

# TEACHING EVOLUTION AT OUR SCHOOLS – WHY AND HOW

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## 1 INTRODUCTION

In this paper I am arguing that we should teach evolution in the senior grades of our schools, let's say in grades 11 and 12. I also propose that in all grades we cease representing modern biological science as intentionally anti-Christian.

I am not a Darwinist. As I will make clear later, for me there are not only theological but also scientific reasons for questioning the neo-Darwinist theory, especially in the case of humans. At the same time I disagree with Christians who tell me that I must hold to a young earth and a static creation. The scientific evidence for an ancient earth and for continuing natural development is very strong. The same, indeed, is true for macro-evolution and common descent or common ancestry, even of humans. Although I do not believe that the evidence is conclusive, I am convinced that as Christians, also as Christian teachers, we may not ignore it and simply dismiss modern scientists as atheists, liars, and deceivers, as in fact happens among us. After all, we take science very seriously when it provides us with medical and technological advances. Is it then not dishonest to qualify the scientific research on which this technology is based as deception, and to demonize the men and women who do this research? True, there are militant atheists among them, but that does not automatically disqualify their work. And there are Christian scientists as well. Modern science certainly did not arise out of anti-Christian motives.

## 2 WHY WE SHOULD TEACH EVOLUTION

### 2.1 Modern science tells us about creation

It must therefore be taken seriously. Just as in the past believers have agreed that the earth is not flat but spherical and that it is not static but revolves around the sun (even though the Bible seemed to teach otherwise), so we too have to take into account the information that comes to us from the book of nature. This means that we may have to reconsider the question whether we are reading the creation account properly when we think that it must be harmonized with modern science. As Calvin already pointed out, God always *accommodates* Himself to the capacity of His people, and Genesis 1 assumes the worldview and world picture of the first readers and hearers, who lived thousands of years ago. The Bible is given to them as God's revelation of Himself and of His gospel of redemption, and not as a scientific handbook. Genesis describes nature as it appeared to the people it first addressed. To use a modern term, it uses *phenomenological* language. We still use that language ourselves, for example when we say that the sun rises and sets.

### 2.2 The need for honesty

I realize that the reference to divine accommodation does not resolve all the apparent conflicts between revelation and modern scholarship. Perhaps they cannot be resolved, at least not in our days. But I am convinced that rather than denying the difficulties or trying to "harmonize" them away, we

should admit them. There is no need to be embarrassed by these difficulties; we are finite beings. The other side also has many unanswered questions, and unbelievers don't let go of their theories because not everything has been proven. So why should we be so timid? If we try to hide the scientific evidence or proclaim it to be false, we fail to prepare our students for their studies at secular colleges and universities, and indeed for their lives as Christians in a secular society. True, I know of the argument that once you let go of the absolutely literalistic meaning of Genesis 1, you also let go of the belief in the gospel of redemption in Christ. This is for many a weighty argument. Such a development, however, is not a foregone conclusion. We all know of Christians who, while accepting an ancient earth or theistic evolution, hold firm to the truth of the Bible and the reality of redemption.

### **2.3 The need to differentiate**

We must distinguish between evolution as a biological theory and evolutionism – that is, evolution as a worldview with its mechanistic and materialistic explanation of all that exists and its rejection of Christianity. If we do properly distinguish, at least some of the tensions will disappear. In the words of Herman Bavinck (who himself rejected Darwinian evolution):

*The relationship between faith and science will certainly improve when the latter surrenders the mechanical worldview; when the hostility toward religion, specifically the Christian religion, is laid aside; and when the other side acknowledges, more so than heretofore, the important element of truth that undoubtedly is implied in the theory of evolution and descent (John Bolt ed., *Essays on Religion, Science, and Society: Herman Bavinck*, p. 117).*

### **2.4 The need to interact with our culture**

To do that properly, we need to be well acquainted with both the Bible and modern scholarship, including modern science. In the words of Christian philosophers J.P. Moreland and William Lane Craig:

*Undoubtedly the most important influence shaping the modern world is science.... If Christians are going to speak to the modern world and interact with it responsibly, they must interact with science. And if believers are going to explore God's world by means of science and integrate their theological beliefs with the results of that exploration, they need a deeper understanding of science itself (*Philosophical Foundations for a Christian Worldview*, p. 307).*

### **2.5 Last but not least: because of the scientific evidence**

More about that in section 4 below. At this point I want to quote Todd Charles Wood, a biochemist, connected with the Center for Origins Research and himself a young-earth creationist, who rejects evolution not on scientific but on theological grounds and warns young-earth-creationists to take the scientific evidence for evolution very seriously.

