

## EVOLUTION EDUCATION; WHY BOTHER?

By Gregory A. Forbes PhD, Grand Rapids Community College & the Evolution Education Institute  
© 2006

For additional information on this topic, contact the author, Dr. Gregory Forbes, MSTA Evolution Education Specialist, [gforbes@grcc.edu](mailto:gforbes@grcc.edu)

Understanding the nature of science is central to a quality science education. Science is more than a collection of facts, theories and formulas as science involves a *process* of empirical exploration of our natural world by which we seek to explain observed phenomena with reference to natural law e.g., laws of chemistry, physics, biology, etc.. A struggle faced by all science educators is one of attempting to balance breadth versus depth in the coverage of their curriculum. All too often the victim of such balancing acts is the instruction in the *nature of science* beyond the rote recall of the scientific method in its many morphs.

Instruction about the nature of science should introduce students to the investigative realm in which science operates; the empirical realm. Students should be introduced to both the power and the limitations of scientific investigation and to the inductive and deductive scientific analysis of data and events. Merely introducing students to the scientific method leaves students with the erroneous idea that science is always done with controlled experiments in laboratory conditions via direct observations of events occurring in the presence of a researcher. This is a misrepresentation of how much of science is conducted e.g., geology, paleontology, evolution, ecology, astronomy, etc..

It should come as no surprise to science educators that, however unfortunate, very few of our students will ever choose science or science education as a career. However, virtually all of our students will become consumers of science. We live in the most scientifically-based society that civilization has ever experienced. Conservative estimates would suggest that there are more scientists working today than the total of all scientists that have ever lived prior to this generation. Correspondingly, members of society must be able to make decisions based upon the best scientific evidence available, e.g., diet, pharmaceutical use, cloning, global warming, technology, etc.. It is therefore incumbent upon science educators to ensure that our teaching is true to the nature of science and that our students understand the nature and process of science and how data are interpreted even in the broadest sense.

Although we hope that our students learn the detailed *content* of our courses, it is of the utmost importance that we ensure that our students learn the nature of science in order to be informed consumers of science. Armed with knowledge of the nature of science, our students should be better equipped to delineate the difference between scientific facts and pseudoscientific claims and just plain nonsense masquerading as science (Forbes, 2005a). This ability is especially important in the evolution/anti-evolution debate.

Evolution theory is the most robust and well-substantiated theory that science has produced (Forbes, 2003) and for that reason alone, it should be included in all science curricula. However, evolution theory also provides a superb vehicle by which students can be introduced to the nature and process of science. The formulation of evolution theory is an excellent study in how the nature of science operates. It was once said that “*evolution is as good as great science gets*” (Nelson, 2001). Although a bold and provocative statement, those familiar with the nature of science would agree that evolution theory represents the culmination of impressive scientific investigation and analysis with corroborative evidence from virtually all fields of science.

The failure of many members of our society to understand the nature and process of science is most likely a significant contributor to the anti-evolution education movement seen in the United States. When an individual does not understand the nature and process of science it is hard to convince them to examine evolution theory from a scientific perspective. If our students fail to understand the nature and process of science, then we should not have high expectations for their understanding and acceptance of evolution theory as sound science. Since the science students of today are the science teachers of tomorrow, the problem perpetuates itself and this problem is passed on from one generation to the next.

Although it may be possible to teach and learn about modern science unaccompanied by an explanation of evolution theory, most sciences, especially the biologi-

cal sciences, become a rather mundane collection of facts and processes that demonstrate few useful causal relationships. As Dobzhansky (1973) states *“Seen in the light of evolution, biology is perhaps, intellectually the most satisfying and inspiring science. Without that light, it becomes a pile of sundry facts some of them interesting or curious, but making no meaningful picture as a whole.”*

### SO WHY TEACH EVOLUTION?

Recognizing the continuing debate over the teaching of evolution in the nation’s public schools, some science teachers may wonder why they should bother teaching evolution when it may result in contacts from concerned parents or in-class commentary from their students. In their 2003 position paper (NSTA, 2003) the National Science Teachers Association (NSTA) recognized *“... that evolution has not been emphasized in science curricula in a manner commensurate to its importance because of official policies, intimidation of science teachers, the general public’s misunderstanding of evolutionary theory, and a century of controversy.”*

The NSTA further acknowledged that *“... teachers are being pressured to introduce creationism, “creation science,” and other nonscientific views, which are intended to weaken or eliminate the teaching of evolution.”* Considering the aforementioned, some teachers and students may need convincing that evolution should be studied and taught even though evolution appears in the science standards in 38 states albeit at sometimes marginal levels (Gross, 2005).

