# INTEGRATING FAITH AND LEARNING IN TEACHING BIOLOGY

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## Introduction

### Organizing Principles in Biology Teaching

The biology classroom presents unique opportunities for the integration of faith and learning. Living organisms are the most complex systems known. They provide impressive evidence of design and examples of God's creative power and genius. On the other hand, the standard biology curriculum is typically shaped around evolutionary theory, with its claims that life gradually developed over millions of years. The need for integration of faith and learning may be felt more strongly in the biology classroom than in almost any other discipline. Achieving this will require development of critical thinking skills, a crucial component of a good education in any subject.

A typical biology course includes four major topics: cellular and molecular biology; organismal diversity; ecology; and vertebrate physiology. Typically, each of these topics is presented with evolution as a central organizing principle. Frequently, evolutionary theory is also presented in a separate module. The Adventist biology teacher has the opportunity to present biology from a Biblical viewpoint, in which design and stewardship are central organizing principles. Differences between the Biblical approach and the textbook's evolutionary approach can be opportunities to teach the difference between the scientific data and the secular presuppositions underlying the textbook's interpretation of the subject. The teacher will also want to encourage students to develop their own ability to re-interpret the material from a creationist worldview. These are the goals to be discussed in this paper.

### Following the data alone?

In discussions of origins, one sometimes hears a call for a release from all preconceptions. "Just follow the data wherever it leads" is the plea. Such pleas imply an unrealistic view of science. *Data have no meaning aside from some interpretive framework.* Data without interpretational presuppositions cannot lead anywhere. The idea of bias-free interpretation has been abandoned by philosophers of science, but one may occasionally encounter it in debates.

Differences in presuppositions may lead different observers to interpret data in ways that are mutually contradictory. For example, all organisms have certain underlying biomolecular similarities. These similarities can be measured and compiled as data. Those with an evolutionary worldview interpret these data as the result of common ancestry. They may analyze the similarities and devise phylogenetic trees to express hypotheses of relationships.

On the other hand, those with a creationist worldview interpret the biomolecular similarities as the result of either of two factors -- common descent in some cases and common design in others. A single Creator used similar principles to create many separate groups of organisms. Further diversification within single lineages has taken place since the creation. Creationists are interested in studying how changes occur, what factors limit changes in species, and how one might determine whether two species are in the same lineage or in different lineages.

Both groups tend to claim that the data are evidence for their presuppositions, but actually it is the presuppositions that provide the data with meaning. Evolutionists may state that similarities are *evidence* of common ancestry, but it is more accurate to state that the similarities are *interpreted as the result* of common ancestry. Creationists may *interpret* the same data as the result of common design. Different presuppositions may give different meanings to the same set of data – common descent or common design.

Other examples could be developed to illustrate how the same data can have different meanings in different worldviews. Students should be taught to recognize the difference between data and interpretation,[1] as well as the role of presuppositions in interpreting data. Some illustrations are given below of how design and stewardship can be utilized as organizing principles for each of the four general topics typically incorporated in an introductory biology course.

## Integrating faith in the teaching of cellular and molecular biology

Cellular and molecular biology forms the foundation of modern biological studies. This subject raises some highly important issues relating to integrating faith and learning. Among these are questions of the nature of life and its origin.

### Biomolecular reductionism and human distinctiveness

Scientists have attempted to explain all activities of living organisms in terms of molecular reactions. Such attempts have been remarkably successful. Although no organism has been completely explained at the molecular level, many aspects of behavior, heredity, and morphology have been explained. This represents a triumph for the notion that the whole organism can be understood as the sum of its parts, a notion called reductionism.

Reductionism is the belief that one may understand a complex system by understanding the functioning of each of its components separately. Reductionists tend to regard living organisms as "biorobots" that can be ultimately explained through biochemistry. Holism is the opposite of reductionism. Holism is the belief that certain properties of a complex system do not reside in any of its components, but are "emergent" properties that depend on the entire system. Holists, if we may use that term, tend to regard organisms as more than "biorobots," and to suppose that some of their properties cannot be predicted from the laws of biochemistry.

