age people, living in a cave for a few days for the benefit of the American visitors.

Reuter wire service carried the news of the hoax to every major newspaper on April 13, the day the story broke in the Swiss newspaper. On April 15, the bombing of Libya by the U.S.A. occupied the news media's attention. As far as can be determined, no North American newspaper picked up this story on April 14 or since.

How was it that the National Geographic Society was taken in by this hoax? The answer is preconception. National Geographic is so totally committed to the theory of evolution, that the Tasady story was picked up and reported without criticism. (Ian Taylor, October 20, 1986, Christian Renewal, p.10,11, and Creation Ex Nihilo, Vol. 9, No. 1, pp.6-10)

3.6 - Krao Farini: The Missing Link

This curious case involved a young female, Krao Farini, born in Burma, who had a rare condition consisting of an abnormal development of hair over her whole body. In 1882, when she was about six years of age, she was exhibited at the Royal Aquarium, London.

Newspapers stated the opinion that this was the case of atavism, or reversion to a low ape-like ancestor. The 1883 edition of Scientific American (48:247) promoted this view by quoting from a German correspondent. Later the widely circulated English Mechanic reported in 1894 (60:429) under the title, "Krao Farini: The Missing Link". The general public believed that a missing link had been discovered in the jungles of Burma. The truth about the matter was published in the British Medical Journal of 1883 (1:28), where it was pointed out that it was simply a rare case of hypertrichosis universalis. Far from having lived a wild life in the jungles, Krao's mother was actually employed at the court of the King of Laos, while Krao, an intelligent child, became fluent in English, French and German. (Ian Taylor, October 20, 1986, Christian Renewal, p.10,11, and Creation Ex Nihilo, Vol. 9, No. 1, pp.6-10)

3.7 - Piltdown Man

In 1912, Arthur Smith-Woodward, Director of the Natural History Museum of London, and Charles Dawson, a medical doctor and amateur paleontologist, announced the discovery of the Dawn Man or Eoanthropus dawsoni. Dawson had recovered the specimens from a gravel pit near Piltdown, England. The discovery included the larger part of the left side of the frontal bone, two-thirds of the right parietal, most of the

lower part of the occipital, almost the entire left temporal bone, the nasal bones, the right half of the mandible, and a lower canine tooth. In addition, there was a lower jaw with the second and third molars intact. The lower jaw was indistinguishable from that of a chimpanzee, but the skull was quite human. The sex and the brain capacity of the find was in dispute, but the find was generally accepted as the Piltdown Man and judged to be 500,000 years old by fluoride dating methods. Although a few experts, such as Boule and Henry Fairfield Osborn, objected to the association of this very ape-like jaw with a human skull, the consensus was that Piltdown Man was an authentic link in the evolution of man.

By 1950 a new method of fluoride dating showed the fossil to be no older than the year it had been found. This dating method is dependent on the amount of fluoride absorbed from the soil by the bones. The skull did have a significant amount of fluoride but it was estimated to be a few thousand years old rather than 500,000 years old. It was discovered that the bones had been treated with iron salts to make them look old, and scratch marks were detected on the teeth, indicating that they had been filed. A modern ape's jaw and a human skull had been doctored to resemble an ape-man, and the forgery had succeeded in fooling the world's greatest experts. (S. Zuckerman, Journal of the Royal College of Surgeons of Edinburgh, Vol.II, pp.87-115, 1966; Paul A. Zimmerman, ed., pp.132-134. Ian T. Taylor, In the Minds of Men, 1984, pp.225-229)

LESSON 4 - Scientific Creationism

OBJECTIVES

At the end of this lesson the student will be able to:

1. Define the terms and concepts of Scientific Creationism.
2. Summarize the historical roots of Scientific Creationism.
3. List ten facts showing that the fossil record reveals fixity of species and sudden appearance of complex life forms.
4. Explain that mutations do not make new species.
5. Discover that some dating methods reveal a young earth.
6. Justify that geology reveals a cataclysmic flood in history.
7. Discover at least two fraudulent cases of the manipulation of data to support scientific creationism.

TOPIC	CONTENT	REFERENCES
History of Scientific Creationism	-discuss creation scientists of the past and present	4.1
Evidence for Scientific Creationism	-sudden appearance of complex life forms	4.2
	-mutations limited within each species	
	-fixity of original plant, animal kinds	
	-evidence of Noachian flood in geology	4.3
	-evidence of relatively young earth	4.4
	-homologies or similarities between species	
	-fossil formations	4.5
	-creation references	4.6
	-audio/visual aids	4.7
False evidence for Scientific Creationism	Thomas Barnes' theory of young earth based on decay of earth's magnetic field	4.8
	Fossil dinosaur and human footprints found together in Paluxy riverbed in Texas	4.9

4.1 - Famous Creationist Scientists

The following list of famous scientists, who were Bible-believing Christians, appeared in January 1981 Acts and Facts leaflet issued by the Institute of Creation Research. It lists their fundamental scientific disciplines, together with some of the important discoveries they made. (Morris, 1984b, pp.463-465)

SCIENTIST	SCIENCE	DISCOVERIES
Agassiz, Louis 1807-1873	Glacial Geology/Ichthyology	
Bacon, Francis 1561-1626		Scientific Method
Babbage, Charles 1792-1871	Computer Science	Actuarial Tables Calculating Machine
Boyle, Robert 1627-1691	Chemistry/Gas Dynamics	
Brewster, David 1781-1868	Optical Minerology	Kaleidoscope
Cuvier, Georges 1769-1832	Comparative Anatomy/Vertebrate Paleontology	
DaVinci, Leonardo 1452-1519	Hydraulics	
Davy, Humphrey 1778-1829	Thermokinetics	
Fabre, Henry 1823-1915	Entomology of Insects	

Faraday, Michael 1791-1867	Electro-Magnetics Field Theory	Electric generator
Fleming, John A. 1849-1945	Electronics	Thermionic valve
Herschel, Wm. 1738-1822	Galactic Astronomy	Double Stars
Henry Joseph 1797-1878		Electric motor
Joule, James 1818-1889	Reversible Thermodynamics	
Kelvin, Lord 1824-1907	Energetics Thermodynamics	Absolute Temperature, Transatlantic cable
Kepler, Johann 1571-1630	Celestial Mechanics Physical Astronomy	Ephemeris tables
Linnaeus, Carolus 1707-1778	Systematic Biology	Classification system
Lister, Joseph 1827-1912	Antiseptic Surgery	
Maury, Matthew 1806-1873	Hydrography	
Maxwell, James Clerk 1831-1879	Electrodynamics/ Statistical Thermodynamics	
Mendel, Gregor 1822-1884	Genetics	
Morse, Samuel 1791-1872		Telegraph
Newton, Isaac 1642-1727	Calculus/Dynamics	Law of Gravity

Pascal, Blaise 1623-1662	Hydrostatics	Barometer
Pasteur, Louis 1822-1895	Bacteriology	Biogenesis Law Fermentation Control Pasteurization Immunization/ Vaccination
Ramsay, William 1852-1916	Isotopic Chemistry	Inert gases
Ray, John 1627-1705	Natural History	
Rayleigh, Lord 1842-1913	Dimensional Analysis/Model Analysis	
Riemann,Bernhard 1826-1866	Non-Euclidean Geometry	
Simpson, James 1811-1870	Gynecology	Chloroform
Steno, Nicholas 1638-1686	Stratigraphy	
Stokes, George 1819-1903	Fluid Mechanics	
Virchow, Rudolph 1821-1902	Pathology	
Woodward, John 1665-1728	Paleontology	

4.2 - Evidence for Scientific Creationism

Early defenders of creation included men such as Clement of Rome, Hermes, Justin Martyr (b.100), Athenogoras, Irenaeus, Hippolytus, Clement of Alexandria, Origen (b.185), Tertullian, Eusebius (b.263), Augustine (b.354), and others.

