SCIENCE TEXTBOOK ACCURACY REVIEW FORM
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ACCURACY REPORT

INTRODUCTION

"Modern Biology" has been around for many years and has gotten better and better in meeting needs for both the student and the teacher. It has had innumerable persons from all levels review its many aspects and many holes have been filled and improved over the years.

The total number of "egregious" errors is minimal. There is little, if anything, that would disqualify it as an excellent textbook. No serious error could be found in terms of content. It is quite accurate in its factual bases of biology and chemistry aspects and is a great start as a text of biology for the student as it develops the information relatively logically for a beginning student having little to no exposure to this area.

The learning aids for the student to study the vast amount of material found at the ends of each section and chapter are especially helpful as that is where the student finds out if he/she learned anything from their reading. The problems in multiple choice answers

format will enable students to practice for quizzes and exams commonly given in that format. The summaries are a great way to review what was covered in a given section and the critical thinking questions are something that desperately needs to be practiced in the process of teaching and learning biological science.

The idea of including sections at the end of each chapter for critical thinking is especially good as the need for more critical thinking has been well documented and espoused. Biology has had rote memory as its process (due to its many facts) and is still quite important in studying categorizations, anatomy, classification systems, etc. This process of teaching/learning is still used in many medical schools which may be one of the last good justifications for continuing strongly in this mode of learning. However, there are many other interesting aspects of biology which require critical thinking to get to the "so-what" aspects and the emphasis in this text in its special section is to be applauded. The MCAT and other aptitude tests for admission to the professional schools, in spite of the teaching methods used in some medical schools once they get there, have begun including many more critical thinking/problem solving type questions. This strongly indicates the testing people's view (preference) on the importance in predicting success in various schools and the admission personnel's agreement with their findings.

TEACHING CRITICAL THINKING

The nature of these critical thinking assignments and the answers given in the teachers' manual, however, leave one with an uneasiness of what is being espoused as critical thinking. Without too much research into this area of critical thinking, one must ask if wonder if critical thinking is being taught well, if at all. Without being too specific, each exercise in critical thinking in the first few examples involved good questions that pertained to some aspect of the material in the chapter. One problem with them was that in many cases there was required (as explained in the answers supplied in the teachers' edition), additional data to answer the question properly. It appeared that the knowledge required was NOT in that particular chapter or textbook and that the information would be learned in an upper level course. This method of enticing interest in the topic (subject) may justify this strategy. There are many interesting questions and some have good answers. However, it may be deceiving or incorrect to call these 'enticing questions requiring additional information 'critical thinking'.

RESPONSE: Modern Biology does indeed provide sufficient information within the student text to enable students to answer the critical thinking questions at a level appropriate for a 9th or 10th grade biology course. Specific examples are addressed within this review.

This in no way disqualifies it as a good text. However, one must be concerned that it is not really enhancing critical thinking as much as it may be alleviating some concerns that a text 'should' include some critical thinking 'elements' even if they are weak or nonexistent.

The literature supports this view on what critical thinking is. (Critical Thinking, Barry K. Beyer, p. 10):

It suggests: "the sign of a poor education ,… is not ignorance. It is .. the thoughtless habit of believing that one's unexamined, superficial or parochial opinions and feelings are the truth; or the habit of timid silence when one does not understand what someone else is talking about. " Skilled use of critical thinking enables us to kick these unthinking habits. And overcoming them is precisely why developing skill in critical thinking is so worthwhile. Only teachers who understand what critical thinking is and deliberately engage in it can help youngsters improve their own critical skills."

COMMENT (by verifier)

The questions included in each review section on critical thinking in the review section often does not adequately demonstrate what the author (Beyer, above) is talking about as he defines critical thinking. Few questions in "modern Biology" do much to enhance the students' ability to learn this important technique and, furthermore, does not assist a teacher not having good knowledge in critical thinking skills to enhance that in their students.

RESPONSE: Beyer's definition of critical thinking (Practical Strategies for the Teaching of Thinking by Barry K. Beyer) defines critical thinking as "a collection of specific operations that may be used singly or in any combination or in any direct order." Beyer lists ten different operations that he identifies as critical thinking skills. These critical thinking skills include "distinguishing relevant from irrelevant information, claims, or reasons;" "determining the factual accuracy of a statement;" and "recognizing logical inconsistencies in a line of reasoning." Students will use these operations as they answer the questions listed under the "Critical Thinking" subheads in Modern Biology. They also will employ the elements of argument, reasoning, and procedures for applying criteria and judgment, which the reviewer lists as elements of critical thinking. Specific examples are addressed below in the responses to specific reviewer comments.