Where do Christians stand on the matter of reductionism? Are living organisms truly "biorobots?" Suppose it could be shown that worms are indeed "biorobots" that can be explained by biochemical principles. Would this mean that humans are also "biorobots?" Could an

evolutionist who believes that worms and humans have a common ancestry claim that but only the worms are "biorobots?" Could a creationist make such a claim?

I suggest that creationists could consider worms as "biorobots" while rejecting that idea for humans; however, evolutionists could not do so, except by special pleading. Creationists believe that worms and humans were separately created, and that the nature of worms does not necessarily imply anything about the nature of humans. This does not, of course, mean that creationists actually regard worms as "biorobots." Evolutionary theory, on the other hand, does not provide any mechanism for distinguishing between the nature of worms and the nature of humans. As the late eminent paleontologist, George Gaylord Simpson wrote:[2]

> "He [Man] happens to represent the highest form of organization of matter and energy that has ever appeared."

This is reductionism at its extreme. Although this is still the dominant position within the scientific community, many scientists today would disagree with Simpson, and allow a special place for humans. Many Christians suppose that human uniqueness is the result of God placing an immortal human "soul" into some ancestral primate, thus "creating" the first human. It is the privilege of the Adventist biology teacher to point out the negative theological implications of this unbiblical theory, and the good news of Biblical creation.[3]

**Scientific evidence for intelligent design in the origin of life**

The origin of life provides a special opportunity for the biology teacher to point to the Creator. Scientists have devoted a great deal of research money and time attempting to explain how life might have originated without supernatural intervention. The theory of life originating from non-life is known as abiogenesis. Some textbooks start by presenting the theory of abiogenesis, often in a way designed to make it seem plausible. Such presentations are frequently misleading.

One may summarize the findings of origin of life research by stating that it has shown us that life could not possibly have originated abiotically under any circumstances known to science. It may be argued that this does not show that life could not have so originated -- we simply have not yet discovered how it might have happened. While this statement is logically true, it is not an argument in favor of a scientific explanation for the origin of life -- rather it is a statement of faith in the presuppositions of naturalistic science. Creationists are not surprised by the results of origin of life research, because they believe life originated by God's creative activity. Some evidence relating to intelligent design in the origin of life is reviewed below.[4]

**Creating life in the laboratory?** The problem of the origin of life involves two different kinds of questions. The first question is whether life can be created in the laboratory under the direction of a team of chemists, using carefully designed experiments. If life can be created in the laboratory, one may then ask the second question – whether the conditions necessary to create life can be found in nature, so that no laboratory or team of chemists is necessary.

It is a well-known fact that scientists have been unable to create life in the laboratory. Thus there is no opportunity to ask whether the laboratory creation of life is a fair representation of what might happen in some natural environment such as space or the deep sea. I will overlook this issue and consider the problem of creating life by any means.

What is life? Suppose someone were to come to you and claim to have created life in the laboratory. How would you test this claim? How would you know if what was produced was actually alive? This question is more difficult to answer than one might expect, but scientists have identified a number of characteristics they regard as necessary for something to be considered alive. These include the following:

1. A system for converting energy from the environment into useful energy within the organism;
2. A system for converting raw materials from the environment into useful products for the activities of the cell;
3. A system for producing new copies of the cell;
4. A boundary that distinguishes the organism from the environment; and
5. A system for storing and utilizing the information that guides all these other cellular processes.

In a typical living cell, these characteristics are provided by a series of specific biomolecules, arranged in a precise spatial ordering. Examples include the cellular metabolism, the ribosomes, the cell membrane, the DNA and its replication system, etc. Any claim for the creation of life should be tested to see if each of these systems has been produced experimentally. If the claim passes this test, one may then move on to the next question: can life be produced by chance through natural processes, or is intelligent design necessary?

**Proteins and probability.** All known life depends critically on two components: proteins and nuclei acids. One of the major problems in abiogenesis (the theory that life spontaneously arises from non-living materials) is to explain the origins of proteins and DNA. Neither material is found anywhere except in association with living organisms. There are no protein or DNA molecules in space, although some of their "building blocks" (e.g., amino acids) have been detected. The presence of the building blocks might seem to increase the possibility of life arising spontaneously, but experimental evidence indicates it does not. I will describe some of the problems.