Motivated, as he states, “by reading yet another clueless, well-meaning person pompously declaring that evolution is a failure,” he writes: “Evolution is not a theory in crisis.... It has not failed as a scientific explanation. There is evidence for evolution, gobs and gobs of it. It is not just speculation or a faith choice or an assumption or a religion. It is a productive framework for lots of biological research, and it has amazing explanatory power.... There has really been no failure of evolution as a scientific theory. It works, and it works well.” And: “People who say [that evolution is a failure] are either unacquainted with the inner workings of science or

*unacquainted with the evidence for evolution. (Technically, they could also be deluded or lying, but that seems rather uncharitable to say....)”*

(For the complete statement see <http://toddcwood.blogspot.com/2009/09/truth-about-evolution.html>).

### **3. HOW TO READ GENESIS 1**

#### **3.1 The theological message**

To deny the scientific character of the Genesis account is not to negate its character of divine revelation, nor is it to reduce its relevance for believers today. The opposite is true. Our obsession with the scientific aspect of the creation account has threatened to close our eyes and ears to the spiritual and theological message of this part of Scripture, a message that is as relevant and “up-to-date” for Christians in the 21<sup>st</sup> century as it was for the ancient Israelites. Someone has called that message a revolutionary one, and in a sense rightly so. Its revolutionary character became especially evident about a century ago with the discovery of masses of written and archaeological sources on ancient Babylonian, Canaanite, and Egyptian religions and creation myths.

These discoveries revealed to biblical scholars the cultural environment of ancient Israel. (See on this my “Genesis in Context,” posted in the “collected papers” on *Reformed Academic*.)

The ANE (Ancient Near Eastern) background showed that Genesis 1 was in some ways an answer to paganism and even, in a sense, a polemic against it. In opposition to the pagan creation myths, it proclaimed

- that God is not part of nature but transcends it,
- that He created the universe by simply speaking the Word,
- that He is eternal (unlike the pagan gods who all had a beginning),
- that He is all-powerful, making and controlling even the oceans and the sea monsters (which pagans often considered to be antagonists of their gods) and creating sun, moon, and stars (which the pagans worshiped as divine) as His servants.

Israel learned that as the almighty Creator of heaven and earth God alone is worthy of their worship and trust; that the pagan deities were nothing compared to Him. We too must learn this when reading the creation account.

#### **3.2 Dangers of a simplistic reading**

We must also keep in mind that, while it seems risky to admit the tension between revelation and science, a blatant denial of this tension is no less dangerous. The kind of simplistic reading of Genesis 1 that young-earth creationists demand is done also by atheists – and for them it serves as a means to ridicule both Christianity and the Bible. Christians are offering them some of the major weapons with which to attack the Bible.

There are other dangers. If students later realize that at school, at home, in catechism classes and in church they have been taught untruths about science and the Bible, there is a real danger that they will reject other religious teachings they have received. Moreover, only if we are scrupulously honest in dealing with the scientific findings will we be in a position to help them distinguish between

science proper and the ideologies that are routinely presented as science. And that, of course, is to be an essential element in our teaching.

In addition, there is the matter of our evangelistic outreach. Promoting young-earth creationism as the only acceptable way of reading Genesis is not only dangerous for our students but also for our missionary and evangelistic efforts. How many secular scientists, indeed how many unchurched people in general, even uneducated ones, will take our message seriously if we come across as obscurantists? If they see us denying what can be seen, how can they accept our testimony about unseen things? It is not surprising that a former apologist like C.S. Lewis and a contemporary one like Tim Keller have refused to associate themselves with young-earth creationism. Let's also not forget that, by taking modern scholarship seriously, Bible-believing Christians will be in a much better position to join the discussion about the limitations of science, and about the difference between science proper and unwarranted scientific interpretations.

#### **4. HOW WE SHOULD TEACH EVOLUTION (I)**

##### **4.1. Scientific evidence for evolution**

The most important reason for teaching an old earth and macro-evolution is the scientific evidence. Most of this evidence is well-known and I don't intend to deal with it in any detail, but I will list the following arguments.

