

## Review of Biology - OpenStax

(First Edition)

Date submitted
2013-09-03 15:57:45

### Reviewer Information

Textbook that was reviewed
Biology
My name
Joan Sharp
My title/position
Senior Lecturer
My institution
Simon Fraser University

### Comprehensiveness

The text covers all areas and ideas of the subject appropriately and provides an effective index and/or glossary.
The text covers most necessary areas, but not always with clarity or accuracy. The index and glossary are fine.
In Chapter 18, the text only includes the biological species concept, with no discussion of its weaknesses or limitations. Other species concepts should be included and the pros and cons of each should be discussed.
How do you rate the book's overall comprehensiveness?
4

### Content Accuracy

Content, including diagrams and other supplementary material, is accurate, error-free, and unbiased.

I noted many errors in the text and I'm sure there are many more.

- On page 65, the text states, "Hydrogen bonds are also involved in various recognition processes, such as DNA complementary base pairing and the binding of an enzyme to its substrate, as illustrated in Figure 2.28." The figure illustrates the former, but not the latter. Plus the right hand side of the drawing is labeled as Cytosine bonded to adenine. Why are two base pairs (T-A and incorrectly labeled C-G) shown? Students will be confused and uncertain how the two strands are represented. Although the text states that H-bonds create the double-helix structure, this is not shown in the Figure.
- On page 90, the text states, "Being the outermost structure in animal cells, the plasma membrane is responsible for the transport of materials and cellular recognition and it is involved in cell-to-cell communication." Why only animal cells?
- On page 96, the text states, "The structural difference between a normal hemoglobin molecule and a sickle cell molecule—which dramatically decreases life expectancy—is a single amino acid of the 600." No, the sickle cell hemoglobin only decreases life expectancy in homozygous individuals.
- There are two errors on page 125: "Have you ever noticed that when you bite into a raw vegetable, like celery, it crunches? That's because you are tearing the rigid cell walls of the celery cells with your teeth." No, it's not the cell walls. It's the lignified schlerenchyma cells. "Fungal and protistan cells also have cell walls." No, not all protists have cell walls.
- On page 159, crenation does not mean shrinkage but refers to the effect of shrinkage on the cell membrane.
- On page 186, the text states, "ATP is a highly unstable molecule." No, not at the range of pH in most cells. If this statement were true, the energy of ATP could not be used to supply energy to reactions within cells.
- In Chapter 8, the text states, "The energy extracted today by the burning of coal and petroleum products represents sunlight energy captured and stored by photosynthesis almost 200 million years ago." No, fossil fuels formed in the Paleozoic, which ended 252 mya.
- On page 243, the text states, "Every single atom of matter and energy is conserved, recycling over and over infinitely." No, this is not so. Energy is conserved, but does not recycle, as energy is lost as heat in each chemical reaction.
- In Chapter 11, the text states, "Spores are haploid cells that can produce a haploid organism or can fuse with another spore to form a diploid cell." Spores never fuse with other spores to form diploid cells. It also states, "Some plants produce spores." No, all plants produce spores.
- This statement on page 488 is not necessarily true: "A geographically continuous population has a gene pool that is relatively homogeneous. Gene flow, the movement of alleles across the range of the species, is relatively free because individuals can move and then mate with individuals in their new location. Thus, the frequency of an allele at one end of a distribution will be similar to the frequency of the allele at the other end." It's inaccurate to claim that allele frequencies do not change over the range of a species.
- On page 503, the text states, "Evolutionary theory states that humans, beetles, plants, and bacteria all share a common ancestor, but that millions of years of evolution have shaped each of these organisms into the forms seen today." No, billions of years.
- In Figure 45.10, there is no such thing as "the carrying capacity of seals". Carrying capacity is a feature of a population's environment, not of the population.
- The text uses the terms primitive and advanced for extant taxa. This terminology is out-of-date and reinforces student misconceptions of evolutionary change as goal-directed and progressive.

There are a number of concepts or topics that are very poorly explained. In some cases, it appears that the authors do not fully understand them. Here are some examples; I'm sure there are many more.