All known life forms contain many kinds of proteins that are necessary for survival. Some proteins are catalysts (enzymes), which are necessary for cellular metabolism. Other proteins are required for the cell membrane to function properly. Still other proteins are needed for replication of DNA. Indeed, proteins are needed in all five of the systems described above as shared by living organisms.

Proteins are made of chains of smaller molecules ("building blocks") known as amino acids. At least 20 different kinds of amino acids are used in proteins, and a protein chain may be 1000 amino acids or more in length. This means that proteins come in an almost infinite variety of amino acid sequences. The structure and function of a protein depends on its amino acid sequence, so proteins can vary enormously in their function.

Proteins are not found independent of living organisms, but amino acids are. Amino acids have been detected in space and on meteorites, and small quantities have been produced in the laboratory under conditions thought to resemble conditions on a lifeless planet. Although no known conditions will result in production of all 20 necessary amino acids, I will ignore the problem of the source of amino acids, and make the assumption, however implausible, that all are available. I will focus on the problems of assembling amino acids into a useful protein molecule.

Assembly of amino acids into a protein involves a number of difficulties. First, nearly all amino acids come in two forms, known as stereoisomers. These two forms can be thought of as "right-handed" and "left-handed." Like our hands, they are "mirror images" of each other. The two forms are chemically equivalent, but their differences are important when they combine because of the effect on the shape of the protein molecule. The following illustration will explain how this works.

Humans usually shake hands using their right hands. Left hands would work just as well, but right hands are the standard way. If one person tried to use his right hand, while the other tried to use his left hand, the handshake would be awkward because the hands don't fit naturally together. This is avoided by the practice of shaking only with right hands. Likewise, amino acids could combine either way, but proteins are produced only by combinations of left-handed amino acids. Combinations of right-handed and left-handed amino acids readily form but they do not produce proteins. All proteins (a few rare exceptions have been reported[5]) use only one form -- the "left-handed" form. Life could probably be based on the "right-handed" forms, but it is not. It is fortunate that all living organisms use the same form (left-handed), for this permits animals to use plant proteins as food.

The necessity of only left-handed amino acids presents a difficult problem for the origin of life. Just as humans have equal numbers of right and left hands, so artificially made amino acids have equal numbers of left- and right-handed forms. Since the two forms are chemically equivalent, they readily combine in mixtures that are unsuitable for making proteins. A simple probability calculation will illustrate the difficulty of obtaining a useful protein by chance.

Suppose one wishes to produce a protein of 100 amino acids from a mixed pool of right- and left-handed amino acids. When the first amino acid is selected, the probability of it being left-handed is one-half. The same for the next amino acid, and for all the amino acids in the chain. The problem is actually more complicated than that, but this illustrates the point. The probability of selecting 100 consecutive left-handed amino acids from a mixture is $(1/2)^{100}$, which is about $10^{-30}$. Some experiments have shown that left-handed amino acids seem to prefer joining to other left-handed amino acids, so the probabilities may not be quite that low, but they are still much worse than the probability of winning the lottery twice in a row. But this is only the beginning of the problems associated with producing a protein by chance.

Proper chemical bonding is another requirement for producing a protein. Amino acids can combine in more than one way, but only one way, peptide bonding, is appropriate for proteins.

The probability of forming different kinds of chemical bonds depends on the specific amino acid involved. If we simply estimate the probability of peptide bonding at one-half, we have the same calculation as before -- the probability of forming 100 successive peptide bonds is about $10^{-30}$. As before, this should be considered only a rough estimate, but it makes the point that we have good reason not to expect to find proteins except where they have been produced by living organisms.

Amino acid sequence is another problem with forming proteins by chance.[6] Merely producing a chain of 100 amino acids is not enough. The number of possible proteins composed of only 100 amino acids is about $10^{130}$ , each with somewhat different chemical properties. What is the probability of getting a useful protein from such a large potential pool? Some of them will probably be similar enough to substitute for one another, so the probability of getting a useful protein is better than simply one in $10^{130}$. How much better? No one knows, but one can explore the probabilities a bit.

