Teaching Evolution as a Science

Dear Editor,

It is with great appreciation I studied your January issue of *The American Biology Teacher*. I have been meaning to write to you about your interest in teaching evolution as a science. I am a retired science teacher, 83 years old.

You seem to be avoiding a central issue. That issue is that evolution cannot be adequately brought to a student's mind without careful consideration of the central position the human genome plays in a program addressing evolution.

It appears to be a known fact that the human genome consists of some 30,000 genes, where only 450 are unique to us as human beings. The rest, 29,550 genes, are identical to those found in the chimpanzee, or, 1.5 percent of the gene text is different between humans and chimps. In addition to this thought, a good portion of our human genes can be found in each, separate species' genome.

I suggest a science teacher might challenge a student to discover that portion of the human genome identical to that of any other separate species' genome from a nematode worm to the human being. Thank you for allowing me to give you my opinion.

Robert G. Maly
Southampton, PA 18966

References

Britten, R. J. (2002) Divergence between samples of chimpanzee and human DNA sequences is 5%, counting indels. *Proceedings of the National Academy of Sciences, 99*, 13633-5.

Ebersberger, I., Metzier, D., Shwarz, C. & Paabo, S. (2002). Genome-wide comparison of DNA sequences between human and chimpanzees. *American Journal of Human Genetics, 70*, 1490-97.

sequence is likewise unique, my point is that evolution involves a series of life cycles rather than one life cycle. Evolution, then, is not "a general characteristic of the universe itself" (p. 7).

This is not minor philosophical or semantic nitpicking. Use of proper language is critical as we strive to educate students without confusing or misinforming them. I realize that my position may run counter to published educational standards (e.g., the National Academy of Science's *Teaching About Evolution and the Nature of Science,* 1998) as well as decades of practice. I certainly recognize the value of thrusting the term evolution into public discussion (outside the classroom) as much as possible, but I hope we can do so in an unambiguous manner. To Darwin, who personally avoided use of the term evolution (largely because it carried negative connotations stemming from its use by earlier scientists), "descent with modification" was the essence of this algorithmic change. I submit that "descent" remains an essential element of evolution.

Alexander J. Werth
Elliott Associate Professor of Biology
Hampden-Sydney College
Hampden-Sydney, VA 23943

Response

The key to understanding Dr. Werth's confusion is the word "change." Everything changes, but does that change occur through "development" or "evolution," or by some other process? Note the importance of the expression "process of change."

Why don't we use the expression "the universe has developed," "a star develops," or "the planet has developed?" Biological development is controlled by the genetic program of an organism, its genome. But it is not reasonable or useful to imply that entities such as the universe, galaxies, stars, or planets have a program which guides their development. The term development does, indeed, imply process of change just as the term evolution does. But evolution is not a process controlled by a program, genetic or otherwise. And while the difference between ontogeny and phylogeny is important in understanding biological evolution, the term development is not appropriate to describe the process of change that occurs in non-living historical systems, be they planets, stars, or the universe itself. Natural evolutionary algorithms, as I have written, because of their substrate neutrality and shared logic, appropriately describe the process of change that occurs in non-living historical systems. By not realizing that evolutionary change is a universal characteristic, Dr. Werth has confounded a restricted biological term, development, with the truly universal process of change by evolution.

I should, also, note that non-biological meanings of development imply a planned set of changes as in land or housing development. It is, however, possible to say that "a plan was developed" but here "developed" implies creation and purpose, as in "a plan was created to achieve a given purpose." The term evolution conveys a non-teleological meaning of change as opposed to the teleological implications of the term development, and is, therefore, appropriate in describing the process of change that occurs in natural, non-teleological systems.

In his letter Dr. Werth states: "I realize that my position may run counter to published educational standards (e.g., the National Academy of Science's *Teaching About Evolution and the Nature of Science,* 1998) as well as decades of practice."

I would like to close by quoting from *Teaching About Evolution and the Nature of Science:*

> *The story of evolution is one chapter–perhaps the most important one–in a scientific revolution that has occupied much of the past four centuries. The central feature of this revolution has been the abandonment of one notion about stability after another; that the earth was the center of the universe, that the world's living things are unchangeable, that the continents of the earth are held rigidly in place, and so on. Fluidity and change have become central to our understanding of the world around us. To accept the probability of change–and to see change as an agent of opportunity rather than as a threat–is the silent message and challenge in the lesson of evolution.*

David L. Alles
Department of Biology
Western Washington University
Bellingham, WA 98225-9160
alles@biol.wwu.edu

William Harvey, Predicting Capillaries, and the Nature of Science–One More Time

Allchin ("William Harvey & Capillaries," *ABT,* 67[1], 56-59) argues that a serious error has been committed by persons who cast William Harvey's research on blood flow in terms of hypothetico-deductive (or hypothetico-predictive) science. In Allchin's view, Harvey did not use his circulation theory to predict the existence of capillaries, and those who think he did are not only mistaken, but are distorting the nature of science–and by implication the way science should be taught. In Allchin's words:

> *Consider, in particular the vast reach of this error. One finds the story of predicting capillaries in a nationally syndicated radio series on science, a biographical reference from a university publisher, a prominent Web site for biology teachers, and even a medical*