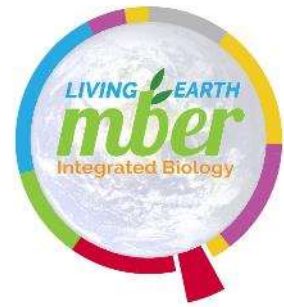


## Chemical Reactions Learning Segment Table: (approximately 8 to 10 traditional class days)



The model – addressing the question, “Why do we need to eat food?”

1. We need food to give us the matter and energy we need to survive.

### ***Ideas About Matter from Food***

2. 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.)
3. Matter is conserved, neither created nor destroyed.
4. Matter is rearranged in chemical reactions.
5. 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 About Energy from Food***

6. Food has energy in the form of calories.
  7. Energy is conserved, neither created nor destroyed.
  8. Energy is transformed in chemical reactions.
  9. Living things get energy by rearranging matter in the form of food and oxygen molecules.
  10. When the reactants have more potential energy than the products, energy is released in the reaction (“downhill” reaction).\*
- \*Conversely, if the products have more energy, energy must be added to get the reaction to occur. We will wait to address this “reverse reaction” in later models.*

Seg	Model Move	Est Time (min)	Overview	What did we figure out?	Model Ideas Generated
1	Q→M	70	Following the exploration of continent formation in the last unit, we turn back to biology by wondering a little about the challenges life faced in the shallow oceans and as it began to crawl onto land. We broaden the conversation to consider, “What do organisms need to take in to survive? What do they use it for and what is given off?” Students work to generate a representation of inputs-outputs-uses.	We have reoriented to biology and have brainstormed a number of challenges all life faces in order to survive and reproduce. We’ve come to represent our thinking as a class on an “inputs-outputs-uses” poster that reflects our current understanding of the needs of organisms.	N/A
2	Q→M	15	We shift our broader conversation about an organism’s inputs and outputs to consider just one in particular--food. And then we probe: WHY do we die if we don’t eat? (Really, why?) We finish by offering some initial ideas.	We have paused to refocus our attention on a specific organismal need—food. And we have a refined question, “Why do we need food? Or, why do we die if we don’t eat?” This becomes the Driving Question for the remainder of the unit.	Students offer initial ideas to address our question about why we need to eat.

Seg	Model Move	Est Time (min)	Overview	What did we figure out?	Model Ideas Generated
3	P	30-55	Students engage in conversation about what is actually in food. After they have described the major components—carbohydrates, fat, and protein, they make a connection to the composition of humans and other organisms. We recognize that “we are what we eat”.	We learned about the composition of food, that both food and our own bodies are made up of carbs, proteins and fats. But what are carbs, fats and proteins made of?	Food gives us the carbohydrates, fats, and proteins (the matter) we need for our bodies since we are made of the same things.
4	P	55	We next go deeper to look at the elements that make up those molecules. Ultimately, we will recognize that mostly the same basic four elements are going into and out of our bodies.	We went deeper in our understanding of the molecular composition of food by studying the structure of biomolecules.	N/A
5	Q→M	25	We pause to pose the questions, “What is matter? What is energy?” The class generates a common understanding of these ideas before moving forward in exploring their roles in the survival and reproduction of organisms.	We have some basic ideas about matter and energy and a bit of common language. We’ve also discussed the <b>Laws of Conservation of Matter and Energy</b> which we will leverage later.	Food also contains calories, which are a measure of energy. Food gives us the matter and energy we (and all organisms) need.  <i>Ideas About Matter &amp; Energy</i> Matter cannot be created nor destroyed. Energy cannot be created nor destroyed.
6	P	55	We next explore the molecular nature of the outputs, setting the stage for the identification of a key phenomenon: What comes out is not exactly the same as what went in. We are matter/molecular transforming machines.	We’ve recognized that <b>in our bodies matter is rearranged</b> . This leads us to ask, “Why?”	Lots of the matter we ingest (especially water but also indigestible matter) basically passes through us. When comparing our inputs and outputs, the same elements come out that went in, but they have often been recombined or rearranged into new molecules. (Nitrogen provides a really clear example. Proteins → Urea)

Seg	Model Move	Est Time (min)	Overview	What did we figure out?	Model Ideas Generated
7	Q→M	15	We are now trying to understand why we transform matter. This is further motivated start by noticing the majority of the matter we take in is not incorporated. Why bother moving all this matter through our bodies? Through discussion, we come to figure out it's all about energy.	We've recognized that matter transformation must have something to do with energy.	We take in much more matter than we need to use to grow or maintain body structures. We really rearrange much of it. This rearranging or transforming matter somehow gives us energy.
8	Q→P	20-55	We recognize that we still don't know how we get the energy from matter transformations. Since calories are a measure of the energy in food and we burn calories, we explore what happens when we burn food. We recognize that there is an input-output transformation in burning a Cheeto or marshmallow, but the inputs and outputs are complex. If we want to track matter and energy in a chemical reaction, we need a simpler system.	We've developed some ideas around food as fuel and burning as an important chemical reaction. However, the inputs and outputs are complex. If we want to track matter and energy in a chemical reaction, we need a simpler system. Therefore, we are moving on to consider the burning of ethanol, a pure fuel source made of C H and O (just like our food).	N/A
9	M→P	55-110	In burning ethanol, we first track the rearrangement of molecules. What are the inputs and outputs? A discussion of burning leads us to the testable idea that oxygen is the other input. Recalling the conservation of matter, we generate ideas about what the outputs might be and test these ideas.	We have a balanced equation for burning ethanol, but we still need to figure out what is happening with the energy.	Matter is rearranged in chemical reactions. Burning reacts fuel and oxygen to produce water and carbon dioxide. Since food is our fuel, our food must react with oxygen in the body to generate the energy we need.

Seg	Model Move	Est Time (min)	Overview	What did we figure out?	Model Ideas Generated
10	Q→M	30	We move on to discuss energy. What does it look like before, during and after the reaction? If energy is conserved, where does it come from? Here we recognize the transformation of energy from potential to other forms through use of an analogy. Students generate a representation of what is happening with energy in chemical reactions like burning. The clear inference is that molecules have different inherent energies. Since energy is released here, the reactants must have had more potential energy than the products.	We know that energy is transformed from potential to visible energy in the burning reaction, and we finally have a model for how energy can be released during chemical reactions.	Energy is transformed in chemical reactions. When the reactants have more potential energy than the products, energy is released during the reaction (represented by a “downhill” reaction).
11	M	30	We take stock of (1) what we have figured out and (2) what we are still wondering about, returning to our driving question. We apply our understanding to a Challenge Question about a coma patient.	We've finalized our model for chemical reactions and have partially answered our driving question, motivating further exploration of Cellular Respiration and other models.	N/A