Comparing HMH Biology to Miller and Levine 2018

Unit 3 (Matter and Energy in Living Systems) from the new HMH book was made available on line as a PDF file. I compared this unit's four chapters (which HMH calls lessons) to the four comparable chapters from our new Honeybee book.

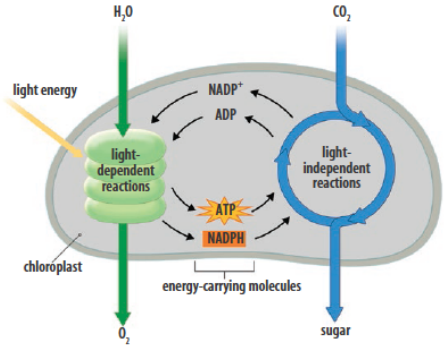
Unit Opener

The Unit Project (p. 115) asks students to model a biome placed inside a bottle (a terrarium) and to make a comparison to the Earth as a closed system. This is an interesting idea, but will actually be difficult to model in the classroom. That's because obtaining the right balance between plants and animals in a terrarium is actually quite difficult. In line with that, there is a "Predict" question asking students to explain how plants and animals grow if no new matter is added to the system. While the authors doubtless expect students to answer in terms of the cycling of materials, the actual answer is that they don't! In a perfectly sealed and balanced terrarium the total biomass is stable over time, so net growth is zero. I suspect this is not what they expect students to conclude.

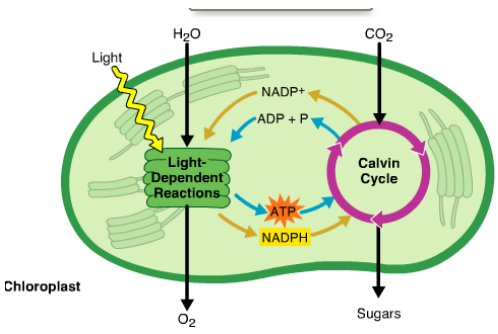
In contrast, our Units open with a much more developed and involved project, which is to analyze ways to produce biofuels by modeling the process of photosynthesis. Our text provides much more support and depth for the learning project, more in line with NGSS goals.

Lesson 1 - Photosynthesis

Figures and Depth: The HMH treatment of photosynthesis is considerably shorter than M&L Chapter 9, and contains much less scientific information. A total of 9 text pages are devoted to the three "Explorations" (HMH's equivalent of our Lessons) compared to the 16 pages in our book. Not surprisingly, the illustration program is much weaker, and much less original. In fact, one of the key illustrations, showing the overall process of photosynthesis, is actually a shameless copy of a diagram from the first edition of our Dragonfly book (published in 2002):



HMH (2018)



Miller & Levine (2002)

Opening Activities: The HMH "Lesson" (Chapter) on photosynthesis opens with a "Can You Explain It?" feature about growing plants on another planet. While this asks students to engage in interesting speculation, our "Case Study" on the artificial leaf is much stronger. It's a real world problem, and is introduced in much more detail, providing a much better introduction to the activity that students are expected to complete.

Writing Style: A recurrent feature of the HMH text is a flat, dull, "just the facts" writing style. Here, for example, is the narrative that opens the text of the HMH photosynthesis chapter:

> Living systems take in energy and matter and convert them to forms they can use. Plants, for example, are producers that capture light energy and convert it to chemical energy to carry out cell processes within the plant. The chemical energy takes the form of chemical bonds in sugar molecules. (HMH 117)

The M&L text takes a very different approach. Rather than just telling students what living systems do, it asks the student reader a question. Where does all that energy come from? This student-directed style of presentation is followed throughout the chapter, and is one of the features that makes the M&L narrative style different from its competitors:

> Homeostasis is hard work. Just to stay alive, organisms and the cells within them have to grow and develop, move materials around, build new molecules, and respond to environmental changes. Plenty of energy is needed to accomplish all this work, to be sure, but where does it come from? (M&L 282)

HMH Ignores a Key Topic: One of the startling things about the HMH presentation is that it takes it for granted that students understand he concept of energy and how it relates to biological systems. On page 121 it simply asserts that ATP, for example, is an energy carrying molecule, and leaves it at that. By contract, we realize that students have a difficult time with the concept of energy-containing molecules, so we develop it much more carefully, using a visual analogy (p. 283) comparing ATP and ADP to partially charged and fully charged batteries. We also develop the idea of high-energy electron carriers on page 288 with yet another visual analogy (hot coals transferred via a frying pan). Our visual approaches are much more intuitive and are greatly appreciated by teachers covering this complex material, while the HMH text lack such analogies.

