TEACHER'S NOTES LESSON 15

Present these key points and questions to the students during the *Activities* section of Lesson 15, as your lecture/discussion.

How Mitochondria Get Energy From the Chemical Energy Bond in Sugars

Before there was oxygen in our atmosphere bacteria made energy by glycolysis. Many still do and use the ATP from this step to form lactate or ethanol. We will study this pathway and look at how the energy and pyruvate from this step is used in aerobic respiration in mitochondria. Show an image of a glycolytic pathway (such as fig. 7.4, p. 113 in Starr's textbook or one from another source such as http://gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookGlyc.html.). Try to make sure that the students understand where these processes are taking place and why it is important. They've been talking about placement and movement through membranes, now they can see how it is important to create energy.

Glycolysis (located in cytoplasm)

1. sugars are broken down into 2 pyruvates
2. net gain of 2 ATPs

Aerobic respiration/Krebs cycle (located in the mitochondrial matrix) Show an image of the Kreb's cycle such as fig. 7.6 p. 115 in Starr's textbook or one that you have from another source such as http://gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookGlyc.html.

1. pyruvate is changed into acetyl-CoA by an enzyme so that it can enter the Krebs cycle
2. acetyl-CoA is cycled into the Krebs cycle which yields NADH, $FADH_2$, CO_2 and ATP

Electron transport (located in the inner plasma membrane of the mitochondria). Show an image of the electron transport chain such as fig 7.7 in Starr's textbook or an image that you have from another source such as http://gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookGlyc.html.

1. Most of the products from the Krebs cycle enter the electron transport system. The $FADH_2$ and NADH give their electrons and H^+ to the system. The final products are CO_2 and ATP.
2. How it works: the H^+ pass from the mitochondrial matrix to the intermembrane space causing a differential in pH between the matrix and the intermembrane space. The gradient of protons (H^+) allows work to occur. The H^+ passes back to the matrix through the ATP synthase, which causes the formation of ATP. The e^- passes through the membrane by oxidation/reduction reactions in the carrier proteins, which allows the protons to be pumped into the intermembrane space, and eventually reunite with a proton and oxygen to form water. I explain this step as a couple dancing together. They are a unit (protons and electrons form the hydrogen atom) and they do steps together during their dance, but at some point in the dance they separate and do individual steps (the proton is pumped across the membrane and then back through the ATP synthase to form ATP; the electron passes through the carrier proteins via oxidation/reduction reactions which cause the proton to be pumped across the membrane and then join the oxygen). Later they come back together to form a couple.
3. The fact that the electron joins the oxygen and hydrogen to form water is why it is aerobic respiration.
4. Have the students note the position of the Krebs cycle in the center of the mitochondria, which allows the products easy access to the inner membrane for the electron transport system.
5. Show slide or overhead of overview image of glycolysis and respiration in Starr's textbook, fig. 7.3 p. 111. Again if you don't have this book, find a comparable image. There's a very nice one at http://gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookGlyc.html.
6. Discuss how this is only one source of energy. In food there are also fats and proteins, which provide fatty acids and amino acids. These can also enter the cycle at various stages to produce energy. There is a diagram in Starr's textbook, fig. 7.12, p. 121. Again if you don't have this book, find a comparable image.

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