Creationists believe that all basic life forms were created perfect, each having its own form and function on the earth. These originally created kinds are now being conserved and maintained by God Himself. This agrees with the universally accepted first law of thermodynamics which states that matter and energy cannot be created or destroyed. This does not mean that change or variety is impossible. The original created kinds contained a tremendous amount of genetic variability to allow for the development of many new varieties. This variability will always be within the limits imposed by the original "kind" or parental type. For example, when plants are exposed to dry conditions, they may respond by developing a deeper root system or by thickening the cuticle on their leaves. This will only happen if the gene pool of the plant has these genes before natural selection operates on it. "Natural selection enables organisms to maintain their state of adaptation, rather than improve it in an "upward", evolutionary sense: it enables a species to keep up with the constantly changing environment" (Pitman, 1984, p.81).

A universal cataclysmic flood that has dramatically altered the shape of the earth's surface and changed the rate of many of the naturalistic processes that were in effect at the time of this flood, is part of the creation theory. The flood helps us to understand the geological formations, meterological patterns, and the paleontological evidence that we find on the earth today. The belief in the universal flood is not unique to the Christian faith, or only recorded in the Bible. Dr. Elizabeth Cass, an ophthalmologist with the Indian Health Services in Canada, collected stories and legends from the Indians. These Indians from the Northwest told stories of a great flood occurring before they had been in contact with white men. There are similar stories among the Plains Indians, Assinoboine, Eskimos and the Hurons. Versions of the legend differ from tribe to tribe, but they form an interesting study (Cass, 1960, p.44).

Every good theory allows us to confirm our predictions and enables us to explain all the data and facts which we can find. If the theory fails to explain any observations or phenomena, then it must be reviewed or abandoned. The permanence of basic "kinds" is supported by all observable biological data. Bacteria have only arisen from other bacteria, earthworms from other earthworms, dogs from other dogs. "Over the last century, more than a couple million generations of prokaryotes have been cultured and, under all sorts of conditions, observed. Although many mutations and strains have appeared, no tendency to evolve into a

eukaryote has been observed either in bacteria, or blue-green algae" (Pitman, 1984, p.175). From all sorts of breeding experiments we can only confirm the law of biogenesis. Thousands of generations of breeding with fruit flies can produce many different eye colours, wing shapes and other mutations, but fruit flies still remain as fruit flies. "In the last century, breeders improved the quality of sheep's wool and raised the yield of sugar in beets from 6 to a maximum of 15 percent. In this century, new varieties of corn, wheat and rice have been developed. In biological terms, there is a limit past which the "elasticity" of a genome cannot be "stretched" (Pitman, 1984, p.67). "Thirty million years ago some green leaves from elm trees in Oregon were rapidly buried under volcanic ash. Some of those leaves are still a vivid green colour today...So far, they find the chemical profile of the prehistoric leaves surprisingly similar to that of modern leaves" (Science News 3, 1977, p.391). A fossilized fly (Mycetophilidae: Diptera) was found entombed in Baltic amber. After investigation, it was found that the fly was practically identical to modern flies, even though it was estimated to be 40 000 000 years old (Poinar, 1982, p.1241). These facts are possible evidence against certain claims of evolution.

Since each created kind was uniquely designed for a specific purpose and niche in the biosphere, we would expect to find great gaps between the basic kinds. What we find in the historical fossil record, and

what we observe in nature today, basically agrees with the premise that there are distinguishable basic parental types.

> "No one has produced yet a single fossil with half-way wings, or a fossil of an animal showing a transition between the cold blooded, scaled reptile and the warm blooded, feathered bird. The earliest vertebrate fish is found in the fossil record as 100 percent vertebrate. Amphibia appear more "recently" in the fossil record than fish. But the amphibia appear as 100 percent amphibians, and no one would confuse them with fish. Not a single transitional form has ever been found" (Moore, 1974, p.16,17).

According to the creation theory, most of the fossils found on the earth would be found in sedimentary rocks that had been laid down by the waters of the Noachian deluge. It is interesting to note that water at some time covered most of the earth's surface. "By volume, sedimentary rocks are about one-tenth as abundant as igneous rocks in the earth's crust; but when it comes to the rocks exposed at the earth's surface, sedimentary rocks or sediments, as they are sometimes called, cover nearly three-fourths of the land surface" (Zumberge, 1963, p.44).

It seems that the only explanation for the numerous vertebrate fossils found in the earth's rocks would be due to a major catastrophe, with rapid burial and lithification. Examples to prove this are abundant. In Baja, California, a team of Mexican and American paleontologists found a 350-mile stretch of rugged coastal terrain where fossils literally covered the ground for square miles in some locations where torrential rains had washed away the soil. The fossil remains of

animals from a variety of geologic periods, and artifacts left by humans, were found. These fossils consisted of diatoms, fish found only in deep water, shark and whale remains, bones of camels, horses, mammoths and the shells of giant tortoises (five feet in length and four feet in height). At other sites, the fossil beds were thousands of feet thick. (Science News 106, 1974, p.247). Even beds of fossilized birds have been found, despite the fact that birds could easily have avoided burial. Enormous concentrations of Presbyorious have been found in the Green River formations. (Feduccia, 1978, p.298) The remains of 400 or more Permian amphibians were found in a series of siltstone channels confined to an area of 50 square feet. (Dalquest, 1963, p.641) It is common knowledge that when an organism dies, scavengers and decay processes do not take very long to dispose of the body. It is logical to assume then that these fossils were all buried very rapidly, and quickly lithified; otherwise they would not have been preserved. These facts all agree with the principle of a very recent catastrophe, as taught by scientific creationists.

4.3 - Summary of the Scientific Evidence for a Young Earth (White, 1985, p.97)

METHOD	AGE OF THE EARTH	ASSUMPTIONS
Lifetime of short-period comets	Less than 10 000 years	1) No short period comets supplied to the solar system from time to time. 2) Observed rate of disintegration of short-period comets unaltered during the last 10 000 years.
Amount of micro-meteoric dust settling onto the earth's surface	9 000 - 26 000 years	1) Micrometeoric dust being transported by the rivers into the oceans. 2) Observed rate of influx of micrometeoric dust onto the earth's surface is fairly constant.
Amount of helium-4 in the atmosphere	About 11 000 years	1) Observed rate of efflux of helium-4 into the atmosphere constant during last 11 years. 2) No helium-4 in the atmosphere to begin with.
Imbalance of the rate of formation of radiocarbon in the atmosphere and its rate of disappearance from the biosphere	About 10 500 years (for the atmosphere)	1) Rate of production of carbon-14 is a constant. 2) No carbon-14 in the atmosphere to begin with.

4.4 - Global Processes Indicating Date of Earth Origin

These estimates are based on standard assumptions of: 1. zero initial daughter component; 2. closed system; 3. uniform rate. (Morris, 1984a, pp.477-479).