Let us suppose that none of the 100 amino acid positions in our hypothetical protein has to have a specific amino acid. Instead, each position may be occupied by any of ten amino acids. In other words, for each position, ten kinds of amino acids are permissible and the remaining ten kinds are not. This means that the probability of getting a useful amino acid at a specific position is ten of twenty, or one-half. What is the probability of filling all 100 positions with a useful amino acid? The calculation should seem familiar -- it is about $10^{-30}$. I doubt any scientist would propose that a protein could tolerate any of ten amino acids at each position and still retain its function. The actual probability of forming a useful protein, although not known, is surely much lower than $10^{-30}$. If each position could be filled with any of just five amino acids, the probability would be less than $10^{-60}$. The probability of getting a useful protein by chance is vanishingly small.

The idea of producing a protein by chance has other problems. For example, without enzymes present, amino acids must be heated in order to cause them to combine. If other kinds of molecules are present in the heated mixture, which will always be the case in nature, a kind of sticky, useless tar will be produced. This is the normal outcome of origin of life experiments. Another problem is that the presence of water will tend to break any bonds that might have formed between the amino acids.

When all these problems are added together, the problem of producing a protein by chance seems impossible. In order to form a protein, all necessary conditions must occur simultaneously. The amino acids must have the proper "handedness", they must combine with peptide bonding, they must form a sequence that is useful, and they must be free from contamination. The probability of all these things happening simultaneously is so small as to be effectively zero. Furthermore, even if a protein were somehow to be formed by chance, one would still not have life. A dead chicken is full of proteins, but it is not alive. It takes far more than a protein to make life, and chance cannot make even a single protein.

Some scientists have criticized probability arguments such as I have presented, by stating that geologic time provides so many opportunities that even highly improbable events will eventually

occur. This argument does not take into account the magnitude of the odds. The age of the universe, according to the standard model, is only about $10^{17}$ seconds. Even if one postulates the existence of $10^{10}$ planets where life might arise, the improbability of life arising spontaneously is hardly affected. It is only faith in one's naturalistic presuppositions that sustains belief in the origin of life by chance.

**Scientific evidence for design in the function of cells**

**Design and irreducible complexity.** The theory of common ancestry is based on the gradual accumulation of changes in small steps. Large steps are too improbable, and would produce too much trauma to a species to be viable. Change must come gradually, one step at a time.

The problem with gradual stepwise change is that, in order to be preserved, each step must be useful. Small steps that do not improve the species are unlikely to be preserved. Changes, or mutations, may cause enough change to be observable, or they may have no noticeable effect. Observable changes are almost always harmful, and natural selection will eliminate them. Mutations without noticeable effect are not likely to be useful, so they will be preserved or eliminated by chance. Neither of these two types of change is likely to result in any meaningful improvement in a species. When one considers the complexity of cellular metabolism, or the human eye, or a host of other features of living organisms, it seems absurd to think they could have arisen by chance. Yet Darwin insisted they did.

Darwin proposed the theory of natural selection to explain the origin of complex systems in living organisms. Darwin made the following statement, which could be called "Darwin's Principle:"[7]

> "If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down."

Darwin added that he knew of no such cases. In Darwin's day, no one knew much about how cells operate, and it was impossible to demonstrate whether such systems existed or not. At that time, the cell was only a "black box" which no one could see inside.

Scientists have made great advances in understanding the cell and its operations, and the "black box" of the cell has been partially opened. Michael Behe has brought the issues to public attention with his book, *Darwin's Black Box*.[8] This book presents examples of biological systems that have been found to violate "Darwin's Principle" as they have become understood at the molecular level. The cilium is a convenient example (see Figure 1).

Cilia are found lining the respiratory tract in mammals. Certain protozoans use them to produce motion for swimming. Their structure is understood well enough to conclude that it is not plausible to suppose they originated in a series of small steps. Here is a summary of the evidence Behe presents.

