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Letters

Dear Editor:

Your excellent article on NABT's National Convention makes me wish I were young enough to go to the convention. Since I cannot go, I will tell you about a part of real science that is largely neglected by the authors of reports on science education.

These authors seem not to know that the formulation and development of theories are the major activities in the growth and in the logical structure of scientific knowledge. This has been true in biology since 1625 when Harvey published his treatise on circulation of the blood. (This was before Newton was born.)

High school and introductory college textbooks name and describe 3 or 4 theories, but there are 50 or more theories in each book. (See the enclosed list of theories present in the green version 1982 text.)

In order for science education in high schools and in introductory college courses to be more like real science, teachers and textbooks should know and use the answers to these questions.

1. What are the embedded and developing theories included in this course? Identify all theories even though they are not commonly called theories, even though they lie hidden in the dogmatic language of textbooks.
2. What are the basic premises, the postulates, of each theory?
3. What are some examples in each theory of:
   1) lines of reasoning used for support of a postulate,
   2) lines of reasoning using a postulate or postulates to explain a known fact or facts,
   3) lines of reasoning using a postulate or postulates to predict a possible new fact.
4. What are the range of applicability and the limitations, the boundaries, of each theory?

Many people seem to think a theory is any idea or notion that comes to mind whereas in science a theory is a nearly geometric pattern of reasoning. Central to each theory are a few ideas stated in the postulates. Lines of reasoning build patterns in three ways: (1) They use facts to support a postulate. (2) They use facts and postulates to explain known facts. (3) And they use facts and postulates to predict possible new facts. Most biology textbooks do not give a clear concise definition of theory nor do they give most of the theories they discuss in a well-structured form. Since theories are so important in science, this should change. The reports on science education have done a poor job on this part of science. They have skipped one of the major parts of science. I hope you, as an editor, might somehow publish papers on the many important theories in biology that are present in the high school and introductory college courses.

Ralph W. Lewis
Michigan State University
East Lansing, Michigan 48824

Dear Editor:

Dorothy Matthews's (1998) recent finding that college students learned less from a computer program on fetal pig anatomy than their fellow students who dissected fetal pigs is notable for its contrast with prior studies. Articles published in this journal by Charles Ralph (1996) and myself (1997) identify sixteen published studies that have found computer-based simulations (as well as 3-D models, and videotapes, or combinations thereof) to be equal or better than traditional methods for learning anatomy and physiology.

While we are pleased to see new data on the question of alternatives' effectiveness, there is an important flaw in Matthews's study: the computer program she chose (Intellimation's *MacPig*) is, in our opinion, quite

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unsuited for college-level students. When Intellimation generously donated a *MacPig* in 1995 for use in our Alternatives Loan Program, we evaluated it and deemed it too rudimentary for use beyond high school; on our list of materials for loan, we recommend it for use at the middle-school level.

Thus, it comes as little surprise that college students who used *MacPig* fared poorly on tests with prosected fetal pigs. Yet, Matthews uses her tenuous finding to dismiss the use of computers in general for anatomy instruction ("It is my opinion that one cannot learn anatomy by viewing a monitor").

While all learning methods—dissections and computer simulations included—have their limitations, perhaps the most salient message from this study is simply that you can only learn as much as what the learning materials offer. *MacPig* is a nice introduction for 7th graders, but for college-level students, we would recommend *Dissection Works Fetal Pig* (CD-ROM by Science Works, 1-800-478-8476, www.scienceclass.com), and/or the video *Dissection and Anatomy of the Fetal Pig* (available from Nasco, 1-800-558-9595, www.nascofa.com).

Dr. Jonathan Balcombe
The Human Society of the United States
Washington, DC 20037

Dear Editor:

In early July, 1998, the Society for the Study of Evolution met in Vancouver and heard speakers discuss the implications of a public largely ignorant of and even antagonistic towards the theory of evolution. The scientific community is finally waking up to the damage being inflicted by a relatively small religious group of creationists influencing a large portion of our population. On a recent visit to the Grand Canyon a woman behind me said, "Just think, this was all caused by Noah's flood." Twenty five years ago I would have laughed—not any more. Her thoughts have influenced more people than scientists' have.

I am a retired high school biology teacher with 30 years' experience. I've always taught biology from an evolution point of view and have had some encounters with creationists. I would like to offer some suggestions on how to win this fight.

Organizations like the Society for the Study of Evolution should find some means of getting in touch with scientists *before* they appear on television or radio newscasts to discuss issues in biology and other sciences. Scientists should be encouraged to include a statement or two relating their topics to evolution. In discussing cloning sheep why not mention that, because of our evolutionary history, the biochemistry of other mammals is similar to our own, and so what can be accomplished with sheep might be accomplished with humans. When talking of a mutant form of the AIDS virus, or any virus, or antibiotic-resistant bacteria, or a human disease caused by mutation, why not briefly mention the relationship of mutation to variations and to evolution. Just this evening, I listened to a 20-minute discussion on the news by an expert on mitochondria DNA and its use in identifying soldiers killed in warfare—and not even one phrase relating DNA to evolution was spoken. Even a simple statement like "Mitochondrial DNA has been passed from generation to generation for *millions of years. . .*" would have helped. A reference to mutation that accounts for the differences between individuals would be even better. A constant stream of comments on evolutionary principles by respected scientists in a variety of fields would be a great asset in fighting ignorance.

Nature-centered documentaries, especially those on ecology, are tremendously popular; but they cater to creationists' ideas in that they hold back on statements relating to how species evolve. For example, in a recent documentary on coral reefs the phrase "millions of years" was used often, as was the term "adaptation." But although many opportunities presented themselves, no reference was made to how "millions of years" and "adaptation" related to natural selection or contributed to the origin of new species. The name of Charles Darwin is seldom if ever used. The reason is obvious. The authors of the documentaries also read the polls. They know that approximately 50% of the public leans towards the creationists' view, and they don't want to offend. Scientific organizations should work to correct this attitude.

Never, never have a scientist debate a creationist with the creationist's ground rules—the scientist will lose every time. In a typical debate the creationist attacks, claiming, for example, that carbon dating is inaccurate. The scientist responds, and in a few short moments discusses Carbon 12 dating. Then the creationist brings up "no transition fossil forms," or the violations of the third law, or a horse evolution controversy, or inaccurate radioactive dating of rocks, or "evolution is just a theory".... The scientist attempts short answers to complex questions in front of an ignorant audience, and the result is that people walk away with the idea that those scientists aren't so smart after all. Maybe the creationists have a point. The creationists win!

Instead, have the scientist discuss what the creationists believe, and what they want taught to our children—that the earth is about 6000 years old; that dinosaurs walked on the earth with humans; that the Grand Canyon was caused by Noah's flood; that dinosaur bones are in deeper sediments because they were heavier than other bones and sank to the bottom faster. Have a pamphlet made stating the beliefs of creationists and send it to scientists before they debated or are interviewed. Most important, have the scientists discuss the effects that a population believing in creationism would have on the sciences of biochemistry, geology, petrology, medical research, astronomy, physics, paleontology, etc. Would a creationist ever think that secretions from green mold could kill bacteria in humans? Would antibiotics exist today if scientists were creationists? Have them point out that the public won't really be concerned with the loss of species if they can't really appreciate or understand what a species is.

Every chance should be taken to repeat and stick to this exact statement: *It is a scientific fact that evolution occurred. How evolution occurred is a theory, and always will be a theory.*

The fact that a person can be a Christian and accept evolution should be emphasized. Evolution can be accepted as part of God's creation.

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