Holt McDougal Review
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This is more detail of some comments made in the summary page.

2Aii

- 2nd reading under 2A insufficiently addresses limitations of science. It is supposed to show how "some questions are outside the realm of science because they deal with phenomena that are not scientifically testable" Since this is biology, natural history needs to be included as a "mixed question", that requires inputs from other areas, like philosophy. Mortimer Adler (1902-2001) has a good explanation on p. 107 of his book *Conditions of Philosophy*, when he said "Men who are scientists (such as geologists, paleontologists, evolutionists) sometimes attempt to establish the spatial and temporal determinants of particular past events or to describe a particular sequence of such events; but when they do so, they cease to be engaged in scientific inquiry and become engaged in historical research." Students need to know clearly that science is limited in its ability to explain past, present, **and** future (i.e., predicting alien life, predicting weather) events that are not testable. Assessment Quiz 2A provides insufficient opportunity to understand the limits of science, especially the confusing connection between real, operational science and natural history research.

3E

- ALL models make assumptions, and this is not addressed anywhere in 3E.

- Natural selection simulation: the model assumes a genetic mutation is required, but a change like this could just be epigenetic.

- None of the examples make an effort to explain the complexity of cells, other than 20th century ideas that eukaryotes are more complex than prokaryotes, and discussions about the origins of eukaryotes. That IS NOT an explanation of cell complexity. Students need to know what a proteome is, and what an interactome is. Proteome: The set of expressed proteins in a given type of cell or an organism at a given time under defined conditions. Interactome: The whole set of molecular interactions in a cell. ncdir.org would be a good place to get some examples of how to explain cell complexity.

These are Factual errors included on the Excel spreadsheet, but they may be easier to read here:

5C

- OKReading: Homeotic genes – 4th paragraph, "For example, a sponge is a simple animal that has at least one Hox gene, while an arthropod has eight. This difference suggests that over time, mutations have caused the original Hox gene to be copied repeatedly, forming a series of similar genes along a chromosome."

  Evolution is defined as a change in heritable traits. Change can mean an increase or decrease in heritable traits. The explanation used here that Hox genes increased from one in a sponge to eight in an arthropod is not a testable explanation (TEK b2 on def. of science). The explanation also assumes that evolution is a progressive ladder (from 1 to 8 Hox genes), while the modern definition of evolution does not mean this. Fruit flies have 10 homeobox genes, and they are arthropods, too. Mice and humans each have about 40, and humans are more complex than mice, with virtually no change in homeobox gene number. Other research suggests some animals have lost homeobox genes over time (http://www.cell.com/current-biology/retrieve/pii/S0960982206002843 Current Biology, Volume 7, Issue 9, R570-R572, 1 September 1997 doi:10.1016/S0960-9822(06)00284-3).

  - Rewrite to say: "For example, a sponge is a simple animal that has at least one Hox gene, while an arthropod has eight. While the explanation of this difference is not currently testable, some researchers speculate that, over time, mutations may have caused the original Hox gene to be copied repeatedly, forming a series of similar genes along a chromosome. Sometimes, there are virtually no differences in homeobox gene

numbers between very different organisms. Mice and humans have about 40 each. There is also evidence that some animals, like the Japanese pufferfish, have lost homeobox genes, although this is not a currently testable hypothesis, either."

- Adjust and assessment questions to reflect this change

7A

- **Lab activity: comparing hominoid skulls**: 2010 research confirms humans and chimps differ by 30%. This fact is not discussed in the lab activity. The human/chimp skull homology does not match the genetic homology. Including the human skull leads students to a conclusion that differs from 21st century scientific research that is testable and repeatable, and should be removed from the activity. "The difference in MSY gene content in chimpanzee and human is more comparable to the difference in autosomal gene content in chicken and human, at 310 million years of separation." The similarities in human skulls with other hominids may be convergent evolution, but it is erroneous to pretend that common ancestry is the cause.

- **Animation: Similarities in embryology**- "Humans and gorillas have gill pouches as early embryos." Change to "Gestating human babies and gorilla embryos have pharyngeal pouches."

- **Reading**: Applying Darwin's Ideas – "For example, if species have changed over time, the genes that determine their characteristics should also have changed." Change "should" to "might." Epigenetic adjustments can cause changes in species WITHOUT changing genes. A good example is the lizard, Podarcis sicula.

- **Reading**: Applying Darwin's Ideas- Figure 7: Whale evolution- 4 fossils is hardly a "transition". 400 intermediates would work. Also, research has shown that there is no reason to believe *Pakicetus* was ever anything but a land mammal. Also, no complete skeletons have been found, but the picture shows a full skeleton, which a major factual error. It is erroneous to include it in

this example. Ambulocetus also shows a full skeleton, which is another major factual error, since no complete Ambulocetus skeletons have been found.