A cilium is made of several necessary molecular components. The main structure of the cilium is made of a molecule called *tubulin*. Tubulin forms tiny fibers that may occur singly or as doublets. In a cilium, nine doublets are arranged in a circle, with two single fibers in the center. The doublets are connected to each other by a "stretchy" molecule known as *nexin*. If two fibers are pulled in opposite directions, the elastic nexin molecule allows them to move a little bit, but not very far. Another protein, "radial spoke protein", connects the ring of doublets with the central fibers. Finally, a molecule called *dynein* links the doublet fibers with each other. Dynein changes its shape when it reacts with an energy source. The ends of the dynein molecule are attached to the doublet fibers so that when the dynein changes shape, the fibers slide past each other. But the nexin prevents them from sliding very far. The result is that one side of the cilium is pushed up while the other side is pulled down, causing the cilium to bend. By repeating this motion many times in rapid succession, the cilium is made to beat back and forth, moving the fluid around it. This is how a cilium works. How could it have originated?

Suppose we wanted to postulate a simpler, ancestral condition for the cilium. Which of the molecules could we remove to achieve a functional ancestral condition? If we remove the tubulin, we have no fibers. If we remove the dynein, we have no motion. If we remove only the nexin, the fibers will slide past each other and the cilium will fall apart. In each case, the function of the cilium is destroyed, and the incomplete cilium is useless. With no function, there is nothing to be favored by natural selection, and Darwin's theory "absolutely break[s] down."

The cilium is both complex and irreducible. Behe has created the term "irreducible complexity" to represent this condition. Irreducibly complex systems violate "Darwin's Principle," and refute his claims for the power of natural selection. Behe lists a few other examples of irreducible complexity, and one gets the feeling that there are hundreds more waiting to be described. Irreducible complexity is a prominent feature of living cells, and is evidence of design to anyone whose philosophical presuppositions permit him to accept this interpretation.

**Summary**. Molecular biology provides at least two types of examples that can easily be presented to biology classes as the result of design. The principles of probability show that chance is not a reasonable explanation for the origin of proteins. Stepwise changes are not reasonable explanations for the origin of irreducibly complex systems. (In a sense, both arguments depend on probability considerations.) Using these and other examples, Adventist biology teachers may shape their presentation of cellular and molecular biology around the idea of design, rather than chance.

## Integrating faith in the study of biodiversity

As noted previously, all organisms share certain features such as having a genetic code and cellular metabolism. The members of a given species are more similar to some species than to others. Evolutionists explain the greater similarities as the result of more recent common ancestry. Creationists recognize two factors that may cause similarities among species: common

descent and common design. If the respective species possess the same body plan and vary only in details, common descent may be a good explanation for their origins. Variation within an ancestral species may give rise to new species with minor differences. In contrast, common descent does not seem to be a good explanation for the origins of species that differ in their body plans or other major features. Similarities among such different species are more likely to be the result of common design.

The process of distinguishing common descent from common design can be challenging, since only indirect methods can be used. Some observations are more readily explained in a creationist view while others are more readily explained by common descent. Several lines of evidence bear on the question of how to distinguish between common descent and common design.

I will first review the nature of some of the evidence that seems supportive of common ancestry. There is a general pattern of similarities that can be described as "nested." A group of highly similar species may form a small group, which can then be linked with one or more other groups of highly similar species to form a larger group. This pattern of groups within groups is what is meant by "nested." This is the same pattern as is seen in mathematical sets and subsets. The arrangement of nested sets is expected by evolutionists, because repeated splitting of lineages would produce such a pattern. Furthermore, the pattern is noticeable at both the morphological and molecular levels. The evolutionary viewpoint is further strengthened by a general correlation between the sequence of fossils and the sequence of nested sets of species, although many exceptions occur.

Having acknowledged that evolutionary theory provides a good explanation for some of the data, we can now point out that some of the evidence does not fit so well with evolution. First, the nestedness of taxonomic groupings is not as clean as one might expect. There are many examples of species that share some similarities with one group and other similarities with another group. Sometimes the pattern of similarities is so confusing that scientists disagree over which groups are more closely related.