##### **4.1.a. The antiquity of earth and cosmos**

Darwinism demands an ancient universe and earth, and this antiquity is found and assumed by practically every branch of modern science. The evidence is strong in astronomy, physics, geology, and paleontology (the study of prehistoric life as evident in plant and animal fossils in geological strata). Rejecting an ancient earth therefore means rejecting discoveries in all these disciplines.

Young-earth creationists often challenge the accuracy of specific measurements of the age of the earth (such as, for example, the radiometric dating of rocks). The conclusions reached by different techniques and in different areas, however, are in essential agreement. We should further remember that the earth's antiquity was not taught first by evolutionary biologists but by geologists, many of whom were Bible-believing Christians. The sometimes self-published research by young-earth creationists denying the evidence has been found wanting by many reviewers, including Christians.

##### **4.1.b. Homologies or similarities between animals and humans**

These are found in such areas as anatomy, psychology, as well as physiology – metabolism, blood circulation, nervous system, reproductive system and organs, and so on. These similarities are an argument in favour of common descent. (Note: It has long been customary to speak in this connection of vestigial organs such as, in the case of humans, the coccyx or tailbone and the appendix. I am told, however, that neither of these is vestigial. The coccyx is an attachment site for the muscles of the anus, and the appendix contains bacteria which can repopulate the colon after purging in cases of severe infection like cholera.)

#### **4.1.c. Molecular homologies**

All living organisms share the same genetic code, and the DNA sequence serves as a tool for establishing genetic relationships among species. Molecular genetics therefore provides knowledge about heredity and mutation that Darwin lacked but that constitutes strong support of this theory. The DNA sequences of humans and primates are very similar: in the case of chimpanzees and humans the correspondence is as much as 99%.

Critics of Darwinism have explained evidence in this section and in section 4.1.b. with reference to a common plan or blueprint used by a common Designer and/or with the “functional argument,” i.e., the argument that the similarities are to be expected because the existing organs and systems function better than different organs or systems would. Recent DNA research has shown, however, that not only the gene sequence, but also various DNA errors are similar in humans and chimps, and that they occur in exactly the same places, which strongly suggests common ancestry.

#### **4.1.d. The fossil record**

The fossil record is not without gaps, but paleontologists, also Christian paleontologists, tell us that there is a definite progression in the distribution of fossils, with one-cellular organisms in older layers and increasingly more complex organisms in subsequent ones. They also tell us that in the older layers we find life forms that are increasingly different from subsequent ones and from those we know today.

#### **4.1.e. Early hominids (humanlike creatures)**

Fossils and other evidence such as ancient bones and skeletons strongly suggest that various species of animals were on earth long before the appearance of *Homo sapiens*, the human being. They also point to the existence of hominids (now extinct) before humans appeared (these hominids or human-like creatures are sometimes called pre-Adamites).

#### **4.1.f. Biogeographical evidence**

This term refers to the geographical distribution of species, and the evidence it gives of a common ancestry of differing species. For example, cave salamanders lack pigment and eyes. They are found in caves in Western Europe and North America. Superficially, lack of pigment and eyes might be taken to mean that European and North-American cave salamanders are more closely related to each other than to their seeing counterparts. But other traits show that the North-American seeing and blind salamander share a more recent common ancestor than they do with their European counterparts. This is what one would expect if the North-American salamanders had evolved from a common ancestor and adapted to different environments. Nor is this the only example. Attention has been drawn to a variety of similar cases ever since the time of Darwin himself, who focused on the differences among finches on various Galapagos island and on the similarities of all these with the finches of the neighbouring South-American continent.

## 5. HOW WE SHOULD TEACH EVOLUTION (II)

### 5.1 Evaluating the scientific evidence

While I maintain what I said in the previous section about the scientific evidence for common descent and macro-evolution, I do want to mention questions that have been raised in connection with these theories, and especially with the evolutionary one.

#### 5.1.a. Do similarities imply common descent?

Not necessarily. While the material similarities between the human and the chimp are many, the spiritual (and even some of the material) differences are equally great. Unlike the animal primate, the human being is capable of abstract thought, has self-consciousness, consciousness of time, a sense of grammar, a highly developed language, is capable of empathy, has a conscience, and has an awareness of the supernatural and the divine. Although some (but only some) of these qualities are found in rudimentary form in animals, the difference between humans and animals is far greater than that among animals.