- On page 52, the text states, "Like hydrogen bonds, van der Waals interactions are weak attractions or interactions between molecules. Van der Waals attractions can occur between any two or more molecules and are dependent on slight fluctuations of the electron densities, which are not always symmetrical around an atom. For these attractions to happen, the molecules need to be very close to one another. These bonds, along with hydrogen bonds, help form the three-dimensional structure of the proteins in our cells that is necessary for their proper function." In fact, interactions between R-groups on amino acids are more important than Van der Waals attractions in stabilizing 3D structure in proteins.
- In Figure 5.12 and throughout the text and chapter questions, the terms hypertonic, isotonic, and hypotonic are used to describe single solutions. You cannot refer to solutions as hypertonic, isotonic, and hypotonic except in comparison to other solutions. The text and figure reinforce a common and significant student error that prevents clear understanding of this key concept.
- On page 749, the text says, "In the following Cenozoic Era, mammals radiated into terrestrial and aquatic niches once occupied by dinosaurs." No, the aquatic reptiles of the Mesozoic were not dinosaurs. Many seven-year-olds could correct the authors on this one.
- On page 1304, the text states, "Animals faced with temperature fluctuations may respond with adaptations, such as migration, in order to survive." This reinforces a common and deeply rooted student misconception that organisms adapt in order to survive. Frankly, I was surprised and appalled to see this sentence in a university level textbook.
- On page 1360, the explanation of keystone species is very weak and insufficient to answer the critical thinking question at the end of the chapter.
- The very brief discussion of sociobiology on page 1372 is biased, sketchy, and inaccurate: "Sociobiology also links genes with behaviors and has been associated with biological determinism, the belief that all behaviors are hardwired into our genes."
- The text generally takes a traditional approach to behavior, with insufficient discussion of behavioral ecology.

Overall, how do you rate the accuracy of the content?

2

## Relevance/Longevity

Content is up-to-date, but not in a way that will quickly make the text obsolete within a short period of time. The text is written and/or arranged in such a way that necessary updates will be relatively easy and straightforward to implement.

I noted quite a few examples of out of date terminology and concepts. I'm sure there are many more.

- Archaea get very short shrift in this textbook. On page 30, the text says, "Many organisms belonging to the Archaea domain live under extreme conditions and are called extremophiles." This would be fine if the text then went on to explain that we now realize that Archaea are far more widespread than previously thought, but the discussion ends there. In fact, throughout the textbook, bacteria are mentioned in contexts where bacteria and archaea should both be included. Students are generally not familiar with archaea and it seems the authors of this textbook share this lack of understanding.
- On page 479, the text states that "Natural selection [is] also known as "survival of the fittest." This outdated phrase is not challenged or revised.
- The terms "warm-blooded" and "cold-blooded" are used throughout the text, e.g., page 749: "The mostly cold-blooded dinosaurs ceded their dominance of the landscape to more warm-blooded mammals." These terms are highly inaccurate. Terrestrial vertebrates differ in the source of body heat and in the variation in temperature they experience and can tolerate, not in the temperature of their blood. The biologically accurate terms are ectothermic and endothermic. Again, this seems to reflect a lack of understanding on the part of the authors, as the inaccurate terms are used consistently.
- The terms higher and lower organisms are used throughout the text. This is outdated terminology that has no place in a general biology textbook.
- There are many cases in which the authors refer to plants and animals, rather than including all relevant taxa. Again, this reinforces student misconceptions and lack of familiarity with fungi, protists, and prokaryotes. Examples are found on page 27: "A community is the sum of populations inhabiting a particular area. For instance, all of the trees, flowers, insects, and other populations in a forest form the forest's community;" in Figure 6.3: "Both plants and animals use cellular respiration to derive energy from the organic molecules originally produced by plants;" and on page 228: "Photosynthesis is essential to all life on earth; both plants and animals depend on it."
- On page 804, the text states, "The notochord, however, is not found in the postnatal stage of vertebrates." On page 807, it says, "In adult vertebrates, the vertebral column replaces the notochord, which is only seen in the embryonic stage." Not so! Consider extinct vertebrate taxa (e.g., ostracoderms and Placoderms) and extant taxa (e.g., lungfishes) that have unconstricted notochords.
- On page 807, the text states, "Based on molecular analysis, vertebrates appear to be more closely related to lancelets (cephalochordates) than to tunicates (urochordates) among the invertebrate chordates. This evidence suggests that the cephalochordates diverged from Urochordata and the vertebrates subsequently diverged from the cephalochordates." Nope, that's out of date. More recent genomic analysis has identified cephalochordates as the most basal chordates. Tunicates and vertebrates are sister taxa that diverged more recently. Urochordate and vertebrate embryos share a novel embryonic tissue layer: migratory neural crest cells.
- On page 808, the text states, "We will consider hagfishes and lampreys together as jawless fishes, the agnathans, although emerging classification schemes separate them into chordate jawless fishes (the hagfishes) and vertebrate jawless fishes (the lampreys)." This is incorrect and out-of-date. In fact, recent genomic evidence shows that hagfishes and lampreys form a clade, the cyclostomes: Hagfishes and lampreys share four unique miDNA families. The term Agnatha was abandoned long ago, as jawless fishes include cyclostomes and ostracoderms and are not a clade.

Overall, how do you rate the relevance/longevity of the book?

3

## Clarity

The text is written in lucid, accessible prose, and provides adequate context for any jargon/technical terminology used.