As the Nobel laureate Hermann Muller observed back in 1959 *“It ill befits our great people, four generations after Darwin and Wallace published their epochal discovery of evolution by natural selection, to turn our backs on it, to pretend that it is unimportant or uncertain, to adopt euphemistic expressions to hide and soften its impact, to teach it only as one alternative theory to leave it for advanced courses where the multitude cannot encounter it or, if it is dealt with at all in a school or high school biology course, to present it as unobtrusively and near the end of the course as possible, so that the student will fail to appreciate how every other feature and principle found in living things is in reality an outgrowth of its universal operation.”* (Muller, 1959).

In light of Muller’s observation, educators and students may find the list that follows useful in answering the

question of “Why should we teach or learn about evolution?”. Although not an exhaustive or definitive list of reasons to teach evolution, it should provide a suitable springboard for discussions in and out of the classroom.

### EVOLUTION IS ALL AROUND US

In general, evolution can be defined as a “non-cyclic change over time”. However, this definition is modified for *biological* evolution. Biological evolution can be defined in very broad manner as “an inheritable change in a species over time”. Although biological evolution is the focus of the anti-evolution education debate, evolution in general is present in all aspects of nature and in society. Correspondingly, knowledge of biological evolution provides an important insight into understanding the evolution found in other aspects of nature and society.

Listed below are fields of science in which scientists investigate the evolution of systems under their study. Only a few examples are provided for each discipline.

Discipline	Example(s) of Area of Evolutionary Study
Cosmology	The origin & development of celestial bodies e.g., black holes
Geology	The formation of land forms, plate tectonics/continental drift
Meteorology/ Climatology	Climate change e.g., global warming, dynamics of the ice ages
Oceanography	El Nino, La Nina, southern oscillation oceanic events
Astronomy	Changes in the orbits of celestial bodies
Linguistics	Changes in & origins of language
Sociology	Changes in social norms & customs within a society
Politics	Changes in political systems, e.g., socialism, Marxism
Economics	Changes in market systems, barter systems, forms of currency
Theology	Changes in religious practices, beliefs & the rise of new religions
Anthropology	Development & diversification of cultures

---

## THE HOW AND THE WHY OF SCIENCE

In order to avoid a science education that is merely a list of disjunct facts and formulas with little coherence, science educators seek to explain *how* natural systems function. For example, we may tell our students *how* a bird is able to fly by producing a low pressure system above its wing or *how* a bird sings by vibrating its syrinx (vocal fold). We may explain *how* it is that our students resemble their parents or *how* plants grow towards light.

Although the *how* of nature is important, the *why* is far more interesting and the realm of evolutionary biology. The evolutionary story of why a bird sings is a very different story than *how* a bird sings. *Why* children resemble their parents is a far more interesting story than how this resemblance is passed between generations. Obviously, the “*why*” of biology must be investigated and studied, but in the absence of the “*why*” provided by evolutionary theory, our understanding of nature is far from complete. An understanding of nature and our world necessitates understanding *why* natural systems have evolved to operate in the manner we observe.

The “big” questions in evolutionary biology are the “whys”. Why are there so many species and why are there groups of species that show similarities? Why do all eukaryotic species operate under the same rules of mitosis, have the same genetic code, similar biochemistry, etc.? Evolutionary biology addresses and seeks to answer such “*why*” questions.

## THE UTILITY OF EVOLUTION THEORY

The goal of continued research into evolutionary theory is multifold with three broad primary goals: 1) Understanding the history of life of Earth 2) Understanding the mechanisms of the evolutionary process (natural selection) 3) Developing evolution theory into a precise predictive tool (the goal of all scientific theory).

Although basic scientific research need not be justified by direct utility or application of its findings, many non-scientists do not understand the value of basic research and feel a need to always find direct technical application of scientific knowledge. As this is most likely the situation with science students as well, it may be of benefit to examine some direct applications of our knowledge of biological evolution. As we continue to build upon our knowledge of evolution theory, we will strengthen its predictive ability (Goal #3 above)

and additional applications of evolutionary theory will ultimately appear.

The examples that follow are brief and non-comprehensive by necessity but the general categories may provide an area for expanded classroom discussion.