PROCESS	ESTIMATED AGE IN YEARS
Decay of earth's magnetic field	10 000
Influx of radiocarbon to the earth system	10 000
Growth of oldest living part of biosphere	5 000
Origin of human civilizations	5 000
Efflux of Helium-4 into atmosphere	1 750-175 000
Development of total human population	4 000
Influx of sediment to ocean by rivers	30 000 000
Erosion of sediment from continents	14 000 000
Leaching of sodium from continents	32 000 000
Leaching of chlorine from continents	1 000 000
Leaching of calcium from continents	12 000 000
Influx of carbonate to the ocean	100 000
Influx of sulphate to the ocean	10 000 000
Influx of chlorine to the ocean	164 000 000
Influx of calcium to the ocean	1 000 000
Influx of uranium to the ocean	1 260 000

Efflux of oil from traps by fluid pressure	10 000-100 000
Decay of C-14 in pre-Cambrian wood	4 000
Formation of river deltas	5 000
Submarine oil seepage into oceans	50 000 000
Decay of natural plutonium	80 000 000
Decay of short-period comets	10 000
Decay of long-period comets	1 000 000
Influx of small particles to the sun	63 000
Maximum life of meteor showers	5 000 000
Accumulation of dust on the moon	200 000
Accumulation of calcareous ooze on sea floor	5 000 000
Influx of sodium to ocean via rivers	260 000 000
Influx of nickel to ocean via rivers	9 000
Influx of magnesium to ocean via rivers	45 000 000
Influx of silicon to ocean via rivers	8 000
Influx of potassium to ocean via rivers	11 000 000
Influx of copper to ocean via rivers	50 000
Influx of gold to ocean via rivers	560 000
Influx of silver to ocean via rivers	2 100 000
Influx of mercury to ocean via rivers	42 000
Influx of lead to ocean via rivers	20 000 000
Influx of tin to ocean via rivers	100 000

Influx of aluminum to ocean via rivers	100
Influx of lithium to ocean via rivers	20 000 000
Influx of titanium to ocean via rivers	160
Influx of chromium to ocean via rivers	350
Influx of manganese to ocean via rivers	1 400
Influx of iron to ocean via rivers	140
Influx of cobalt into ocean via rivers	18 000
Influx of zinc into ocean via rivers	180 000
Influx of rubidium into ocean via rivers	270 000
Influx of strontium into oceans via rivers	19 000 000
Influx of bismuth into ocean via rivers	45 000
Influx of thorium into oceans via rivers	350

4.5 - Living Fossils (Moore, 1983, p.209,210)

1. Crinoids - Flowerlike echinoderms, commonly called sea lilies or feather stars. There are about 2,100 species of fossil crinoids and about 800 species of living representatives. Found in Palaeozoic strata (2-5 billion years ago).

2. Lingula - Within the phylum Brachiopoda, the genus Lingula, which currently lives in the oceans of the world, is found attached to the bottom in mud or sand by a peduncle. This same genus is found in the fossil marine fauna of the Cambrian strata (up to 500 000 years ago).

3. Tuatara - This relic of the past is the only survivor of the order Rynchocephalia, or beak-headed reptiles. Living specimens have been found only on islands off New Zealand, where they live in holes on sandy hills by the shore. The skeleton of one of these reptiles found in Jurassic deposits of Europe is almost exactly like the living tuatara. Fossil evidence of this organism is found in the Early Cretaceous, which supposedly leaves a time gap of 135 million years.

4. Coelancanth - In 1937 a coelacanth was caught alive east of London, Cape Province, South Africa. According to the paleontological record, the last coelacanth lived about 70 million years ago. More specimens have been taken in the vicinity of Màdagascar and South Africa. The bony structures of our modern coelacanth are almost exactly the same as those left by coelacanths hundreds of millions of years ago.

5. Neopilina - On May 6, 1952, ten specimens of this deep-sea mollusc were dredged from a depth of 3,500 m off the Mexican coast. According to paleontologists, Neopilina became extinct about 280 million years ago during the Devonian period. It is not found in intervening rocks.

6. Cycads - Zamia grows in parts of Florida, the West Indies, and South America. The East Indian genus Cycas attains a height of 67 feet and is 40 inches in diameter. Fossil cycads, quite abundant in Mesozoic formations (70-200 million years ago), have been found in many areas with abundant remains in the Black Hills.

7. Metasequoia - Fossils of Metasequoia make it the most abundant genus of the Taxodiaceae, or cypress-like family, in North America in the upper Cretaceous to Miocene formations (25-70 million years ago). Ever since 1946 many living specimens of Metasequoia have been found in China.

8. Bat - 50 million years.

9. Cockroach - 250 million years.

10. Dragonfly - 170 million years.

11. Starfish - 500 million years.

12. Bacteria - 600 million years.

13. Ginkgo tree - 200 million years.

14. Shark - 181 million years.

15. Nautilus - 100 million years.

16. Sea Urchin - 100 million years.

17. Club mosses, horsetails, ferns, liverworts, mosses, hornworts - 400 million years.

4.6 - Annotated Bibliography
Scientific Creationism

Bird, Wendall R. Freedom From Establishment and Unneutrality in Public School Instruction and Religious School Regulations. Harvard Journal of Law and Public Policy, 1979.
A lawyer's analysis of the establishment clause issues involved in public school presentation of the general theory of evolution alone and of scientific creationism with evolution.

Bliss, Richard. Origins: Two Models, Creation Life Publishers, 1976.
Made to be usable in junior and senior secondary schools; also very helpful for general use. Presents creation and evolution viewpoints side by side together with questions. Richly illustrated.

Creation-Life Publishers. Biology: A Search for Order in Complexity. 1970.
High school biology text that gives both creation and evolution views in first origins questions.

Gish, Duane. Evolution? The Fossils Say No! Creation-Life Publishers, 1979.
Brief and compelling summary of evidence from fossil record showing the fallacy of evolution.

Morris, Henry. Scientific Creationism. Creation-Life Publishers, 1974.
Creationist alternative on every important topic related to origins.

Morris, Henry, Whitcomb, John. The Genesis Flood. Grand Rapids, Michigan: Baker Book House, 1981.
Major book presenting creation and flood geology.

Moore, John N. How to Teach Origins Without ACLU Interference. Milford, MI: Mott Media, 1983.
A response to the question, "How do you teach creation in a public school institution?"

Slusher, Harold S. Critique of Radiometric Dating. San Diego, California: Institute of Creation Research, 1973.
Study of the principles, assumptions and methods of the most frequently used radioactive "clocks".

Whitcomb, John. The Early Earth. Creation-Life Publishers, 1972.
A refutation of theistic evolution.

Wysong, R.L. The Evolution-Creation Controversy. Midland, MI: Inquiry Press, 1976.
A comparison between two emotionally charged spheres of thought involving disciplines from chemistry, geology to philosophy. Includes 138 illustrations.

Smith, A.E. Wilder. Man's Origin, Man's Destiny. San Diego, CA: Creation-Life Publishers, 1968.
A scholarly work which gives the reader insight into the pros and cons of evolution.

Smith, A.E. Wilder. The Creation of Life. Wheaton, Ill: Harold Shaw Publishers, 1970.
Evaluates evolutionary design and data. Emphasizes the need for design in nature and the necessity of an efficient designer. An exhaustive probe of the evolution-creation controversy. One of the most informative, unusual and understandable presentations dealing with the whole range of issues.

4.7 - Audio/Visual Aids for Scientific Creationism

Audio Cassettes

Producer - Creation Life Publishers
Author - Henry M. Morris
Titles - Flood Geology vs. Evolution
Modern Science and the Genesis Record
The Flood and the Genesis Record
Many Infallible Proofs
Evolution and Science

Overhead Transparencies

Producer - Creation Life Publishers
Author - Richard B. Bliss
Title - Origins: Two Models (Public School edition, 1978 - 1 book, teacher's guide, 16 transparencies)

Slides (S)/Filmstrips (F)/Audio Cassettes (AC)

Producer - Creation Life Publishers
Titles - Creation vs. Evolution (S,F,AC) 22 min.
Design in Nature (F)
Fossils, Strata, Evolution (F,AC) 25 min
Miracle of it All (F)
Mystery of Man (F)
Rocks Reveal Noah's Flood (F,AC) 28 min.
Whose World? (F)
Winged Royalty (F)
How the Sun Affects our World (F)
Scientific Evidences on Origins (100 S)
Age of the Earth (F,AC) 40 min.
Geologic Formation: Young or Old, 28 min
Mystery of Early Man (F,AC) 22 min.