#### 5.1.b. Does our DNA explain everything?

The question confronting us, therefore, is whether our material DNA determines our essence. Not every scientist, not even every unbelieving scientist, thinks so. Note, for example, the arguments of developmental biologist Richard Lewontin (in his book *The Triple Helix*, 2001) against genetic reductionism. Lewontin shows here that outcomes are determined not just by genes, but by the interaction of genes, the organism and the environment. A similar conclusion is drawn by Christian molecular geneticist Francis Collins in his book *The Language of God* (2006), which deals, among other things, with the effect of our genes on behavioural traits and spirituality. Like Lewontin, Collins rejects genetic reductionism and biological determinism and stresses the role of environmental factors. By doing so he rejects the claim of some modern atheists that religion is simply a “natural phenomenon,” the result of a “god-gene,” and therefore an illusion. Collins draws the following conclusion, based on his work of sequencing the human genome:

*There is an inescapable component of heritability to many human behavioral traits. For virtual none of them is heredity ever close to predictive. Environment, particularly childhood experiences, and the prominent role of individual free will choices have a profound effect on us.... Yes, we all have been dealt a particular set of cards.... But how we play the hand is up to us (p. 263).*

#### 5.1.c. The nature-nurture controversy

Lewontin and Collins lead us back to the well-known nature-nurture debate. Lewontin in fact provides a brief historical survey of that debate. He writes that until World War II biologists were mostly biological determinists who explained social, psychological and cognitive differences among individuals chiefly with reference to genetics. The rise of Nazism and of racism resulted in a large-scale revulsion against biological determinism (just as it caused a large-scale revulsion against Social Darwinism). Differences were now once more explained also with reference to the environment, i.e., to nurture. But this environmentalism did not last. Within a few decades the emphasis on genetic factors returned, and

it is still the reigning explanatory model. But it is one-sided. It is of course true that “the biology of a species is limited by the possibilities circumscribed by its DNA.” The DNA determines, as Lewontin points out, the differences among a lamb, a lion, and a human being. It does not, however, fully determine the differences between two lambs or two lions or two humans. The environment plays a role as well. Humans (and humans alone) can speak because they have the right genes **and** the right social environment (*Ibid.*, 16-30).

#### **5.1.d. The fossil record**

There are other problems with the neo-Darwinist theory of macro-evolution. For one thing, while the fossil record indeed indicates a movement from simple to complex, it contains few if any convincing transitional forms (i.e., forms that give evidence of a gradual transformation from one species into another). Questions have also been raised about the slow, gradual evolutionary process as taught by both Darwin and contemporary neo-Darwinism. This does not fit, for example, the so-called “Cambrian Explosion” of some 540 million years ago, when many kinds of animals appeared very suddenly, with little or no evidence of preceding evolutionary development. The fossil record, in short, does not provide foolproof evidence for neo-Darwinism.

#### **5.1.e. Biogeographical evidence**

Questions can also be raised in connection with the evidence of biogeography – see the example of the cave salamanders under 4.1.f. above. Critics of Darwinism would agree that the blind and seeing North-American salamanders have a common ancestor, and that the differences between them are a result of adaptation to different environments (such as the fact that the blind ones live in dark caves). They also point out, however, that while this shows that creatures adapt to their environment, it does not show that **all** species share a common ancestor. Moreover, all these species continue to be salamanders and finches. They did not evolve into different animals groups.

#### **5.1.f. The mechanism: Natural Selection**

There is further the problem of the proposed mechanism: random genetic mutations, natural selection and “the survival of the fittest” (the idea that beneficial mutations, by being passed on to the individual’s offspring, can in the end lead to the development of a new, more complex species). This is a questionable explanation. It is generally agreed that most mutations are harmful. It is also difficult to believe that random processes can really explain the development from a one-cellular organism to the human – no matter how many billions of years one allows for this development. And then there is the question why the human being has gifts for music, science, literature, art, and so on, all of which are unnecessary for its survival in nature. It is part of the scientific credo that evolution selects only for reproductive advantage; i.e., that nature grants no gifts to a species except those that confer a survival advantage over others. How then can evolutionists explain these specifically *human* gifts?