There are a number of examples of complex terms or concepts that are not clearly explained. Here are some examples:

- ❑ In Chapter 3, the Evolution Connection on cytochrome C is not well explained: "When human and rhesus monkey sequences were compared, the single difference found was in one amino acid. In another comparison, human to yeast sequencing shows a difference in the 44th position." This suggests that humans and yeast are as closely related as humans and rhesus monkeys. And why specify the position of the one change? The significance of these comparisons is not explained.
- ❑ On page 94, the term homology is used but not clearly defined or explained.
- ❑ Figure 3.32 is not helpful and does not show H-bonding or antiparallel arrangement clearly.
- ❑ Unless I missed it, the R in Figure 2.27 is undefined.
- ❑ On page 54, this sentence requires a fuller explanation: "Cells can only survive freezing if the water in them is temporarily replaced by another liquid like glycerol."
- ❑ This explanation on page 58 is overly simplified: "So how do the cells of the stomach survive in such an acidic environment? How do they homeostatically maintain the near neutral pH inside them? The answer is that they cannot do it and are constantly dying. New stomach cells are constantly produced to replace dead ones, which are digested by the stomach acids."
- ❑ On page 154, the text states, "For example, think about someone opening a bottle of ammonia in a room filled with people. The ammonia gas is at its highest concentration in the bottle; its lowest concentration is at the edges of the room. The ammonia vapor will diffuse, or spread away, from the bottle, and gradually, more and more people will smell the ammonia as it spreads." No! This is an example of convection, NOT diffusion. Diffusion plays a key role in the movement of molecules across plasma membranes, which are only 8 nm thick. Many students imagine that diffusion explains the spread of molecules of dye in a beaker of water or the movement of molecules of scent in a room and this example feeds this misconception. It is also important to emphasize to students that diffusion is an effective and important process for transport of molecules over small distances but is completely irrelevant at macroscopic scales. See Vogel (1994) Dealing honestly with diffusion. American Biology Teacher 56:7, 405-407.
- ❑ On page 242, the discussion of CAM and C4 photosynthesis is far too brief.
- ❑ On page 285, the text states, "Cells in G0 phase are not actively preparing to divide. The cell is in a quiescent (inactive) stage that occurs when cells exit the cell cycle." A G0 cell is far from quiescent metabolically and this term will mislead students.
- ❑ On page 313, the explanation of The Red Queen Hypothesis in the Evolution Connection is very weak and unclear.
- ❑ On page 481, the text fails to explain why a mutation may be neutral.
- ❑ On page 496, the explanation of punctuated equilibrium is very weak.
- ❑ On page 518, the term linkage disequilibrium is very poorly explained.
- ❑ In Chapter 19, the discussion of some evolutionary mechanisms, e.g., nonrandom and assortative mating, is very sketchy.

Chapter 20 shows a very weak understanding of a key topic: phylogeny. Students struggle with "tree-thinking", a necessary skill for anyone who plans to continue in biology. Phylogenetic trees are poorly explained in this chapter and the discussion on how to construct them is confusing. I honestly do not think that the author has a clear understanding of this important topic.

Some examples:

- ❑ On page 524, phylogeny is very poorly defined: "Phylogeny describes the relationships of an organism, such as from which organisms it is thought to have evolved, to which species it is most closely related, and so forth." Ouch!
- ❑ On the same page, "Scientists consider phylogenetic trees to be a hypothesis of the evolutionary past since one cannot go back to confirm the proposed relationships." Yes, phylogenetic trees represent hypotheses about evolutionary relationships, but not because these hypotheses cannot be tested!
- ❑ In Figure 20.7: "For example, the bones in the wings of bats and birds have homologous structures." This is a poor example, since these wings are both homologous as vertebrate forelimbs and analogous as wings. Later, the text (page 530) says, "Some structures are both analogous and homologous: the wings of a bird and the wings of a bat are both homologous and analogous." True, but the author does not explain why these structures are both homologous and analogous!
- ❑ The chapter appears confused about how time is represented in phylogenetic trees, saying both that trees do and do not have a time axis.
- ❑ On page 534, the text states, "The vertebrate in Figure 20.10 is a shared ancestral character." Huh?
- ❑ The discussion of horizontal gene transfer is very lengthy but very poorly written. For example, the discussion of Lake's work would not be accessible to general biology students. It's not clear that the author understands it, frankly.

Overall, how do you rate the clarity of the book?