Videotapes

Producer - Creation Life Publishers
Titles - Creation Interpretation of Scientific Data. BETA, 30 min. George Pearce and Fred Kanwisher

Evolution or Creation - A Second Look. BETA, 50 min. Dr. Gary Parker

Evolution Creation Debate. BETA, 120 min. Dr. Robinson, Dr. Gish

Producer- Canadian Scientific and Christian Affiliation
Titles - Here's Life. BETA, 60 min. Dr. Daniel Osmond, Dr. Kelly Seagreaves

Puzzle of the Ancient Wing. BETA, 30 min. CBC Man Alive

Creation Science Organizations

1. Canadian Scientific and Christian Affiliation, P.O. Box 386, Fergus, Ontario, N1M 3W2

2. Creation Science of Ontario, P.O. Box 461, Station O, Toronto, Ontario, M4A 2P1

3. Creation Science Association of Canada, P.O. Box 34006, Vancouver, British Columbia, V6J 4M1

4. Creation Life Publishers, Inc., P.O. Box 15666, San Diego, California 92115, Tel. (714) 449-9420

5. North American Creation Movement, P.O. Box 5083, Station B, Victoria, British Columbia, V8R 6N3

4.8 - Good-bye Paluxy

It is generally thought that dinosaurs became extinct 70-120 million years ago, that is, long before the appearance of human beings. According to Louis Leakey's most recent estimates, the immediate predecessors of man developed 1-10 million years ago. In Glen Rose, Texas, near the Paluxy River, innumerable footprints of various dinosaurs can still be found today. The huge footprints of Brontosaurus, weighing about 70 tons, are still clearly preserved in many places. The tracks of Tyranosaurus Rex have also been found. Several scientists and geologists have found what appear to be human footprints quite near to the dinosaur footprints in the chalk. These footprints have been photographed and duly published (Wilder Smith, 1981, pp.95-98). A film has been made of some

of these discoveries and has attracted much attention in the U.S.A. (Footprints in Stone, S. Taylor, Films for Christ Association, 1974). The Paluxy river bed in central Texas is alleged to contain "large numbers of both dinosaur and human footprints" (Morris, 1974, p.122; Wysong, 1976, pp.373-377).

How are we to interpret such discoveries? If they are factual, it would appear that humans and dinosaurs existed simultaneously. This would shake the foundation of evolutionary theory, because dinosaurs are supposed to have been extinct long before hominids came on the scene.

Evolutionary theorists reply that the footprints are not genuine, or they have been modified. Many of the tracks are not readily distinguishable by paleontologists. In addition, during the Depression, a few of the local inhabitants made money by carving tracks in pieces of rock. Even John D. Morris, a member of the Institute of Creation Research, has said,

> "Another type of problem associated with the Paluxy tracks is whether the prints may in fact be carvings and not real footprints at all. Undoubtedly this contention has some basis in fact, for back in the thirties, once the best specimens had been removed from the river bottom and sold, a few enterprising Texans from Glen Rose began to copy the originals on limestone chunks and then offer these forgeries for sale also. The going price for prints ranged form $10.00 to $50.00, and since the dinosaur prints were much more in demand, they brought the highest price. Evidently dozens of dinosaur tracks were carved, but as near as the researchers can determine, only a very few "man tracks" were carved..." (John D. Morris, Tracking Those Incredible Dinosaurs, Creation Life Publishers, 1980, p.109).

Many Creationist books do not intimate that much of the Paluxy data is already recognized as dubious by Creationists themselves--and that even people who share their theological views reject it wholesale (Kitcher, Abusing Science, 1983, pp.121-123).

4.9 - What Price Creationism? Earth's Magnetic Decay

Thomas Barnes, in a monograph, discusses the decay of the earth's magnetic field and the relation of magnetic decay to the origin and antiquity of the earth (T. Barnes, 1973, Creation Life Publishers). Based on figures from 1835 to 1965, the half-life of the earth's magnetic field has been calculated to be 1,400 years. Calculating the rate of decay of the magnetic field today and extrapolating backwards, we find that at 20,000 years the joule heat generated from the magnetic field would probably liquify the earth. "The decay of the earth's magnetic field speaks to an age of the earth of less than 10,000 years" (Wysong, 1976, p.161). According to Barnes' calculations, prior to 10,000 B.C., the earth's magnetic field would have been impossibly strong.

However, there is overwhelming geophysical evidence for the claim that the earth's magnetic field fluctuates both in intensity and direction. Barnes' extrapolation from the present is simply misguided

(Kitcher, 1983, p.163) Barnes chose a process that we know operates at different rates at different times and then used the observed rates to estimate the time when the process began. Dating the past is a complicated and technical business. "By carefully picking a process on the basis of its ability to give the desired result, without attending to the question whether it is reasonable to think that it happened at a constant rate, creationists attempt to convince the uninitiated that their blind dates have scientific references" (Kitcher, 1983, p.163).

LESSON 5 - Other Origin Theories

OBJECTIVES

At the end of this lesson the student will be able to:

1. Understand the basic principles of the Panspermia Theory.
2. Understand the basic principles of the Directed Panspermia Theory.
3. Understand the variations in the views of Progressive Creationism and Theistic Evolution.
4. Appreciate that data can fit more than one model of origins.

TOPIC	CONTENT	REFERENCES
Panspermia Theory	-discuss the principles in the theory of Panspermia	5.1
Directed Panspermia	-discuss the differences in the theory of Directed Panspermia	5.2
Progressive Creationism	-suggested readings	5.3
	-Theistic evolution statement	5.4
	-Theistic evolution pamphlets	5.5
Interpreting Data	-discussion on metaphysical presuppositions	5.6
	-varied interpretations of data	5.7

5.1 - Panspermia

Panspermia is the classic extraterrestrial view which originated after Pasteur's disproof of spontaneous generation. It was popularized by S. Arrhenius who won the Nobel Peace Prize for chemistry in 1903 (Arrhenius, Worlds in the Making, New York: Harper and Row, 1908). According to this view, a life spore was driven to the earth from somewhere else in the cosmos by electromagnetic radiation pressure. The idea is sometimes called radiopanspermia. Arrhenius calculated that a particle in the size range 0.1 to 3 microns could escape solar gravity and be pushed along in space by the pressure of light waves. Arrhenius also calculated that any life spore larger than 1 micron in diameter would burn up upon entry into the earth's atmosphere. Most plant and animal cells are in the range of 10 to 40 microns.

This theory fails to account for three problems:

1. it does not answer the question of origins;
2. there are no means of protection from lethal radiation in outer space
3. there are no mechanisms for safe entry to the earth's atmosphere.

Scientists Fred Hoyle and N. C. Wickramasinghe have revived interest in Panspermia by offering calculations to show that a

particle up to 60 microns in size (which includes all living cells) could have reached the earth safely (Hoyle and Wickramasinghe, Evolution From Space: A Theory of Cosmic Creationism, New York: Simon and Schuster, 1981). Apparently, through radioastronomy, scientists have discovered organic molecules in space that are considered to be precursors to life. Apparently these molecules are protected by thin layers of graphite dust a few tenths of a micron thick which provide a shield from the destructive rays of u.v. light.