Beyer , p.10, defines critical thinking as having elements of:
Dispositions

Criteria
Argument
Reasoning
Points of view
Procedures for applying criteria and judgment

There seems to be missing a few very important facts which after becoming aware of them, one can get a rather simplistic conclusion which has few, if any of the elements of: argument, reasoning, point of view, dispositions, procedures for applying criteria and judgment. The missing facts necessary to solve the often already known solution need to

be part of the question, then somehow extended to require critical thinking. The student can then use some of the real elements of critical thinking OR these questions ought to be relabeled to something else without misleading either the student or the teacher into believing that they are developing any skills in the area of critical thinking.

There are two places where critical thinking is regularly used in the text. There is one question in the review section at the end of each section and there is a section of several critical thinking questions at the end of the chapters. The first single question often seems to require additional knowledge to make a rather simple answer and does not require the elements of critical thinking. This would put these questions in a category of 'additional information required' and an 'educated guess' is about the only way to approach most of these questions. While this may not be bad to instill some interest in the student, it is in error to call it a critical thinking question for either the student or the instructor.

EXAMPLE I.

One example of the six questions on p. 34 in the teachers' manual:

Hydrogen used to inflate airships no longer is used but rather helium. Why was helium preferred over hydrogen.

There is a very logical answer to this and it needs very few (if any) of the elements of critical thinking as defined above other than reasoning. Nowhere in the text does it say that helium is nonflammable due to its unreactivity in air with its special noble gas arrangement of electrons. Most may have picked that up that fact in a general science course but it turns to be more guessing than reasoning if they have not had this one important fact. Again there is little need for any of the elements mentioned above.

RESPONSE: In the review form, the reviewer has not included the complete text of Question 6 on page 34. To answer the question correctly, the student does not need to know the detailed explanation suggested by the reviewer ("that helium is nonflammable due to its unreactivity in air with its special noble gas arrangement of electrons"), which is beyond the scope of a $9^{th}/10^{th}$ grade biology course. To answer the question, students must be able to find the relevant information in the text (p. 33: helium, like neon, is an example of an element that consists of atoms whose energy levels are filled with electrons; thus, helium tends not to react with other elements) and recognize that helium, unlike hydrogen, is not flammable.

EXAMPLE II

A second example on p. 37 says: "Living things need energy even though many of the chemical reactions they undergo release energy. Why is this true? "

Answer in the teacher's manual is: "even exergonic reactions need a small amount of activation energy to begin a reaction."

This question may be more of an opportunity to think critically than many of the others. This answer given is far too simple and somewhat incorrect as most simple exothermic chemical reactions supply the necessary activation energy from the energy given up in the reaction.

The real answer is much more complex than simply adding activation energy. There are many steps in the mechanism for most biological reactions and this complexity involves many activation energies with enzyme catalysts and exothermicities which must be known to fully understand the answer to this question.

RESPONSE: The answer to the question can be found in the introductory paragraph at the top of page 35. A more detailed answer would lie outside the scope of the lesson, which provides a brief overview the role of energy in the living world. The answer supplied in the teacher edition is sufficient and appropriate within the context of a $9^{th}/10^{th}$ grade biology course.

EXAMPLE III

A third example found on p. 45 is:

"How can a substance be changed from a solid to a liquid to a gas?"

The given answer is: "Increasing temperatures changes solids to liquids to gases"

The answer given in the teachers' edition is correct only in the specific examples of simple elements and compounds. In the case of proteins and most complex biological macromolecules this is not true. Eggs, for example, cannot be heated and gasified into egg vapors. There are many similar examples in biological compounds where heating does not change solids into liquids or gases.

RESPONSE: The answer quoted by the reviewer is not the answer that appears in any of the teacher edition printings for the ©2002 edition of Modern Biology. The answer that does appear ("If sufficient energy is added to a solid, it will change to a liquid and then to a gas") is correct and appropriate given the broad nature of the question and the general explanation of states of matter that is found on pages 35 and 36 of the student textbook.

