MISCONCEPTIONS—WHAT STUDENTS THINK THEY KNOW

Joel Michael

Department of Physiology, Rush Medical College, Chicago, Illinois 60612

Key words: alternate conceptions; physiology education

Students’ understanding of many physiological phenomena is often seriously flawed. That is, students have faulty mental models of many of the things we ask them to learn. Such conceptual difficulties are often referred to as misconceptions. The problem with misconceptions is that they are often quite persistent, and they seriously interfere with the students’ ability to learn physiology.

How do you know that a student has a misconception? You ask a question and find that the answer you get is wrong, often in an odd or unexpected way. So, you ask a follow-up question, or you ask the student to explain the previous answer, and again you get an odd answer or explanation. Thus the questions that you have asked, whether in the classroom or in your office, are diagnostic probes, and the answers that you get are diagnostic signs of the possible presence of a misconception.

What do you do when find a misconception? First, you try to help the student repair the faulty mental model. Second, if you know that a particular misconception is quite prevalent, you try to provide your students with learning resources and activities that will assist them in remediating the misconception or in building a more correct model. Finally, you may change the way you teach the topic to make it less likely that students will develop the misconception in the first place.

This column is intended to be a forum where we can share with the whole community of physiology teachers the student misconceptions we have encountered. Only when we know about the possible existence of a misconception can we look for it in our students and try to find ways to help them repair their faulty mental models.

So, share your teaching experience with your colleagues. Tell us about those misconceptions that you are aware of. What we want to know is:

What is the misconception?

How do you know the misconception is present? How does it reveal itself?

What is the underlying conceptual difficulty? In what way is the students’ mental model faulty?

What can we do about the misconception? How can we help students repair this particular faulty mental model?

What has worked for you, and what hasn’t worked?

Send us the misconceptions that you have encountered. The misconception described in this issue of the journal is meant to be a representative sample, not a strict model, of what we are looking for. Try to keep the number of words between 500 and 1,000. Send your misconceptions to me at jmichael@rush.edu or fax (312) 942–8711.

Here is an example of a misconception.

A VERY PREVALENT MISCONCEPTION ABOUT RESPIRATORY PHYSIOLOGY

What is the misconception?

Students believe that tidal volume is fixed and that it can not increase if breathing frequency increases (as occurs during exercise).
How do you know the misconception is present?
We have asked more than 2,000 students the following question (1, 2, personal observation):

Your friend runs up the stairs to the 5th floor because the exam is about to start. When she sits down, you observe that her breathing frequency (no. of breaths/ min) is increased. At that time, her depth of breathing (the amount of air she takes in each breath) is ____________ at rest.

a. greater than (the correct answer)
b. less than
c. the same as

Approximately 40% of the student picked “a” (the correct answer), whereas more than half of the students surveyed picked answers “b,” and the remainder picked “c.”

I have asked this and similar questions involving increases in tidal volume (as would occur upon exposure to high altitude or in the presence of a metabolic acidosis) to students in small group discussion sections for many years and have found that at least half of them exhibit this misconception.

What is the underlying conceptual difficulty?
When asked to explain their predictions (either by writing a brief statement or picking an explanation from a multiple-choice question), most students say that depth of breathing (tidal volume) must decrease when breathing frequency is increased because there isn’t enough time for more air to move.

It would appear that these students do not understand the mechanism by which an inspiration is produced; if the inspiratory muscles are made to contract more strongly, alveolar pressure will become more negative, and the pressure gradient driving air into the lungs will be increased. Thus, even if the time available is decreased, more air will flow into the lungs with each breath.

Anecdotally, students also tell me that tidal volume (a term that was deliberately NOT used in the test question) cannot change because it is defined as the amount of air that moves in a single breath at rest. While this definition is not incorrect, it would appear that these students have not incorporated into their understanding of this parameter the idea that it can be, and is, varied by the body to contribute to homeostasis.

What can we do about this misconception?
It is, of course, easy to have students demonstrate to themselves that, during a voluntary hyperventilation (it is best that they are seated when they do this!), breathing frequency is increased and tidal volume is also increased. Or a single student (or even the instructor) can demonstrate this in front of the class. However, the strength of this misconception is truly impressive, and I have had students watch me hyperventilate who would admit only most grudgingly that tidal volume did, in fact, increase.

We (3) have also used a standard student laboratory experiment (spirometry at rest and during exercise) to allow students to discover for themselves that tidal volume does increase during exercise. However, such an experiment is most effective at helping students correct their faulty mental model if you can get them to predict the outcome they expect to see, then do the experiment, and finally compare their results with their predictions. With such a protocol, 75% of the students who entered the laboratory with the misconception left having corrected it. Only 30% of the students with this misconceptions remediated it by use of the standard “cookbook” protocol.

Address for reprint requests and other correspondence: J. Michael, Dept. of Physiology, Rush Medical College, 1750 W. Harrison St., Chicago IL 60612 (jmichael@rush.edu).

Received 6 December 2001; accepted in final form 6 December 2001

REFERENCES