The Murchison meteorite which fell in Australia in 1969 contained dl-amino acids, including some proteinous ones. Another meteorite said to be 3.83 billion years old, found in the Antarctic deep freeze, contained amino acids. It was hailed as proof that the amino acids were of extraterrestrial origin (Thaxton, 1984, pp.191-194).

According to Cyril Ponnamperuma, quoted in an article entitled Odds Favour Life Beyond the Earth which appeared on January 10, 1979, in the Dallas Times Herald, B3, "The process of chemical evolution appears to be common in the solar system...Nobody has found life beyond the earth, but all of the evidence we are finding seems to point in that direction. I am certain that it is there."

Hoyle and Wickramasinghe feel that the invasion of living spores from outer space is not a one-time event, but is an ongoing process that feeds the evolution of life. "In our view the arrival at the earth of

living cells, and fragments of genetic material generally, is a continuing ongoing process that directs the main features of biological evolution. It is this process which does the job that is usually attributed to Darwinism" (Hoyle and Wickramasinghe, 1981, p.51).

5.2 - Directed Panspermia

Directed Panspermia has been suggested by Francis Crick and Leslie Orgel. This hypothesis purports that life spores were sent to the earth in some kind of rocket ship by extraterrestrial intelligence (ETI), most likely from some other galaxy. Crick gives two main reasons for this theory, and they are the same reasons given for Panspermia:

1. If it is true that the primitive atmosphere contained a significant amount of oxygen, then it would be difficult to imagine chemical evolution.
2. In the fossil record, the earliest organisms appear suddenly without any evidence of a prebiotic soup or any simple precursors. (Crick, Life Itself, New York: Simon and Schuster, 1981, pp.79,144)

5.3 - Annotated Bibliography of Progressive Creationism/Theistic Evolution

Brooks, Jim. Origins of Life. Bellville, MI: Lion Publishing, 1986.
A British geochemist examines the evidence for origins in a beautifully illustrated volume.

England, Don. A Scientist Examines Faith and Evidence. Delight, Ark: Gospel Light Publishing Co., 1983.
A chemistry professor's guide to searching for truth in "the book of nature" and in Scripture.

Fischer, Robert B. God Did It, But How? Grand Rapids, MI: Zondervan Publishing Co., 1981.
A chemist's thoughtful view of science and the Bible.

Gange, Robert A. Origins and Destiny. Waco, Texas: Word Books, 1986.
A physicist examines the origins of the world, of life and of human beings.

Hayward, Alan. Creation and Evolution: The Facts and Fallacies. Philadelphia, Penn: Fortress Press, 1985.
A physicist examines the problems of evolutionary theory and of young-earth creationism.

Hummel, Charles E. The Galileo Connection: Resolving Conflicts Between Science and the Bible. Downers Grove, Ill: Intervarsity Press, 1986.
Insights from the history of science on today's science/religion controversies.

Newman, R.C. and Eckelmann, H.J. Jr. Genesis One and the Origin of the Earth. Grand Rapids, MI: Baker Book House, 1977.
An integration of modern cosmology and the Bible by an astrophysicist and a theologian.

Pun, Pattle P.T. Evolution: Nature and Scripture in Conflict? Grand Rapids, MI: Zondervan Publishing Co., 1982.
A biologist honours both science and the Bible.

Thaxton, Charles B., Bradley, Walter L., and Olsen, Roger L. The Mystery of Life's Origin: Reassessing Current Theories. New York: Philosophical Library, 1986.
A valuable summary of the evidence against the chemical evolution of life out of non-living matter. It provides a very well thought out and clearly written analysis of the alternative theories of the origin of life.

Thurman, L. Duane. How to Think About Evolution and Other Bible Science Controversies. 2nd ed. Downers Grove, Ill: Intervarsity Press, 1978.
Help from a biologist for Christian students wondering about evolution and creation.

Wiester, John L. The Genesis Connection. Nashville, Tenn: Thomas Nelson Publishers, 1983.
Scientific history of the universe and life on earth written in the outline of Genesis 1.

Van Till, Howard J. The Fourth Day. Grand Rapids, MI: Wm. B. Eerdmans, 1986.
A physicist argues that evolution and creation are not alternatives but complimentary views.

5.4 - We Believe in Creation

Richard H. Bube, Ph.D.
Department of Materials Science
Stanford University

Reprint from the Journal of the American Scientific Affiliation (abridged).

It should be well known to readers of the Journal ASA that the American Scientific Affiliation does not take an official position on controversial questions. Creation is not a controversial question. I have no hesitancy in affirming, "We believe in creation", for every ASA member.

It is because of this foundational character of the Biblical doctrine of creation that it is unfortunate when the word "creation" is used narrowly and restrictively to refer, not to the fact of Creation, but to a possible means in the creative activity, usually to that means known as fiat creation. When it is implied that creation and evolution are necessarily mutually exclusive, or when the term "creation" is used as if it were primarily a scientific mechanism for origins, a profound confusion of categories is involved. The implication is given, deliberately or not, that if evolution should be the proper mechanism for the growth and development of living forms, then creation would have to be rejected. To pose such a choice is to do basic damage to the Christian position. It is to play directly into the hands of those evolutionists who argue that their understanding of evolution does away with the theological significance of Creation. If such an evolutionist is wrong to believe that his description does away with the need for a theological description, the Christian anti-evolutionist is wrong to believe that his theological description must make any biological description impossible.

The key to much of the evolution controversy lies in the recognition of the necessity and propriety of descriptions of the same phenomena on different levels of reality. Even a complete biological description does not do away with the need for a theological description, any more than a completely theological description does away with the

possibility of a compatible biological description. Evolution can be considered without denying creation; creation can be accepted without excluding evolution. Evolution is a scientific question on the biological level; it would be unfortunate indeed if a scientific question were permitted to become the crucial point for Christian faith.

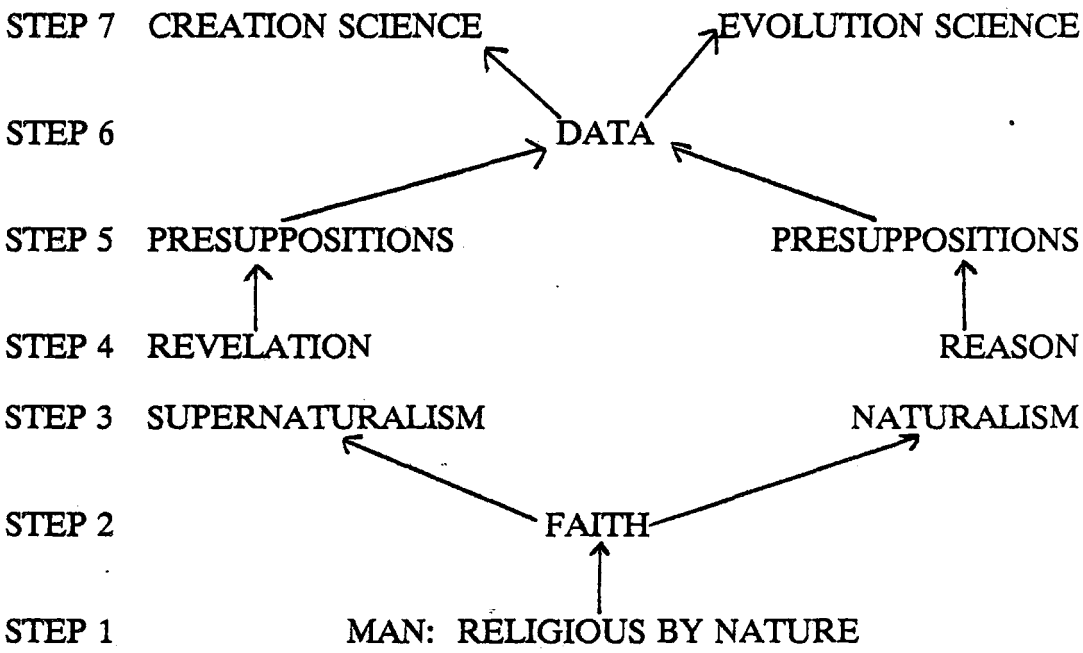
5.5 Theistic Evolution Pamphlets

For information on the American Scientific Affiliation, its Journal, or the pamphlets listed below, write to:

American Scientific Affiliation
5 Douglas Avenue
Elgin, Illinois 60120

1. We Believe in Creation, by Richard H. Bube
2. General Evolution and the Second Law of Thermodynamics, by J.A. Cramer
3. Mechanism, Naturalism, and the Nature of Social Science, by G.R. Lewthwaite

5.6 - Metaphysical Presuppositions
(adapted from David Herbert, The Necessity of Creationism in Public Education)



Understanding the diagram:

STEP 1 When viewing the panorama of history, one is immediately struck with the inescapable fact that man is religious by nature.