## **6. LET'S KEEP IN MIND THE NATURE OF SCIENCE**

While there is much scientific evidence in favour of common ancestry, there is no reason to consider scientific theories as absolutely beyond questioning. Consider the following:

### **6.1. Science offers no demonstrative proofs**

Demonstrative proofs can be had only in mathematics. Scientific evidence is more like that used in a court case, where the case for or against a charge is determined by the apparent weight of the evidence. The same applies to the choice for or against a scientific theory. Although some theories are by now well-established, absolutely certain evidence for the truth of a theory cannot be had. Counter-evidence may turn up at any time. Scientific theories are always provisional; it is of their nature to be refined and modified, and occasionally they are discarded altogether. This happens even with theories that “work.” Think of the old Ptolemaic, earth-centred solar system which, although now superseded, functioned well enough to predict eclipses.

### **6.2. The subjective element in science**

Thomas Kuhn, Michael Polanyi and other philosophers of science have shown that in their search for and interpretation of facts and in their acceptance or rejection of theories, scientists are influenced by such things as the spirit of the age, their own worldview, their loyalty to a specific paradigm, and so on. In view of all this, it is clearly unwise to base one's faith on a scientific theory. In the words of one commentator, those who marry such a theory will soon find themselves widowed.

## **7. THE SCIENTIFIC RECORD: INCREASING VERISIMILITUDE**

The provisional character of scientific theories is obvious. As Reformed Dutch philosopher Egbert Schuurman recently pointed out, we must learn to relativize science, rather than try to harmonize science and revelation. There is, however, a *caveat*: we must also keep in mind the fact of ever-increasing scientific verisimilitude. In this sense science has a special place in our culture: There is scientific progress, so that past science is out of date, whereas new concepts in art, literature, philosophy, religion, and so on, do not necessarily disqualify older ones. The explanation is that science is based on observation and causation, and that it has techniques of prediction, evidence, and verification for which there are no equivalents in other branches of knowledge. History shows this increasing progress in scientific exactitude. It warns us not to be too fast in putting limits on science.

## **8. CONCLUSION**

The neo-Darwinist theory is a successful scientific theory in the sense that it has great explanatory and predictive power. It is based on masses of scientific evidence and should be taught to our students. But these students should also learn that there are scientific problems with neo-Darwinism. Above all, from grade 1 onward they must hear from us the central message of Genesis 1, namely that God is the all-powerful Creator, that He was and is involved in every aspect of creation, and that His handiwork proclaims His glory. The beauty and functionality of world and cosmos must also at

all times be emphasized. For that reason it is important to acquaint students with other sciences, for example astronomy.

Meanwhile, as already suggested, our task is not completed by teaching the strengths and weaknesses of neo-Darwinism. We must also give attention to the use that is being made of this theory as a basis for an overall evolutionist and anti-Christian worldview. This implies, among other things, the need to organize courses in apologetics or philosophy for our older students. Here they are to be taught about “scientific” atheism, about the social and economic abuse of evolutionary theories (such as Social Darwinism), about the reductionisms to which materialistic science has led (for example the belief that humans are no more than a machine or an animal, that human thought is simply the secretion of the brain just as urine is the secretion of the kidneys), and so on.

### **A HELPFUL RESOURCE FOR TEACHERS**

**The Discovery Institute** has issued the book *Explore Evolution: The Arguments For and Against Neo-Darwinism* (Hill House Publishers, 2007, 160 pages). I have made use of it in the foregoing and also in drawing up the glossary (below), and I warmly recommend it to our teachers. The book attempts to be even-handed, even though the arguments against Neo-Darwinism receive more attention than those in support of it. Although the authors have questions about evolution, they believe that “students should learn *more* – not less – about this theory than they presently do.” As is to be expected of the Discovery Institute, the authors’ sympathy appears to be with the theory of Intelligent Design (ID).

The book is helpful, but does not answer every question. It rejects, for example, the idea of the fixity of species and admits the possibility that all life evolved from a small number of common ancestors (perhaps 18), but does not explain how these gave rise to the variety of species existing today. I also missed an acknowledgement of what is by now one of the strongest arguments in favour of the common ancestry of chimpanzees and humans, namely the common errors found in the DNA of both species. But the positive aspects of the book far outweigh the weaknesses and I think it deserves a place in all our schools. (I am not herewith suggesting that in my opinion ID is to be considered **the** Christian position in science.)