Figures without Context: Students have a very hard time understanding how different biochemical pathways related to each other, such as photosynthetic electron transport and carbon fixation. HMH ignores this problem. We don't. Look at Figure 9-8 (p. 293) to see how we illustrate the location of electron transport reactions, their placement within the chloroplast, and also how they relate to the light-independent reactions. Then compare it to HMH's Figure 10 (p. 122), and ask a teacher which diagram better

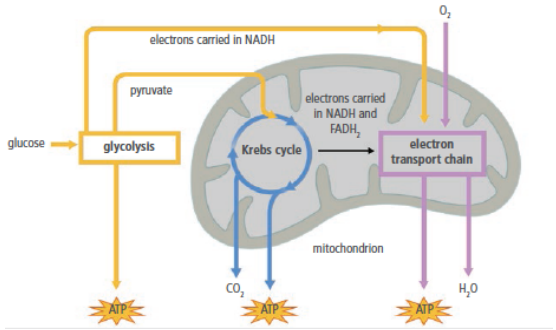
promotes student understanding. Our figure showing carbon fixation (p. 295) also outshines the similar figure in HMH (p. 123).

Case Studies v. Can You Explain It? There is no comparison between the glib, superficial self-checks of the HMH book (p. 126) and the in-depth Case Study Wrap-Up of the M&L book (pp. 298-299). HMH has nothing to match our Career features (one per chapter), our Technology features (one per chapter), and it complete lacks the Performance-Based Assessments that appear in each of our chapters (pp. 302-303).

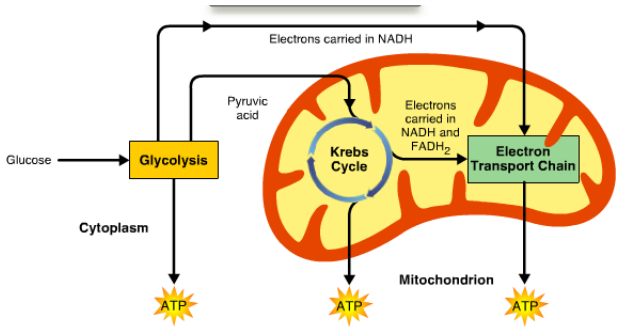
Assessments: HMH offers only a single page of "Checkpoints" for each of their chapters. We provide students with a detailed 2-page Study Guide, a 3-page Assessment section, and a page of Standardized Test Practice. Our text does a much, much better job of providing materials to prepare for standardized tests.

Lesson 2 - Cellular Respiration

Figures and Depth: As with the previous topic, the HMH treatment is in much less death and detail. There are 9 pages of content in the HMH book (counting two 1-page labs), while the Honeybee book has 16. The HMH figures are flat, superficial, and fail to provide cellular context for the pathways of respiration. And, once again, they have copied a figure directly from our 16 year old Dragonfly book:



HMH (2018)



Miller & Levine (2002)

Note just how blatant the copying is for this figure. They've even matched, line for line, the curves of the inner mitochondrial membrane as well as the arrows showing how materials move into and out of the mitochondrion. Incredible.

Note that once again, HMH presents complex pathways (Figures 9, 10, and 11) without showing the links between them. Compare this to our carefully integrated art pieces (Figures 10-3, 10-4, and 10-5), each of which includes a small road map to show how they fit into the larger whole.

Opening Activity: The opening project here (p. 128) isn't a project at all, but just an invitation for students to make a a comparison between a gasoline engine and the human body. Not much to be learned here. The Case Study in our book involves not

only some basic biology, but also a real hands-on activity, which is using yeast to cause dough to rise in baking bread. In the Case Study Wrap-Up we even give students a bread-making recipe that should be fun to carry out. HMH has nothing comparable.

What's Lacking? A lot. HMH mentions fermentation, but never shows students the reactions involved (we do that in Figure 10-7). It never gives students an idea of the relative amounts of chemical energy (ATP) formed from each of the pathways (we do that in 10-6). It fails to explain the amount of energy in food (see our Analyzing Data feature on p. 311). It lacks a detailed discussion of energy and exercise that might explain how the aerobic and aerobic pathways interact (we do that on pages 324-325). And, as usual, it lacks the narrative style of Miller & Levine. Compare, for example, the opening lines of each text, HMH on page 126 and M&L on page 310. As was noted in the previous chapter, our end of chapter material in terms of tech features, study guide, review questions, etc… are much richer and more complete.