STEP 2 In arriving at meaningful and satisfying answers to the three eternal questions--"Where did we come from? Why are we here? Where are we going?"--we need to recognize the importance of the element of faith.

STEP 3 Two of the answers to the three eternal questions are Supernaturalism (there is a supreme Creator-God who has fashioned the universe and is directing the course of history), and Naturalism (life caused by chance and random variation).

STEP 4 The basis of authority for supernaturalism is divine revelation. The basis of authority for naturalism is human reason and deduction.

STEP 5 From the religious base of understanding of nature, certain assumptions or presuppositions have arisen as to how one views the world.

Supernatural presuppositions:
1. The universe was created and is maintained by an eternal God and master-designer.
2. The fixity of kinds.
3. Belief in a global flood.
4. Man is created in the image of God.

Naturalistic Presuppositions:
1. Matter-energy is eternal.
2. Complex life forms arose from simpler forms by means of natural selection.
3. The principle of uniformitarianism.
4. Man is a direct product of natural processes.

STEP 6 Data or physical evidence are meaningful only if we can fit them into a presuppositional framework.

STEP 7 The issue is resolved by turning to Creation science or Evolution science, depending on the presuppositional framework.

5.7 - Dual Uses of Specific Groups of Scientific Data
(Levitt, 1976, p.121)

Class of Data	Emphasizes Similarities EVOLUTION MODEL	Emphasizes Differences SCIENTIFIC CREATIONISM
Genetics and Variation	-Broad change -Change from kind to kind -Accumulation of beneficial mutations -Differences due to genetic recombination	-Limited change -Variation within kind -Mutations mostly harmful -Definite breeding gaps -No connections between kinds
Classification	-Grouped to similarities -Common gene pool	-Fixity of basic kinds -Persistence of characteristics
Comparative Anatomy	-Common gene pool -Common ancestry	-Common plan of Creator -Consistence of master plan
Comparative Embryology	-Genetic relationships -Common gene pool -Common ancestry	-No connection between kinds -Common plan of Creator -Consistence of master plan
Geographic Distribution	-Descent with change due to modified environments	-Barriers result in centres of population growth geographically isolated
Fossil Evidences	-Successive layers of evidence of succession of life forms	-Definite gaps between kinds -No intermediate forms -World-wide flood cause

Dating Estimates	-Assumptions-constant decay -Radiometric dating plus geologic column	-Evidence of young earth -Rapid burial, catastrophism

LESSON 6 - Sharing Session

OBJECTIVES

At the end of this lesson the student will be able to:

1. Orally relate his/her personal views on origins in class discussion.
2. Discern and recognize bias in articles dealing with origins.
3. Practise skills of critical thinking and critical analysis.
4. Recognize assumptions in articles dealing with origins.
5. Develop fluency in the topic of origins for defense of personal views.

TOPIC	CONTENT	REFERENCES
Classroom Discussion Guidelines	-use the opportunity in discussions to teach the students to ask critical questions, weigh the options and separate facts from opinions -set the limits of discussion to narrow the focus to a few clearly defined questions -show respect for opposing views; the logical weight of an argument is what counts in scientific discussions -consider the whole spectrum of opinion and avoid reducing discussions to extreme opinions -seek common ground in classroom discussions -watch your language and terminology to avoid any confusion -keep asking questions and avoid taking sides	
Debate	Invite guest speakers or appoint students to debate on theories of origins.	6.1
Critical Analysis	Critical analysis of articles or quotations having a one-sided interpretation or obvious bias.	
	1) Canadian Geographic article, Tropical Arctic, James F. Basinger, Dec. 1986	6.2
	2) Time magazine article by Natalie Angier, Feb. 25, 1985, p.68, Bomby the Bombadier Beetle	6.3
	3) Famous quotations	6.4

6.1 - Guest Speakers - Canadian Scientific Affiliation

In response to requests for speakers, the Canadian Scientific Affiliation provides the following names of people to speak on the Origin controversy. These people should be contacted directly because they have not necessarily agreed to speak, but we believe that they have the competence and interest to help you.

Dr. T.H. Leith, Atkinson 438, York University, Downsview, Ont. M3J 1P3

Dr. Margaret Munro, 380 Dixon Rd., Apt. 2346, Weston, Ont. M9R 1Y3

Dr. W.D. Morrison, R.R. 4, Fergus, Ont. N1M 2W5
Dr. Paul L. Pitt, 5 Bendale Blvd., Scarborough, Ont. M1J 2B1

Dr. Daniel H. Osmond, Medical Sciences #3334, University of Toronto, Toronto, Ont. M5S 1A8

Dr. Steven R. Scadding, 72 Fountain St. West, Guelph, Ont. N1H 3P3

Dr. Robert E. VanderVennen, 1 Massey Square, Suite 1910, Toronto, Ont. M4C 5L4

Dr. Ian Taylor, Dept. Anatomy, Med. Science, University of Toronto, Toronto, Ont.

Dr. Merville O. Vincent, 151 Delhi St., Guelph, Ont. N1E 4J3

Dr. Mary S. Van Leeuwen, Dept. of Psychology, York University, Downsview, Ont. M3J 1P3

Dr. Grace M. Anderson, 40 Third Avenue, Kitchener, Ont. N2O 1N6

Dr. Leroy L. Cogger, 250 Dalhurst Way N.W., Calgary, Alberta T3A 1P5
M.G. Barrington, 100 Clarke Avenue, Thornhill, Ont. L3T 1S9

Dr. Evelina O. Miranda, Dept. Educ. Foundations, Faculty of Education, University of Calgary, Calgary, Alberta

Gerry de Koning, 134 Wells Street, Toronto, Ont. M5R 1P4

Dr. William Vanden Born, Dept. of Plant Science, University of Alberta, Edmonton, Alberta T6G 2E1

Dr. Ross G. Donovan, 17 Markland Drive, Etobicoke, Ont. M9C 2M8

Dr. Paul Buxton, R.R. 3, 5705 Oldfield Rd., Victoria, B.C., V8X 3X1

James C. Ellis, 78 Diffin Street, Welland, Ont. L3C 3K3
Dr. Helmut E. Fandrich, 6411 Cambie Street, Vancouver, British Columbia

Dr. Richard K. Herd, 3 Donna Street, Ottawa, Ont. K2G 2V5

Dr. Edward Piers, 7780 Lucas Road, Richmond, British Columbia V6Y 1E9

Dr. Robert E. Jervis, 30 Chestergrove Cres., Agincourt, Ontario M1W 1L4

Dr. Jena-Pierre Adoul, University of Sherbrooke, Sherbrooke, Quebec J1K 2R1

Dr. James C. Kennedy, Dept. of Pathology, Queens University, Kingston, Ont.