These passages wrongly state that biochemical and anatomical phylogenies uniformly agree

- "Reading: Applying Darwin's Ideas," (p. 384) "Biochemistry," par. 2, lines 2-8

"... A comparison of DNA or amino-acid sequences shows that some species are more genetically similar than others. These comparisons, like those in anatomy, are evidence of hereditary relationships among the species. For example, comparing one kind of protein among several species reveals the pattern shown in Figure 10. The relative amount of difference is consistent with hypotheses based on fossils and anatomy."

Correct by saying "... A comparison of DNA or amino acid sequences shows that some species are more genetically similar than others. These comparisons may suggest patterns of descent inconsistent with expectations based on comparative anatomy. For example, comparing two proteins among various species reveals discrepancies shown in Figure 10. In comparative biochemistry, anatomical homologies may not be evidence of close common ancestry."

- "Figure 10: Scientists have compared the amino acids that make up hemoglobin proteins in several species. Organisms that have fewer differences are more likely to be closely related. How does this pattern relate to genetic change?" To Correct, add a second table to Figure 10 entitled "Insulin Comparison" showing that compared to mice, the percentage of insulin amino acid sequence differences in Chickens, Ducks and Turkeys (birds) is 20%; in Rattlesnakes (reptiles) is 27%; in Bonito (fish) and Cod (fish) are 28% and 31% respectively; in Tuna (fish) and Angler fish are 33%; and in Guinea pig and Coypu (mammals) are 35% and 38% respectively. Revise the Figure 10 caption to read: "A phylogeny is an evolutionary tree showing descent from common ancestors. How would a phylogeny based on the insulin comparison differ from a phylogeny based on the hemoglobin comparison?" "Teaching Notes," "Reading: What Darwin Explained," "Answers – Caption Questions ... Figure 10" "Genes change (by

mutation) over time; the genes of populations may diverge over time after once-related populations no longer interbreed." Revise TEKS 7A – "Teaching Notes," "Reading: What Darwin Explained," "Answers – Caption Questions ... Figure 10," to read: "It would indicate a different pattern of descent with conflicting close common ancestry. Specifically, contrary to evolutionary predictions based on comparative anatomy, a phylogeny based on the insulin comparison would relate mice more closely to three birds, one reptile and four fish than to some other mammals."

- "Student Resources, "Animation: Similarities in Macromolecules" "Darwin observed anatomical features of organisms and hypothesized that organisms that appear similar have a more recent common ancestor than do organisms that do not appear similar. Modern biology proves on the molecular level what Darwin noticed on the anatomical level. The number of amino acid differences in homologous proteins of different species is proportional to the length of time that has passed since the two species shared a common ancestor. Thus, the more similar the homologous proteins are in different species, the more closely related the species are thought to be." Revise "Student Resources, "Animation: Similarities in Macromolecules," as follows: "Darwin observed anatomical features of organisms and hypothesized that organisms that appear similar have a more recent common ancestor than do organisms that do not appear similar. Yet modern biochemical phylogenies often contradict Darwin's anatomical phylogenies. Phylogenies based on biochemical similarities invoke 'convergent evolution' to explain anatomical similarities among life forms which they portray as distantly related. For instance, evolutionary biologists say that horseshoe crabs, reclassified as more closely related to spiders than to crustaceans due to biochemical similarities, more closely resemble crustaceans than spiders anatomically because of 'convergent evolution.' But the number of transitional forms between horseshoe crabs and a common ancestor with spiders would far exceed those between horseshoe crabs and a common ancestor with other crustaceans. Thus biochemical phylogenies can multiply the number of transitional forms missing in the fossil record, compared to anatomical phylogenies."

- "Teacher Resources," "Audiovisual: Similarities in Macromolecules – Teach from Visuals" "Remind students that molecular homologies can provide evidence of common ancestry. Ask If

the amino acid sequences of homologous proteins in three organisms are known, how could it be determined which two of the organisms shared the most recent common ancestor? (The two organisms with the least amount of difference between their amino acid sequences have the most recent common ancestor.) How is the evidence from macromolecules different from Darwin's evidence of common ancestry? (Darwin observed anatomical features of organisms. He did not use evidence on the molecular level.)"Revise "Teacher Resources," "Audiovisual: Similarities in Macromolecules – Teach from Visuals," to state: "Remind students that a phylogeny shows evolutionary relationships among life forms based either on their anatomical or their biochemical similarities and differences. Ask:Do phylogenies based on comparative anatomy and comparative biochemistry always agree with each other? (No) How does 'convergent evolution' address discrepancies between anatomical and biochemical phylogenies? (It postulates that more closely related life forms evolved traits like those of less closely related life forms.) How does 'convergent evolution' often weaken homologies as evidence of close common ancestry? (It claims that close common ancestry is often not the source of homologies.)Do fewer transitional forms in the fossil record enhance or reduce the evidence for 'convergent evolution'? (They reduce it.)"