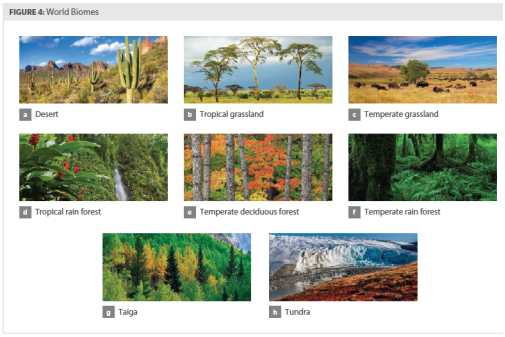
Lesson 3 - Modeling Matter and Energy in Ecosystems

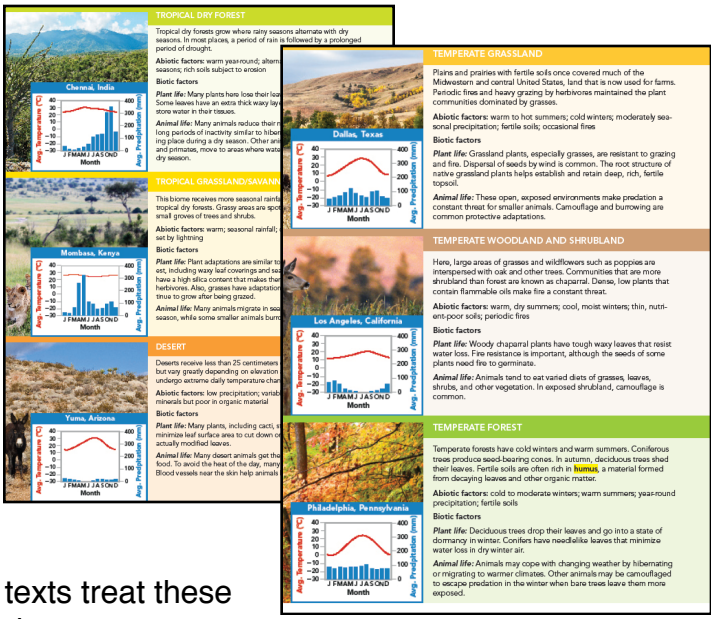
Note: Lessons 3 and 4 in the HMH book correspond loosely to Chapters 3 and 4 in Miller and Levine, although there are some differences in organization. Therefore, it's difficult to compare the page lengths of these two chapters, although it's clear that M&L covers the same topics as HMH in great depth throughout.

Opening Activity: The opening page for this chapter (140) shows a satellite image of the earth color-enhanced to reveal chlorophyll concentrations in the world's oceans. The challenge to students is how a decrease in phytoplankton might affect the global flow of matter and energy. Quite frankly, this is not much of a challenge. It would result in a decrease in photosynthesis, followed by a decrease of atmospheric oxygen and an increase in carbon dioxide. Our Case Study is a bit more sophisticated, asking students to analyze a real world experiment carried out in Biosphere 2.

Figures and Depth: There are 13 pages of instructional text in this chapter, compared to 24 (!) in M&L. Deficiencies in depth and figure presentation become immediately apparent when one compares HMH's 2-page treatment of Biomes (pp. 142-143) to the M&L textbook's 10 pages (pp. 92-101). Even more glaring is HMH's failure to illustrate or explain the 8 terrestrial biomes it depicts on page 142. All that students are given is a series of small photographs with the name of the biome. Nothing is offered in terms of temperature, moisture, or biodiversity. In contrast, M&L goes to great lengths to ensure that student have an in-depth understanding of these, with beautiful illustrations and informative descriptions (compare HMH to pages 94-96 in M&L).

As a result, HMH students will not know the differences between Taiga and Temperate Forests, while M&L students will. That's a problem for the HMH text (left), compared to ours (right):





Food Chains and Webs: While both texts treat these in a similar way, the M&L treatment is clearer, more detailed , and better illustrated. HMH barely defines a "producer" (p. 146), while M&L goes into great depth regarding primary producers and their roles (pp. 115-116). Food chains and webs are also described more clearly in M&L (pp. 118-120) and, as usual, M&L uses a helpful visual analogy (Figure 4-4 in page 120) to explain a concept that the other text treats superficially.