Dr. John White, 74 Roslyn Crescent, Winnipeg, Manitoba R3L 0H7

Robert J.H. Miller, 3073 Jonquiere, Ste-Foy, Quebec G1X 1G8

Dr. Harry Cook, The King's College, 10020 - 108 Street, Edmonton, Alberta

Duane Nieuwsma, R.E. 1, Bowmanville, Ont. L1C 3K2
Dr. W. Stanford Reid, P3, 120 Edinburgh Rd. S., Guelph, Ont. N1H 5P7

Graham M.L. Gladwell, R.R. 1, Elmira, Ont. N3B 2Z1

Dr. Bruce M.T. Rowat, 11A Edgevalley Dr., Islington, Ont. M9A 4N6

Paul LaRoque, 116 Brunswick St., Apt. 2, Fredricton, New Brunswick E3B 1G6

Dr. Paul T.P. Wong, Trent University, Dept. of Psychology, Peterborough, Ont. K9J 7B8

6.2 - Critical Analysis of Tropical Arctic

One very recent example, illustrating the point that the same facts may fit both theories of origins equally well, is the article in Canadian Geographic (December, 1986) by Dr. James Basinger, a botanist and paleontologist at the University of Saskatchewan, Saskatoon. This article features the discovery of the remains of what was once a tropical forest in the Canadian Arctic, just 1,100 kilometres from the North Pole, on Axel Heiburg Island. Stumps of the dawn redwood (Metasequoia) and the swamp cypress (Glyptostrobus) were found in very good condition.

> "The wood has not been altered through all this time; it looks and feels almost like freshly cut wood--it splits and splinters, it can be carved with a knife, and it burns as readily as kindling...we are picking up pieces of wood, digging silt away from stumps still rooted in ancient soil, and lifting thick mats of conifer leaves from near the bases of trees. What had preserved these fossils for so long? Why had they not been lost to time and decay?...Far rarer, though, were catastrophic events that could preserve an entire forest. Such events could only have been floods of immense proportions, carrying huge quantities of sediment into the river systems and spilling out over the flood plain, rapidly burying the lowland swamp forests beneath a suffocating blanket of silt. Such events occurring once in perhaps tens of thousands of years, would envelop entire forests, preserving roots, stumps, logs and even the litter and soil of the forest floor" (Basinger, 1986, pp.34,35).

How should we explain these facts? We can look at the facts in different ways, depending upon our presuppositions. The evolutionist analyzes the nearby rocks in order to date the forest.

> "This formation consists of thick layers of sands, silts, and coals, most of them accumulated on deltas at the mouths of the great northern rivers of 45 to 60 million years ago, the early part of the Tertiary period immediately following the extinction of dinosaurs...Walking among the stumps and logs, it is so easy to let imagination erase tens of millions of years, to step not over a fossil, but freshly fallen trunks, almost to feel the lushness of the forest" (Basinger, 1986, pp.31-34).

No evidence is given to support these dates, but by analyzing the surrounding rocks and soils, the evolutionist places the trees in a specific time frame. He comes to the data with his presuppositions and fits the data into this framework.

A scientific creationist may look at the same set of data, having his own presuppositions, and come up with a completely different analysis. What kind of catastrophe could have buried these Metasequoia so suddenly so that the wood was so well-preserved? A flood of such immense proportions could only be explained by the belief in the Noachian deluge. Prior to the flood, the vapour canopy that surrounded the earth would explain why we could have a tropical forest near the North Pole. After the flood, when the vapour canopy collapsed, the climate would no longer support such vegetation.

A theistic evolutionist may look at the same set of data, having his own presuppositions, and come up with a third interpretation. He would not deny the evolutionists interpretation of the data, but he would also acknowledge that a Creator-God was responsible for directing the course of evolution as well as the catastrophe that destroyed this forest. He would have no problem reconciling the biological description of evolution of life along with his theological description of God being the prime mover and cause of all these events.

6.3 - Bomby, The Bombadier Beetle

TIME magazine, February 25, 1985, reviewed the book, Bomby the Bombadier Beetle, which was published by the Institute for Creation Research and written by Hazel May Rue.

The author, Hazel May Rue, argues that, "the nature of the creature's defenses proves that it could not have evolved. It must have first appeared in its present form, carefully fabricated by God", she maintains.

TIME writer, Natalie Angier, in commenting on this book says,

> "At first glance, the bombadier 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 degrees Fahrenheit. What is more, the fluid is pumped through twin rear nozzles, which can be rotated like a B-17's gun turret, to hit a hungry ant or frog with bulls-eye accuracy."

Creationists argue that the beetle could not possibly have evolved separate chambers of chemicals that, in the event of a genetic misstep, would have blown the insect up. A prominent member of the Institute of Creation Research, Dr. Duane Gish, who holds a doctorate in biochemistry from the University of California, Berkeley, contends the beetle would not have any use for its storage, temperature and aiming facilities until they were completely formed.

Thomas Eisner, a biologist from Cornell University says, "the bringing together of appropriate chemicals at appropriate times is the basis of all biology. It's as old as life itself". Eisner points out that none of the bombadier's chemicals are unique to the insect. "The beetle didn't invent anything, it just found novel uses for existing elements". Eisner claims that the bombadier beetle descended from a family of ground beetles that have single internal chambers and merely added the second one by subdividing the first. Eisner also offers strong evidence in the form of "living fossils", proto-bombadiers found in Africa, California and Australia.

ASSIGNMENT

1. Read the article written by Natalie Angier in TIME magazine.

2. What is the opinion of the writer of this article with respect to the question of the origin of the bombadier beetle?

3. Can you notice any bias in this article? If so, indicate where.

4. How does this article influence your thinking about the origin controversy?

6.4 - Famous Quotations

Discuss the meaning of each quotation, and its relevance to first origins.

"We had the sky, up there, all speckled with stars, and we used to lay on our backs and look up at them, and discuss about whether they was made, or only just happened--Jim he allowed they was made, but I allowed they just happened; I judged it would have took too long to make so many. Jim said them moon could a laid them; well, that looked kind of reasonable, so I didn't say nothing against it, because I've seen a frog lay most as many, so of course it could be done."

Huck Finn in Mark Twain's Huckleberry Finn (1884)

"Science can only be created by those who are thoroughly imbued with the aspiration towards truth and understanding. This source of feeling, however, springs from the sphere of religion."

Physicist Albert Einstein in Science, Philosophy and Religion (1941)

"Americans remain deeply divided in their beliefs about the origin and development of the human species, and a significant number care strongly enough about those beliefs to dispute how to teach the subject in school."

Attorney and science historian, Edward J. Larson, in Trial and Error: The American Controversy Over Evolution and Creation (1985)

"The extremity of creationist charges and claims is, to a degree, a reflection of corresponding extremities of evolutionists themselves. Both extremes tend to fuel the fires of the other, and to find their worst fears realized."

Conrad Hyers in The Meaning of Creation (1984)

"A revitalization of interest in scientific honesty and integrity could have an enormous benefit both to science and to the society we serve."

Physicist Lewis M. Branscomb, Chief scientist of IBM Corp, in Integrity in Science, American Scientist (Sept/Oct 1985)

"Of all the mysteries in biology, unquestionably the most baffling is the question of how life arose on the earth."

Gordon Rattray Taylor, science writer, in The Great Evolution Mystery (1983)

"When considering our origins it is clear that we have been less than objective."

Anthropologist Richard Leaky in The Making of Mankind (1981)

"The origin and earliest evolution of the metazoan (multicelled) phyla cannot be documented from fossil evidence."