### **GLOSSARY**

- ancient earth and cosmos:** the age of the earth is approximately 4.5 billion years, the cosmos about 13.7 billion, and the Milky Way galaxy about 13.2 billion.
- Cambrian explosion:** a period of less than 10 million years, beginning about 530 to 540 million years ago, when almost all major animal groups (phyla) first appeared in the fossil record and did so relatively suddenly rather than gradually as taught by Darwin and Neo-Darwinism.
- common descent (or common ancestry):** the theory that all organisms descended from one common ancestor (monophyletic) or from a limited number (polyphyletic).
- competitive advantage:** the increased ability of an organism to reproduce compared to other organisms competing for limited resources (also called selective advantage).

**-Darwinism:** the theory that all life descended from a common, one-cellular ancestor and that incremental changes from one species to another occurred as a result of random variation and natural selection of heritable traits. This is generally called evolution (or “descent with modification,” to use Darwin’s term). (See also neo-Darwinism below.)

**-determinism:** the doctrine that all my actions and thoughts are determined by physical causes, i.e., by causes outside my will; specifically, that it is the motion of the atoms in my brain that determines my behaviour, my thoughts, my choices, my beliefs. There is therefore no freedom or responsibility, nor is there ultimate truth. This is part of the naturalistic-materialistic worldview. It is related to **materialism** (philosophical/scientific), **naturalism** (ontological), **reductionism** (ontological), and **sociobiology** (for all these, see below), and implies that there is no ultimate truth. (All these doctrines are ultimately illogical – see below under self-refuting ideas – and are generally seen to have been ruled out by quantum physics in the early 20<sup>th</sup> century. They nevertheless continue to be proclaimed.)

**-evolution:** see under Darwinism and Neo-Darwinism.

**-evolutionary ethics:** the doctrine that moral behaviour is the product of evolution and natural selection. Our genes select for behaviour that confers survival benefits, which means that both selfish and unselfish behaviour is “good” if it contributes to the survival of the species. We tend to behave unselfishly (in the traditional meaning of the term) when our behaviour benefits our immediate family, because they are genetically closest to us (kin selection) or, in the case of strangers, when we expect them to return the favour (reciprocal altruism). Evolutionary ethicists have difficulties explaining acts of kindness to strangers who cannot possibly repay us. Although Darwin also suggested aspects of evolutionary ethics, the name of Herbert Spencer (1820-1903) is most closely connected with the doctrine.

**-fixity of species:** the belief that all species were created in their present form and that only unimportant changes have taken place (microevolution rather than macroevolution).

**-fossil:** the mineralized remains, impression, or trace of a once-living organism preserved in sedimentary rocks (i.e., rocks deposited by wind, water, and/or ice).

**-fossil succession:** the order of fossils, from lower to higher, in geological strata.

**-Intelligent Design (ID):** adherents generally reject the fixity of species and a young earth; some believe in evolution and in universal common descent but hold that the universe and living things show evidence of “intelligent design.” Complex biological structures, such as the bacterial flagellum, the vertebrate eye, the immune system, etc., are irreducibly complex (Michael Behe) and cannot be explained in terms of random natural processes.

**-macroevolution:** large-scale changes in an organism leading to the origin of a new species.

**-materialism (philosophical/scientific):** the belief that the material reality is the only reality and that matter is eternal. There is no God, no supernatural, no human or any other spirit. Consciousness and thought are the result of the motions of atoms in our material brain; there is “no ghost in the machine.” Humanity is the accidental product of nature; the universe and all it contains are without purpose. Philosophical materialism is closely related to **naturalism** (ontological) and **reductionism** (ontological) – see below.

**-microevolution:** small-scale changes within an existing species.

**-monophyletic:** all species are descended from one common ancestor.

**-mutation:** the alteration of an organism's DNA due to mistakes during replication or to damage from external agents such as chemicals or radiation.

**-naturalism (methodological):** in their research scientists tend to explain natural phenomena by material causes only, without recourse to the supernatural.

**-naturalism (ontological):** this is similar to philosophical/scientific materialism: there is nothing outside matter; natural processes alone exist; all that happens and all we do is without purpose; humans are complex machines; our character and personality are the product of chemistry and physics alone.

**-natural selection:** organisms that because of random mutations are better adapted to their environment survive and reproduce at a faster rate than others, as a result of which their characteristics are more prevalent in subsequent generations (also called reproductive success), as *versus* artificial selection, where *humans* select for desirable traits by arranging for animals or plants with these traits to breed. (Buzz words: mutation, variation, heritability, competitive advantage, and differential reproduction through natural selection.)