EXAMPLE III

On p. 51: "Most automobiles have water-cooled engines. What must be true about a solution that can replace water in the cooling system, such as antifreeze?"

Given answer is: “Solutions replacing water as a coolant in automobile engines must have the ability to absorb large quantities of heat.”

This answer is, overly simplistic as there are many properties of ethylene glycol that make it a good coolant over many other options. Melting and boiling points are, probably, much more important than heat absorbing capacity. The cost is also a major factor, and the ability to cool quickly in the radiator is also equally important. Again, what is needed are facts about engine cooling, operation of cooling systems, and properties of molecules involved in cooling such as heat capacity, boiling point, etc. There is little discussion in the chapter that would allow the student to make any judgment let alone the answer given in the teachers manual. On the other hand there are many better examples of questions that might be used instead of the ethylene glycol to demonstrate with less information needed which would be better for this particular area of chemistry in biology.

RESPONSE: As the reviewer points out, other properties of ethylene glycol (such as its melting and boiling points) plus additional factors such as engine cooling, operation of cooling systems, etc., all play a role in the suitability of ethylene glycol as an engine coolant. However, coverage of these additional topics lies outside of the scope of a $9^{th}/10^{th}$ grade biology course. The answer supplied in the teacher edition is sufficient and appropriate within the context of a $9^{th}/10^{th}$ grade biology course. The answer to the question can be found on page 51 in the last paragraph, which describes water’s ability to absorb large amounts of heat.

The second group of 4-9 critical thinking questions at the ends of the chapters is a little less problematic in not being true critical thinking questions. They seem to evoke some opinion based upon knowledge already learned in the particular chapter, although, too often they, also, require knowledge from elsewhere which they are could be expected to know at this point.

EXAMPLE I

However an example on p. 63 states: “Starch easily dissolves in water while cellulose does not. Both substances, however, consist of chains of glucose molecules. What structural difference between starch and cellulose accounts for this different behavior in solubility?”

Given answer: “Starch occurs in either highly branched chains or long, twisted chains, while cellulose occurs in long straight chains with extensive hydrogen bonding between them.”

While the answer is probably due to differences in hydrogen bonding due to differences in branching, there is only minimal discussion of this in the chapter for cellulose and little to no information is given about any hydrogen bonding or lack thereof or the basic

structure of the two with differences H-bonding . Once the student knows about the hydrogen bonding differences, the question becomes easily and quickly answered. Again, it still does not require the elements which define critical thinking including dispositions, criteria, argument, reasoning (perhaps with additional data required), points of view, or procedures.

RESPONSE: Hydrogen bonding is defined and discussed on page 50 of the student edition. The discussion of the structural differences between glycogen and starch (under the subhead "Disaccharides and Polysaccharides") on page 56 provides sufficient information to enable students to answer Question 3 on page 63.

The errors in this section might be defined as serious. They are inaccurate but not so much to make this an unacceptable text. The next edition should look at the critical questions issues and be changed to more accurately include the elements of true critical thinking in future revisions.

Overall, the text "Modern Biology" is excellent in its content, its appropriate level of reading, and its accuracy of information in the worlds of both biology and chemistry. It continues to be an excellent text for the high school classroom. No comparison was made between different texts that have similar targeted markets and there may be other equally appropriate texts in this area.

Laboratories integrated with the Text.

Sciences require lab experiences to fully appreciate and understand the principles involved. The investigations are extremely well placed in the text to integrate with the text. There are, in many cases, extraordinarily cheap materials required which is excellent as there are so many students taking biology and funding is often a problem. There are sufficient 'live' experiments for biology observation and interaction. The use of programs on a CD is particularly attractive as there are many things that can be recorded such as kinetics experiments, growth patterns, photos, slides of expensive rare specimens that can easily be recorded on a CD and observed by many students. The provide ways to otherwise hazardous experiments or expensive experiments to carry out shorten the time in which a student has to work on each principle. The 'Quick Labs' in many chapters, also, are excellent tools to help student observe the concepts first hand in an even shorter time. The accuracy is often a moot point in experiments of observation of structure and use of the CD was not observed but assumed to be accurate and very revealing to the student.

The experiments cover a wide range of material and they use appropriate materials for the various interactions/experiments. The procedures for the teachers are especially helpful as they are always in a hurry with many different sections. The list of materials listed along with the expected outcomes and reasoning used is often included for the teacher and is very helpful.