Biologists T. Dobzhansky, F.Y. Ayala, G.L. Stebbins, and J.W. Valentine in Evolution (1977)

"It seems beyond all question that such complex systems as the DNA molecule could never arise by chance, no matter how big the universe, or how long the time. The creation model faces this fact realistically and postulates a great Creator, by whom came life."

Dr. Henry Morris in Scientific Creationism, p.62 (1974)

LESSON 7 - Evaluation

The evaluation of student achievement and program effectiveness must be an integral, ongoing part of the teaching-learning process. This evaluation can satisfy different functions:

1. To provide the student with information concerning what he/she has learned and what still has to be learned.
2. To provide parents with information concerning the student's progress.
3. To verify the appropriateness of the stated objectives.
4. To provide information that will allow the teacher to modify the program as needed.
5. To assess the quality and effectiveness of the learning strategies and materials that have been used.
6. To spur the student on to further achievement.

Students exploring areas of interest may demonstrate creativity, originality, organizational skills and writing ability through projects, reports and essays. Where such activities are to be evaluated, the way in which they are to be assessed and their relative importance in the total evaluation process should be clearly outlined in advance. (see 7.1)

A short test or quizzes may also be used to assess student progress. Ideally these should be used for formative evaluation. If the results of such tests form part of the student's summative evaluation, the tests should be carefully designed to reflect the clearly established objectives of the unit. (see 7.2)

At times, self-evaluation can be useful and may stimulate the achievement of realistic goals. Students can find out how much they have learned, what they have not learned--identify strengths and weaknesses. They can be given a questionnaire to be completed at home; the answers can then be supplied the next day in class with students marking their own papers. This suggests implicit faith in them and their ability to examine themselves and then to consider the consequences realistically. (see 7.4)

Perhaps the aim of the unit is not to conclude with any summative evaluation, but simply to expose the students to the options and alternatives that are available to them. In this case, the goal may simply be that the student form some opinion or value into which all subsequent learning can be moulded. The student should be given some oral or written opportunity to express these views, so that the teacher can see that the issue has been dealt with. This type of evaluation supports the Values Clarification method of teaching morals. (see 7.3)

It is most desirable, of course, to employ a wide range of methods in student evaluation. Since not all students are comfortable with

one particular method of evaluation, excessive use of one method could significantly affect the results of some students. Diverse methods of assessment will ensure fair and equitable results. Some of the choices open to the instructor are:

1. Short answer,
2. Completions of sentences,
3. Labelling exercise,
4. True/false questions,
5. Multiple choice,
6. Matching,
7. Mathematical problem solving,
8. Notes and reports,
9. Projects,
10. Puzzles,
11. Essay,
12. Critical analysis of an article, and
13. Development of attitudes.

7.1 - Science Project - Origins

SCIENCE PROJECT - ORIGINS

As part of our study of origins, you may choose one of the following topics to research. In your paper, try to bring out original and interesting ideas that have not been discussed in class.

Length 1000 words minimum

Due Date _____

Format a) title page
b) double-spaced essay
c) write on one side of the page
d) bibliography - minimum of three books or articles
e) footnotes - can be listed at the end of the paper

Topics
1. Scientific Creationism
2. Darwinian Evolution
3. Neo-Darwinian Evolution
4. History of Evolution
5. The Genesis Flood and Science
6. Dinosaurs: What Happened to Them?
7. Palenontology and Origins
8. Scopes Trial: A Historical Review
9. Limitations of Science in Studying Origins
10. Science vs. Religion: The Great Debate
11. Creationism in the History of Science
12. Scientific Dating Methods
13. The Origin of Life
14. The Origin of the Earth
15. Macroevolution or Microevolution?
16. The Punctuated Equilibrium Theory
17. Origins and Ethics: Is There a Connection?
18. The Evolution of Man: Fact or Fiction?
19. The Big Bang Theory
20. The Age of the Earth
21. The Panspermia Theory

22. Theistic Evolution
23. ...other topics upon approval of the instructor

Evaluation		
	Title Page Bibliography	5
	Content	25
	Originality	10
	English	10
	TOTAL	50

7.2 - Origins Test

Answer the following questions in complete sentences or short paragraphs.

The value of each question is indicated.

(5) 1. Why is it important to study origins?

(5) 2. Can theories of origins be proven with present day phenomena?
Why or why not?

(5) 3. What is the scientific method?

(5) 4. Give five (5) major lines of evidence cited by evolutionists in support of their theory.

(5) 5. What is Darwinian Evolution?

(5) 6. What is Scientific Creationism?

(5) 7. What is Theistic Evolution?

(5) 8. Give five (5) major lines of evidence cited by creationists in support of their theory.

(4) 9. Give two (2) examples of false evidence evolutionists have used to support their theory, and two (2) examples of false evidence cited by creationists in support of their theory.

(5) 10. What is the theory of Panspermia? How does it differ from Directed Panspermia?

(5) 11. What is the connection between a world-view and a theory of origins?

(10) 12. State clearly your own personally-held theory of origins and your reasons for holding to it.

7.3 - Origins Preference Chart

Below you will find nine statements which express an idea about origins. Place an "x" next to the statement that you feel comes closest to your view. Mark only one "x" on this sheet. At the end of this exercise, write a page to express why you chose this particular statement.

1. Evolution is a fact that has been proven by scientific studies.
2. Evolution is true because many scientists affirm it.
3. Evolution of life seems fairly certain from scientific studies.
4. Evolution occurred with the help of God.
5. Neither evolution nor creation is a very good explanation of origins.

6. Creation started life, but evolution has taken over.

7. Creation of all life seems fairly certain from scientific studies.

8. Creation is a fact that has been proven by scientific studies.

9. Creation is a fact because God has revealed it to us.

What are the reasons for your choice? Answer in the space below.

7.4 - Self Evaluation
(adapted from Moore, 1983, pp.27-32)

Below you will find statements made about various aspects of several models of origins. An answer key is provided with five possible choices for each question. Try to match the statement to the best choice(s) in the answer key. More than one possible answer may fit some of the statements. (Teacher's answers are provided in brackets).

KEY: 1. Evolution model of origins.

2. Creation model of origins.

3. Panspermia model of origins.

4. Theistic evolution model of origins.

5. All models of origins.

1. Some integrative and innovative principle or principles have been involved in changes of living things. (1) (3) (4)

2. Variation and speciation has been and is limited to changes within possible kinds. (2)

3. Basic plant and animal kinds with ordinal characteristics resulted from acts of a Supreme Being. (2)

4. Some conservational and disintegrative principle or principles have been involved in changes of living things. (2)

5. Gradual changes have occurred of least complex kinds into more complex kinds with transitional series linking all kinds with no systematic gaps. (1) (3) (4)

6. Origin of all living things from a single or very few living sources which came from inanimate matter because of inherent properties of inanimate matter. (1) (3)

7. This model is untestable directly, but primarily only by analyzing logical reasonableness. (5)

8. Sharp boundaries exist between major classification groups with no transitional forms between higher categories. (2)

9. Geologic column is evidence of a vast history of the earth. (1) (3) (4)

10. Only local sedimentary columns exist and worldwide destruction is evidenced by worldwide distribution of sedimentary rocks. (2)

11. Some forces of origination and integration have been involved in changes of living things. (1) (3) (4)

12. Life arrived at the planet Earth by intergalactic space travel. (3)

13. The theological description of a Creator-God and the biological description of evolution can be harmonized and are not mutually exclusive. (4)

14. Matter that existed eternally somehow generated into a whole series of elements, stars and planets. (1)

15. There are no initial events that can be used as a basis for this model of origins. (5)

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