In his well-known book, *Wonderful Life*,[9] Stephen Jay Gould notes that the Cambrian fossils of the Burgess Shale do not fit a nested pattern. He compares them to the results of a "great token-stringer" who assembles the parts and then mixes and matches them in various combinations. Perhaps this is a cue for creationists. The anomalies of classification, commonly called convergences, may be evidence of common design.

One person who makes a claim along these lines is Walter Remine, in his book, *The Biotic Message*.[10] In this book, Remine claims that God deliberately designed nature in such a way that it would appear to be the result of a single Creator, but would resist attempts to interpret it as the result of common ancestry. In his view, similarities among organisms point to a single Designer, while differences among organisms are reminders of separate ancestry. Whether or not one agrees with his viewpoint, the biotic message theory is an interesting way to interpret the patterns of similarities among species.

A second problem with the idea of common ancestry is the matter of "morphological novelty." Morphological novelties are structures found only in a certain group of species, but not found in any other group. Most examples are unique to a single higher taxon; for example the water vascular system is characteristic of echinoderms, and the respiratory system of birds has a unique structure. Although these systems have not been thoroughly analyzed as examples of irreducible complexity, they appear to be good candidates. If so, they can readily be interpreted as the result of separate ancestry rather than descent with modification.

Recent genome studies have shown that different types of bacteria have different genes not shared with any other known group.[11] Unique genes may be called "biomolecular novelties." Biomolecular novelties appear to be a common feature of bacteria. Further research will show whether they are also common among higher organisms. As our knowledge of biomolecular novelties improves, creationists may have another useful tool to help identify groups with separate origins.

A third problem of common ancestry is the pattern in the fossil record known as "radiation." Many groups, although not all, first appear in the fossil record in a rich diversity of higher taxa. The most famous example is the Cambrian Explosion, in which many phyla and classes appear abruptly, and at about the same level, in the fossil record (see Figure 2). Other lesser examples are known also. Although evolutionists interpret radiations as the result of rapid evolution, this explanation seems strained when applied to higher taxa. Perhaps a highly variable species could radiate rapidly into a diversity of species in one or a few genera, but it is implausible that a single species could give rise to a group of divergent Classes in a short time. Our experience with living organisms suggests that this does not happen. Interpreting fossil radiations as a result of evolutionary processes is based on the evolutionary presupposition of common ancestry rather than on empirical observation.

Creationists can explain "radiations" in the fossil record as the result of catastrophic destruction. Sudden burial of the seafloor, or another habitat, might preserve a group of fossils related ecologically but not genealogically. Similarities could be due to common design for similar habitat requirements rather than to common descent. This might explain many features of the "Cambrian Explosion," and perhaps some other fossil examples.

Radiations in the fossil record could also reflect diversification of species before the Flood. A single ancestral species might diversify in a particular region, producing a group of similar species. If this group was restricted to a single region, it might not appear in the fossil record until that specific region was destroyed and its organisms buried. The resulting pattern might be interpreted as a "radiation." Groups that were more widespread would not necessarily be buried together, and might produce a different kind of fossil pattern.

**Summary.** Patterns of biodiversity can be explained as the result of common descent or common design. Each interpretation has its strengths and weakness. Adventist biology teachers can point out these strengths and weaknesses to their students. They may teach their students the importance of presuppositions in interpretation of data, and show them how a creationist might interpret some of the data used by evolutionists.

**Integrating faith in the study of ecology**

Christians have often been accused of being poor stewards of the environment. Many Christians have used the creation story as an excuse for destructive environmental practices. They quote Genesis 1:28:

"Be fruitful and multiply, and fill the earth and *subdue* it; . . ."

The earth is sometimes considered to be like an enemy to be subdued and conquered. However, this is a misuse of the text. Humans were appointed to guard and care for the earth. We are to manage the natural world for the good of all. It is wrong to use this text to justify whatever action we think will bring us the quickest economic gain. God gave us responsibility for managing the world, and He will hold us accountable for the way we have done it. This accountability is noted in Revelation 11:18:

"I will destroy them that destroy the earth."