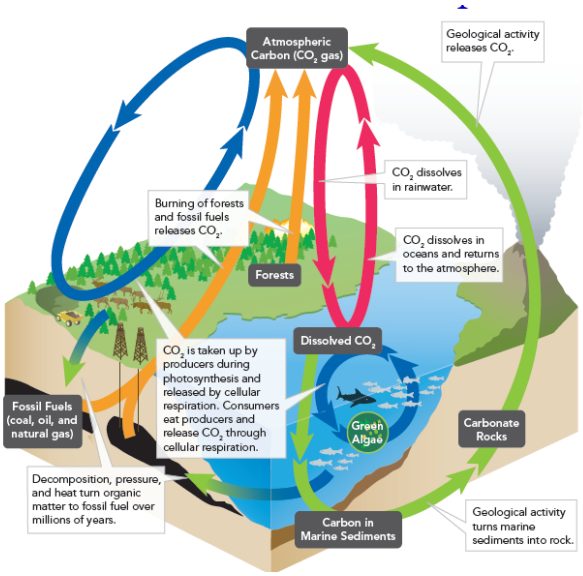
Lesson 4 - Cycling Matter and Energy in Ecosystems

Opening Activity: M&L has an excellent opening Case Study relating to algal blooms in Florida. The HMH lesson is on Biosphere 2, similar to the M&L Case Study for Chapter 3.

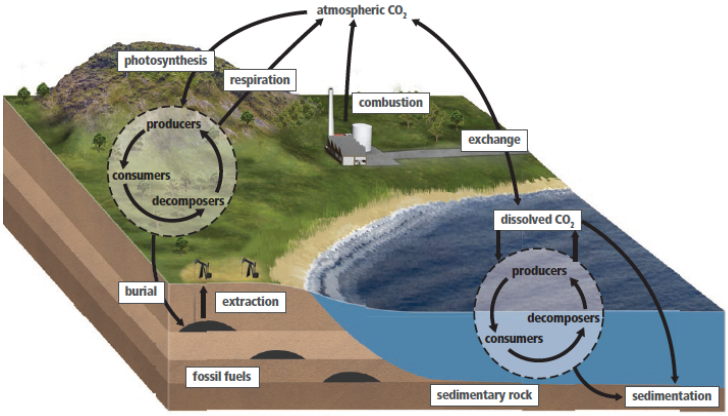
Global Climate: The HMH treatment of climate and the greenhouse effect is remarkably superficial (see HMH p. 159), mentioning only solar radiation as a driver of climate. The M&L text also mentions solar radiation in the context of the greenhouse effect with much better illustrations (see p. 86), but also takes into account latitude, differential heating, ocean currents, and regional climate, all of which are missing from HMH.

Figures and Depth: Both textbooks have realistic 3D diagrams showing material cycles of carbon, nitrogen, and water, but there is a key difference in the M&L approach. Realizing that students struggle to comprehend these complex diagrams, we have color coded each element of the cycle to make clear whether that element is physical, geological, biological, or human. This is particularly clear in our carbon cycle diagram

(Figure 4-11, p. 127), where the sources of each portion of the cycle are clearly indicated.



Compare this to the HMH diagram (at right) from page 162 and the increased clarity will be obvious. Also, it's worth noting that the HMH authors and artists missed one of the most important sources of carbon dioxide emissions, volcanic (geological) activity. We didn't.



It is also important to note that the HMH text gives only cursory treatment to human impacts on the environment, covering topics like air pollution and climate change in a paltry 2-page spread (pp. 166-167). The M&L text devotes all of Chapter 7 to human impacts on the environment, and is particular strong on climate change. By contrast, the HMH textbook can be criticized as giving short shrift to one of the major challenges our planet faces, which is climate change.

Summary

While only one unit of the HMH book has been made available at this time, several patterns are clear. The first is that the writing style in the HMH book is flat, dull, and uninspired. It does not speak directly to students, make helpful comparisons, or use colorful language in the manner of the M&L book. A second, very obvious, difference is its much weaker illustration program. It contains fewer illustrations and those that are found are not placed in visual context that would help student understanding. It even contains a few illustrations that have been copied directly from older editions of the M&L textbook.

The HMH textbook is also much weaker in terms of pedagogical support, with fewer study guides, review questions, and test prep resources. It lacks M&L's regular emphasis, in each chapter, on technology, careers, and problem-based learning. It will be a more difficult book to learn from, and will provide fewer resources for teachers to help their students meet NGSS and state-specific learning standards.