**-Neo-Darwinism:** the modern version of Darwinian evolutionary theory according to which variations originate by DNA mutations upon which natural selection acts to produce evolutionary change.

**-old-earth creationism (OEC):** OEC rejects evolution but holds that the days of Genesis 1 must be interpreted as lengthy periods (also called progressive creationism).

**-paleontology:** the study of fossils to learn about ancient organisms.

**-polyphyletic:** species are descended from more than one ancestor.

**-punctuated equilibrium:** new species appear suddenly in the fossil record, then remain unchanged until they disappear; see Cambrian Explosion above.

**-radiometric dating:** some atomic isotopes are unstable and decay naturally. Each of these has a characteristic half-life, which is the time it takes for half of the atoms in the sample to decay. By comparing the amount of the radioactive element to the amount of the decay product, scientists determine when the material formed.

**-reductionism (methodological):** the practice of studying and explaining complex things by studying and explaining the nature and working of their parts. As a methodology it often plays a positive role in science. Even human life can and must on one level be described in terms of material factors. Methodological reductionism is applied in medical science in general but also in a human science like psychology; think, for example, of the role of biochemical factors in certain mental illnesses.

**-reductionism (ontological/philosophical):** the doctrine that complex systems are not only analyzable in terms of their parts, but can be reduced to them and are nothing but organizations of these parts. It means that chemistry can be fully reduced to physics, biology to chemistry, and human thought and behaviour to biology and biochemistry. Ultimately, there is nothing but the parts (the idea of "nothing-buttery"). Some examples: Human behaviour can be reduced to nothing but stimuli and responses (Pavlov); sunsets to nothing but waves of energy; romantic love to nothing but hormonal secretions; love of beauty to nothing but subconscious drives; altruism to nothing but genetic self-interest (the work of our selfish genes), thought to be nothing but secretions of the brain. (See on this also Arnold Sikkema, "Nothing-Buttery," <http://ReformedAcademic.blogspot.com>, July 2009.)

**-self-refuting (or self-contradictory) statements:** statements that are issued as truth but are logically contradictory and in fact saw off the branch on which the author of the statement is sitting.

Philosophical materialism, for example, proclaims as ultimate truth that there is no ultimate truth, and

so refutes its own creed. Another example is that of sociobiology and related disciplines, according to which religion, beliefs, and morality can be explained away as products of the brain's evolution, thereby implying that the sociobiologist's own beliefs can similarly be explained away as products of the brain's evolution. If belief in God is simply an evolutionary product of our brain, then the same must apply to atheism.

**-Social Darwinism:** the idea that competition and natural selection (resulting in the survival of the fittest) are necessary for the evolutionary improvement of both individuals and society – including ethnic groups, races, and nations. This had led to human eugenics (selective breeding), laissez-faire capitalism (only the best businesses and the rich deserved to survive), increased racism, and in the early 20<sup>th</sup> century the approval of warfare (for the sake of progress the fittest nations should eliminate the unfit). Hitler's actions against the mentally handicapped and against the Jews and other "lower" races were also justified with reference to Social Darwinism. As in the case of evolutionary ethics, Herbert Spencer's name is most closely connect with the teachings of Social Darwinism.

**-sociobiology:** Related to Social Darwinism and evolutionary ethics. The brainchild of scientist E.O. Wilson, sociobiology explains all social and all spiritual behaviour in biological terms and on the basis of that behaviour's positive value in the Darwinian process of natural selection. Led by our selfish genes, we believe certain things and act in certain ways because it is beneficial to the survival and spread of our genes. Wilson stated that if religion, for example, can thus be explained, then "its power as an external source of morality will be gone forever" – in fact, it will be shown to be an illusion (Kenneth R. Miller, *Finding Darwin's God*, p. 284). The fact that this argument cuts both ways (see above under "self-refuting statements"), is ignored.

**-speciation:** the evolutionary process of new species arising from existing ones.

**-species:** a group of individuals that can interbreed.

**-theistic evolutionism:** belief in a God-guided evolution.

**-transitional form:** an organism that is intermediate between an ancestor and a new species.

**-young-earth creationism (YEC):** rejects evolution; holds to a young earth (6,000 to 10,000 years) and a literal 6-day creation, explains the fossils as a result of a world-wide (Noachian) flood.