Some Adventists are tempted to reason that this earth is only temporary anyway. Jesus will soon arrive and fix everything that we have damaged. But this is not a responsible attitude. Truly, Jesus will come and fix everything, but that will not do us any good if we are judged unfaithful stewards. Furthermore, we do not know how long it will be before Jesus comes, and it is our responsibility to provide for the survival and happiness of our children and grandchildren.[12]

The ancient Hebrews were given instructions on how to prevent or slow down ecological deterioration.[13] Unfortunately, careless exploitation and over-development resulted in desertification of much of the Mediterranean region. Some of this was probably the result of Solomon's harvesting of timbers for the temple and other building projects. We see this trend accelerating today as forests are destroyed for quick profits with no consideration of the economic and environmental effects of such drastic actions. Christians should support attempts to develop ecologically responsible methods of economic development. The establishment of forest and game reserves helps protect the environment against too rapid development and resulting environmental deterioration.

Another aspect of ecology that deserves consideration is the evidence for design in the interrelationships of nature. The nitrogen cycle provides an interesting example.[14] Nitrogen is a vital ingredient in proteins and nucleic acids, both of which are required by living organisms. Nitrogen exists in various chemical combinations, most of which cannot be absorbed by plants. Various bacteria act to convert nitrogen into a chemical form useful to plants, through a series of chemical steps. The process appears to be designed.

The oxygen cycle is another example that appears to be the result of design. Plants produce oxygen and carbohydrates from carbon dioxide and water. Animals consume the oxygen and carbohydrates and produce carbon dioxide and water. What if it were different? Could animals survive long without plants? Clearly not. Plants could probably survive longer without animals, but plants rely on bacteria and other organisms, and also benefit from animal activities.

Other examples of ecological interdependence could be given. Ecological cooperation is a significant feature of living systems. Experiments have shown that biological productivity is enhanced by biodiversity. Natural habitats that are rich in biodiversity produce less total biomass when some of their species are removed.[15] It seems that living organisms interact in ways that benefit the entire ecosystem. One may interpret this as a lucky result of chance, but creationists can regard it as the result of intelligent design.

**Summary.** The principles of environmental stewardship should be stressed by Adventist biology teachers. Good ecological practices are encouraged by the Scriptures, and illustrated by the rules given to the ancient Hebrews. We have a God-given responsibility to manage the earth in such a way as to preserve life. The nearness of the Advent should encourage us to bring our ecological practices in harmony with the responsibility we have been given, not to disregard the consequences of our actions. The Adventist biology teacher can instill in his or her students a respect for good ecological practices, and an appreciation of ecological interrelationships that the Creator designed to sustain and enrich our lives.

## Integrating faith in the study of human body and mind

The principle of stewardship applies also to our own bodies and minds, as Adventists have taught for decades. This is so familiar that I will not pursue it in detail here. I will simply point out the connection between body and mind, in which a poorly maintained body results in a poorly functioning mind. Since the mind is the only avenue of communication between God and us, it is vital that we maintain both body and mind in good condition.

The mind also provides an example of intelligent design. Scientists do not understand the material basis of human self-awareness, so we cannot describe in detail the features that are evidence of design. However, it is easy to believe they are there because the human mind has features that do not seem to fit evolutionary theory, but which can be explained as the result of intelligent design.

Evolutionary theory explains the origin of complex features through successive small improvements that increase the probability of survival. But the human mind has abilities that do not seem needed for survival. How is human survival improved by an appreciation of art, music, or spirituality? Human brains appear to be specially designed for speech, yet the origin of speech is a mystery to evolutionists. Other unique human abilities include abstract reasoning; communication through physical symbols such as writing, totems, etc.; use of complex tools; and the ability to use fire. How could these abilities originate through chance?

Natural selection is not expected to produce features that are not of immediate use, yet humans seem to have abilities they would not have needed until "recently" in evolutionary development. Creationists have a good explanation for human "over-development." God created humans with greater capacities than we now possess. We have lost some of our God-given abilities, but we still retain more than the minimum needed for survival. The differences between humans and the other animals are due to intelligent design by our Creator.

**Summary.** Humans have many unique features that are best explained as the result of intelligent design. Adventist biology teachers can point their students to these evidences of design, and remind them that God has given special care and attention to our species. The special status we enjoy gives us the responsibility to act as faithful stewards of our minds and bodies.

