Biosynthesis Learning Segment Table
(approximately 4 traditional class days)

Note this unit is part 3 of 4 total units in the MBER Curriculum that explore how living things get and use the matter and energy they need to survive. Broadly these first 3 units are asking the question, "Why do organisms need to eat food?" Below is a summary of the model ideas that have already been developed in the previous 2 units (Chemical Reactions and Cellular Respiration) and those that will be developed during this unit. This is summarized so you can track the model development over time. ***The step-by-step learning segment table begins on p. 2***

Matter from Food	Energy from Food

Ideas from Chemical Reactions (previous unit)
• Matter is conserved, neither created nor destroyed. Matter is rearranged in chemical reactions.
• Food has matter in the form of protein, carbs and fats- the same things we find our bodies are made of. We also take in matter as oxygen and water.
• Some of this matter is used in our body, but we take in much more matter than we need to use to grow or maintain body structures.
• Some of this matter (especially much of the water but also some indigestible material) basically passes through us.
Ideas from Cellular Respiration (previous unit)
• Some of this matter is really taken in for energy. It is rearranged to obtain energy in a reaction called cellular respiration. The products are expelled from the body as carbon dioxide and water.
New Ideas from Biosynthesis (this unit)
• **Some of our digested food is broken down and rearranged to build new macromolecules we use to repair tissue and to build new body tissue.**
• **Food consumed in excess of what we need for energy and growth/repair is converted to fat and stored.**
	Ideas from Chemical Reactions (previous unit)
	• Energy is conserved, neither created nor destroyed. Energy is transformed in chemical reactions.
	• When the reactants have more potential energy than the products, energy is released in the reaction ("downhill" reaction).
	• Food has energy in the form of calories.
	• Living things get energy by rearranging food and oxygen molecules.
	Ideas from Cellular Respiration (previous unit)
	• Living things rearrange food (specifically glucose - $C_6H_{12}O_6$) and O_2 into CO_2 and H_2O
	• ($C_6H_{12}O_6$ + O_2) have higher energy than (CO_2 + H_2O) so this rearrangement releases energy.
	  • The rearrangements occur in a series of steps rather than all at once.
	  • Collectively the reactions are called cellular respiration.
	  • Usable cellular energy is released in the form of ATP.
	New Ideas from Biosynthesis (this unit)
	• **Building new biomolecules (proteins, fats and carbs) from the products of digestion requires energy (which is provided by cellular respiration).**
	• **More generally, in chemical reactions where the products have more potential energy than the reactants, energy must be added to the reaction ("uphill" reaction).**
	• **If you run out of glucose, your body can pull from fat stores—and then as a last resort, amino acids—to provide fuel for cellular respiration.**

Seg	Model Move	Est Time (min)	Overview	What did we figure out?	Model Ideas Generated
1	M→Q	20	We remind ourselves of where we left off at the end of Cellular Respiration. We also return to the Inputs-Outputs-Uses diagram we developed during Chemical Reactions. We go a little deeper on the Uses of matter in our bodies for growth and repair.	By looking back, we realize that so far we have figured out a lot about how the body gets energy from food but not much about other ways the body uses matter from food. We end this learning segment with a revised question about how we build body tissues that are different from what we ingest.	N/A
2	Q→M	20	We review the big ideas about digestion—that polymers of fats, carbs and proteins are broken down into monomers. We look at some data about the composition of different body tissues and realize that while our bodies are also made up of fats, carb, and proteins, the specific arrangements and tissue types differ from what we ingest.	We explore more about the idea that our bodies are rearranging matter by breaking it down and rebuilding new structures from the parts. We add this as a new idea to our model.	Some of our digested food is broken down and rearranged to build new macromolecules to repair and to build new body tissue.
3	Q→M	20-50	Next we consider how this idea of breaking down and building new structures might relate to energy. We review the energy diagram we developed for cellular respiration as a way to begin to think about energy in chemical reactions. We explore how proteins are assembled through either a quick video or a more extended activity.	By considering what goes into assembling proteins we realize that this process involves work and therefore energy. We represent that with an energy diagram that is opposite of what we used for cellular respiration and add a model idea to our list.	Building new biomolecules (proteins, fats and carbs) from the products of digestion requires energy which is provided by the cellular respiration reaction.
4	Q→M	20	We go a bit deeper on the idea of biosynthesis by considering the specific case of fat storage. When we take in more than we need for cellular respiration or maintenance/repair, we can store the excess as fat. We look at an extreme example of this in a bear preparing for hibernation. We consider the purpose of storing excess matter in this way.	We reinforce an earlier idea that we can rearrange the molecules of the matter we ingest in order to make different substances in the body. In the case of the bear, the wide range of foods are converted to fat. We learn that cellular respiration is actually quite a complex system of processes and that the body can use more than just glucose in that process.	Food consumed in excess of what we need for energy and growth/repair is converted to fat and stored. If you run out of glucose, your body can pull from fat stores and then as a last resort, amino acids to provide fuel for cellular respiration.

Seg	Model Move	Est Time (min)	Overview	What did we figure out?	Model Ideas Generated
5	M→P	50-100	We continue to consider what happens with the bear but now focusing on its weight change throughout the entire year as it prepares for hibernation and then actually hibernates. We make posters to completely explain this phenomenon. Finally, we consider if what is happening with bears might help us understand what happens to humans when their weight fluctuates.	We use our models to figure out what is happening to the matter and energy in the bear. Our big a-ha is that while the bear was hibernating it lost hundreds of pounds of matter by simply breathing out carbon dioxide and water! We take this back to our broader ideas about matter rearranging and finally answer our driving question: why do we eat.	N/A