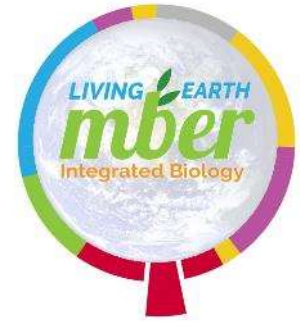


## Cellular Respiration Learning Segment Table: (approximately 6 to 7 traditional class days)



The model – continuing to address, “Why do we need to eat food?”

### ***New Ideas About Matter from Food (developed in this 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 About Energy from Food (developed in this unit)***

- $(C_6H_{12}O_6 + O_2)$  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.
- UNITY AND DIVERSITY: Other reactions (such as fermentation) can produce biologically usable energy, but they are usually less efficient. We see these reactions in some groups of organisms that have evolved under different environmental conditions and in our own bodies during times when oxygen is not readily available.

Seg	Model Move	Est Time (min)	Overview	What did we figure out?
1	Q→M	30	As we review what we have figured out about how we get the matter and energy we need from food, we explicitly begin tracking two different models.	We've realized that a useful way to track our continuing investigation of food is by developing two complementary models: "Matter from Food" and "Energy from Food" We now turn our focus primarily to energy.
2	M→Q	15	We review the model for Chemical Reactions (the downhill reaction in particular) and recall that we haven't identified the specific reaction(s) that tell us how we get the energy from carbs, fats, and proteins. Now we ask that question.	We have a new driving question (something like): How do living things do the "downhill" reaction to get energy from food?
3	Q→P	20 – 40	We return to burning as a chemical reaction that can help us understand how we get energy from food. We explore burning in a bit more detail.	We've developed some ideas around food as fuel and burning as an important chemical reaction. We recognize that burning food does give energy and that burning organic molecules made of Cs Hs and Os yields $CO_2$ and $H_2O$
4	P→M	30	The burning reaction takes in oxygen and gives off $CO_2$ , so might the reaction that living things do be similar? What happens under conditions when we need more energy (exercise), do we put off more $CO_2$ ? We explore through a lab that connects energy needs and $CO_2$ output.	We have further evidence that burning (the reaction of organic carbon with oxygen) is important for living things to obtain energy, and we've done a bit of thinking about the relationship between the rate of that reaction and our $CO_2$ production.
5	Q→M	35 – 55	Now that we are thinking it IS some kind of burning reaction, what is the specific fuel that reacts with oxygen in our cells? Cellular respiration in most organisms is set-up to preferentially use glucose, the building block of carbohydrates. We can easily balance this equation.	We have a balanced equation for cellular respiration. We now know that glucose is what we're burning in cellular respiration but that the body can also draw upon proteins and fats as fuel as needed.

Seg	Model Move	Est Time (min)	Overview	What did we figure out?
6	Q→M	20 – 40	We recognize that burning glucose gives a TON of energy per glucose molecule. What happens with this energy in the cell? We develop a refined model idea for how cellular respiration occurs where energy is released stepwise through a series of reactions inside cells and in the mitochondria.	We have a better understanding for how the energy from CR is available to our cells and have summarized our overall model of for explaining how we get Energy from Food.
7	P→M	55 – 110	Here we take up questions related to unity and diversity: Do all living things use cellular respiration to obtain energy? What about living things that don't have mitochondria? What about cases where there is little to no oxygen? We explore the universality of CO <sub>2</sub> output with a lab and also consider the alternative of fermentation. (Optional fermentation lab adds time to this segment.) We end this unit by taking stock of what we have figured out about the broad question of why organisms need food.	We've recognized that most organisms use cellular respiration as a means for getting energy from food. But we've also considered alternative pathways when oxygen is not available. All organisms need to acquire energy, but there is some variation in the exact pathway used in different circumstances. In this way, we once again highlight the unity and diversity of life.