## Conclusions

Two features of nature, design and stewardship, can be used to shape biology teaching around Biblical principles. Both concepts have their roots in the creation story of Genesis 1. Design is implicit throughout the creation account and in the statement that everything was "very good." Evidence of design is seen in the irreducible complexity of the cell and many of its subunits. Design is also seen in the fitness of organisms for their environment, and in the interrelationships among all living organisms and their environment. Design is also seen in the human mind.

Stewardship of the creation is one of only three human attributes mentioned in Genesis 1.[16] As appointed stewards, it is our obligation to wisely manage the systems produced by the Designer. Humans have the responsibility of managing the other species, the physical environment, and their own bodies and minds. This responsibility is more than a self-centered desire for survival, it is based on a relationship with the Creator. This relationship brings fresh meaning to the study of nature, and stimulates the biology teacher to integrate his faith with his teaching in the biology classroom.

## End notes

[1] Kennedy, Elaine. (2001). Data and interpretation: Knowing the difference. *Dialogue*, 13(3), 15-19.
[2] Simpson, G.G. 1971 (1949). *The meaning of evolution*. NY: Bantam. p 314.
[3] See, e.g., Gibson, L.J. "An Adventist approach to Origins." 23rd Faith and Learning Seminar; University of Eastern Africa, Nov 22-Dec 4, 1998. Gibson, L.James. 2004. Issues in Intermediate Models of Origins. *Journal of the Adventist Theological Society* 1:71-92.
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[13] Periodic "rest" for the land was prescribed in Leviticus 25:1-7.
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[15] Worm, B., Barbier, EB, Beaumont, N. et al. 2006. Impacts of biodiversity loss on ocean ecosystem services. *Science* 314:787-790.
[16] The three attributes are: image of God; dominion/stewardship; and reproduction/marriage

Appendix. Illustrations

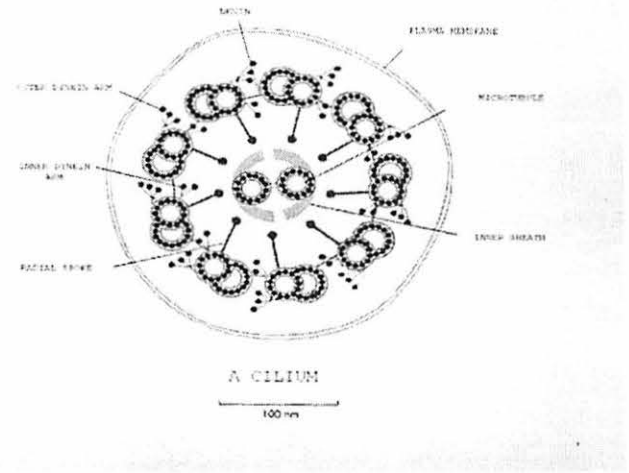


Figure 1. Structure of a cilium, a structure with the property of irreducible complexity.

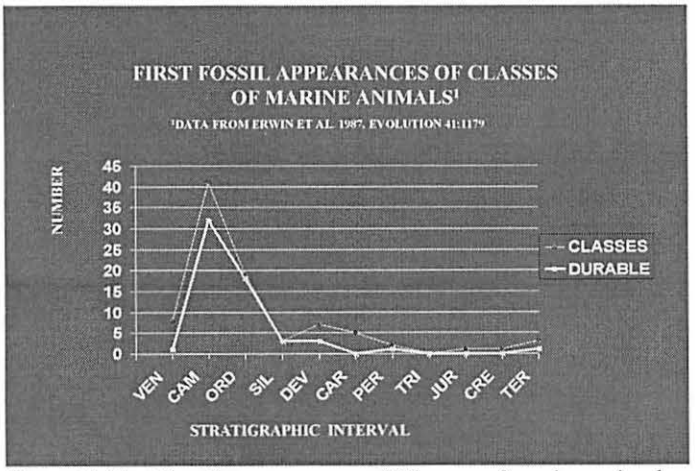


Figure 2. First fossil appearances of Classes of marine animals, a part of the Cambrian Explosion.