2

## Consistency

The text is internally consistent in terms of terminology and framework.
<p>Many terms are used before they are defined. I noted several examples and I am sure that there are many more.</p> <ul style="list-style-type: none"> <li>• On page 24, the term “germline cells” is used but is not clearly defined.</li> <li>• In Figure 1.16, just before three domains are introduced, many taxa (species and higher taxa) are introduced with no context.</li> <li>• On page 80, the term “daltons” is used but not defined.</li> <li>• The term “emulsification of fats” is used on page 90 but not defined or explained until page 988.</li> <li>• On page 151, the term “monocyte” is used but not defined.</li> <li>• On page 538, the terms “proteobacteria” and “Gram-negative bacteria” are introduced without explanation.</li> </ul> <p>It's unusual to address adaptive radiation and extinction primarily in the ecology chapters instead of the evolution section. Personally, I do not support this organization.</p>
How do you rate the overall consistency of the text?
3

## Modularity

<p>The text is easily and readily divisible into smaller reading sections that can be assigned at different points within the course (i.e., enormous blocks of text without subheadings should be avoided). The text should not be overly self-referential, and should be easily reorganized and realigned with various subunits of a course without presenting too much disruption to the reader.</p> <p>The text is fine in this regard.</p>
Overall, how do you rate the modularity of the text?
5

## Organization/Structure/Flow

<p>The topics in the text are presented in a logical, clear fashion.</p> <p>I noted several examples in which material is explained clearly in one part of the text, with inaccurate or inconsistent information in other places. I'm sure there were many others.</p> <ul style="list-style-type: none"> <li>• On page 188, the text states, “Due to this jigsaw puzzle-like match between an enzyme and its substrates (which adapts to find the best fit between the transition state and the active site), enzymes are known for their specificity.” No, it's not like a jigsaw puzzle. This will confuse students, many of whom have trouble grasping induced fit, which is introduced on the next page.</li> <li>• On page 482, the text states, “Although natural selection may work in a single generation on an individual, it can take thousands or even millions of years for the genotype of an entire species to evolve.” The idea that evolution and speciation require millennia is included as a misconception later in the chapter!</li> <li>• On page 676, the text confounds green algae and charophytes, referring to all green algae as charophytes. The distinction between charophytes and the other taxon within the green algae was made clearly in Chapter 23. The distinction is also clear on page 682.</li> </ul>
Overall, how do you rate the organization/structure/flow of the text?
3

## Interface

<p>The text is free of significant interface issues, including navigation problems, distortion of images/charts, and any other display features that may distract or confuse the reader.</p> <p>I did not note any problems with the interface.</p>
Overall, how do you rate the textbook's interface?
5

## Grammatical/Spelling Errors

The text contains no grammatical or spelling errors.

The text contains few grammatical and spelling errors. Here are a few errors that I noted:

- On page 54: Unites States
- In Figure 4.6: "Relatives sizes on a log scale"
- On page 123: "... proteins synthesis is an essential function of all cells"
- On page 176, this sentence is very poorly written, with a full and confusing sentence in brackets: "Photosynthesis is the primary pathway in which photosynthetic organisms like plants (the majority of global synthesis is done by planktonic algae) harvest the sun's energy and convert it into carbohydrates."
- Gene and allele names/letters and variables in equations should be italicized, but are not. This is a problem throughout the text.
- On page 486, this sentence is incomplete: "Define species and describe how species are identified as different"

How do you rate the grammar and spelling of the text?

4

## Diversity and Inclusion

The text reflects diversity and inclusion regarding culture, gender, ethnicity, national origin, age, disability, sexual orientation, education, religion. It does not include insensitive or offensive language in these areas.

The text is not culturally insensitive and uses a wide variety of examples.

Overall, how do you rate the diversity and inclusion of the text?

5

## Recommendation

Do you recommend this book? If not, why?

There are many examples (e.g., government regulations such as the FDA, examples of careers) that are American and explicitly not Canadian.

American spelling is used throughout, which is fine with me.

The text has some good features.

- Learning outcomes are specified throughout and are clear and complete.
- The Career Connection sections are good, although they are definitely American and not Canadian.
- The critical thinking questions are generally pretty good. Do students have access to answers to these questions and to the others included in some figures? If so, how?
- One of the best features is the Everyday Connection sections, which are imaginative and will be interesting to students.
- The introduction to scientific approach and the culture of science is generally good.

One very serious weakness of this text is the art: the figures, the animations, and the Art Connection features. They are very basic and do little to help students visualize biological concepts and structures. Some of them (Figure 5.11, Figure 18.6) are truly awful.

Currently available textbooks have made huge strides in producing carefully rendered and accurate illustrations and animations that are produced by talented teams of artists and animators. I realize that it is impossible to provide this quality of artwork in an open source textbook, but I think it is also important to recognize how important such features are for students attempting to visualize complex structures and to master difficult concepts. It is a false savings to provide a free textbook that lacks features that are crucial and necessary to student understanding of what is, frankly, very challenging material.