- Environmental Conservation- Knowledge of the environmental constraints influencing the evolution of a given gene pool allows biologists to anticipate outcomes of managing different species e.g., the possible success of relocating black rhinos to habitats where white rhinos evolved.
- Agriculture- Knowledge of the evolutionary/ecological adaptations and the ancestry of crops and livestock allows their introduction into new favorable environments and allows cross breeding between related species.
- Pharmaceuticals- Knowledge of evolutionary relationships allows beneficial natural chemicals discovered in a given species to be harvested from related species that may be more abundant or easier to harvest.
- Understanding Human Disease- Understanding the evolution of sickle cell anemia and its relationship to malaria provides important insight into the treatment and prevention of these diseases.
- Biotechnology- Knowledge of the evolution and natural selection of genes allows gene splicing of beneficial genes between species thereby allowing beneficial traits to be combined e.g., disease resistance corn (Bt corn). Evolution theory also alerts us to the cautions of such technologies.
- Understanding Human Physiology- Evolution theory provides insight into why such human conditions as ADD and autoimmune disorders have persisted in the human genome.
- Understanding Human Behavior- Evolution theory provides insight as to why human behaviors such as aggression and compassion are common in the human genome and helps us understand the survival advantages of each behavior.
- Understanding Market Dynamics- Evolution theory allows those in business to understand why some products and services are no longer valued in a changing market while others increase in popularity.
- Food Production- Our knowledge of how natural selection works has allowed us to artificially select for desirable characteristics in crops and livestock.
- Understanding the Evolution of Disease- Natural

---

selection is instructive in anticipating the outcome of the overuse of antibiotics in humans and in livestock and the mutation of pathogens e.g., avian flu, West Nile virus.

- Treating Disease- Knowledge of natural selection allows us to gain advantage in the treatment of resistant diseases by utilizing “drug cocktails” as in the treatment of HIV/AIDS.
- Science Education- Learning about biological evolution introduces the student to the nature and process of science and allows application of evolution theory to other fields of human inquiry.

### **EVOLUTION IS THE ONLY SCIENTIFIC EXPLANATION**

Although those opposed to the instruction of evolution may suggest that there exist “alternative theories” to evolution, the fact remains that evolution theory is the best and only *scientific theory* to explain the history and diversity of life on Earth. Although non-scientific ideas such as intelligent design (ID) have been offered as alternatives to evolution theory, they remain non-scientific alternatives and therefore have not earned their place in the science classroom (Forbes, 2005). These non-scientific alternatives may be interesting philosophies or theologies but they remain non-scientific and therefore may not be introduced into the science classroom.

### **STRONG PROFESSIONAL, JUDICIAL AND INSTITUTIONAL SUPPORT**

Virtually all professional scientific organizations in the United States as well as most educational, religious and civil liberty organizations have adopted position papers that advocate a science education that includes a comprehensive presentation of evolution theory and the exclusion of non-scientific ideologies such as intelligent design and creation “science” (National Center for Science Education, 2000). Recent federal court decisions (Kitzmiller v. Dover School District, 2005) provide legal reaffirmation that evolution is the only scientific explanation of the history of life on Earth that may be taught in public schools.

### **CONCLUSION**

Evolutionary biology remains the only scientific explanation of the history of life on Earth and it represents an excellent example of how the nature and process of science operates. In any field of human inquiry, it

is the professionals and academicians in the field that determine the appropriate scholarship in their field. In science, it has been determined that evolution theory is the only scientific explanation for our natural world. While recognizing that there are other important fields of human inquiry besides science, such as theology and philosophy, it is incumbent upon us as science educators to limit our instruction to topics appropriate to a science curriculum and to not represent non-scientific ideologies as science.

Our students will enter the most scientifically-based society that civilization has ever experienced. If our students are to remain globally competitive in science and technology, we cannot afford to hinder their science education by compromising their knowledge of evolution theory, the most robust and well-substantiated theory that science has constructed.

### **LITERATURE CITED**

- Dobzhansky, T. 1973. “*Nothing in biology makes sense except in the light of evolution*”, Am. Biol. Teacher 25: pp.125- 129
- Forbes, Gregory A. 2003. “*Is evolution a theory in crisis?*” MSTA Journal, Fall 2003. pp. 3-7.
- Forbes, Gregory A. 2005a. “*Science, pseudoscience and just plain nonsense; helping our students tell the difference*”. MSTA Journal, Spring 2005. pp.2-6.
- Forbes, Gregory A. 2005b. “*Intelligent design; A challenge to evolution or the evolution of a challenge?*”. MSTA Journal, Fall 2005. pp. 2-5.
- Gross, Paul R. et. al. 2005. “*The State of Science Standards*”. Thomas Fordham Institute, Washington D.C. pp.74.
- Kitzmiller T. et al. v. Dover Area School District, 2005, U.S. District Court, Middle District PA. Case 04cv2688.
- Muller, Hermann j. 1959. “*One hundred years without Darwin are enough*”. School Science and Math. April 1959. pp. 304-6 as quoted in Moore, John A. 2003 “*Science as a Way of Knowing*. Harvard U. Press, pp.133-4.
- National Center for Science Education 2000 . “*Voices for Evolution*”. <http://www.natcensci.org/article.asp?category=2>
- National Science Teachers Association, 2003. “*NSTA Position Paper- The Teaching of Evolution*”. <http://www.nsta.org/positionstatement&psid=10>
- Nelson, Craig 2001. (*Personal communication*)