Topic 8 Study Guide

Remember, this is just a GUIDE. You should do other things to ACTIVELY MAKE YOUR BRAIN THINK other than reading through this. Make flashcards, go to my website and re-watch simulations, draw diagrams, build models, form study groups, or ANYTHING ELSE to help you learn. The more activities/things you do with info, the stronger your long-term memory becomes because you are making more connections with the material. To adequately prepare for the exam, you should be able to elaborate upon each of the understandings applications and skills set forth by the IB curriculum.

**Topic 8.1 – Metabolism (Enzymes)**

Understandings:

* Metabolic pathways consist of chains and cycles of enzyme-catalysed reactions.
* Enzymes lower the activation energy of the chemical reactions that they catalyse.
* Enzyme inhibitors can be competitive or non-competitive. [Enzyme inhibition should be studied using one specific example for competitive and non-competitive inhibition.]
* Metabolic pathways can be controlled by end-product inhibition.

Applications and Skills:

* End-product inhibition of the pathway that converts threonine to isoleucine.
* Use of databases to identify potential new anti-malarial drugs.
* Calculating and plotting rates of reaction from raw experimental results.
* Distinguishing different types of inhibition from graphs at specified substrate concentration.

**Topic 8.2 – Cellular Respiration**

Understandings:

* Cell respiration involves the oxidation and reduction of electron carriers.
* Phosphorylation of molecules makes them less stable.
* In glycolysis, glucose is converted to pyruvate in the cytoplasm.
* Glycolysis gives a small net gain of ATP without the use of oxygen. [The names of the intermediate compounds in gylcolysis is not required.]
* In aerobic cell respiration pyruvate is decarboxylated and oxidized, and converted into acetyl compound and attached to coenzyme A to form acetyl coenzyme A in the link reaction.
* In the Krebs cycle, the oxidation of acetyl groups is coupled to the reduction of hydrogen carriers, liberating carbon dioxide. [The names of the intermediate compounds in the Krebs cycle is not required.]
* Energy released by oxidation reactions is carried to the cristae of the mitochondria by reduced NAD and FAD.
* Transfer of electrons between carriers in the electron transport chain in the membrane of the cristae is coupled to proton pumping.
* In chemiosmosis protons diffuse through ATP synthase to generate ATP.
* Oxygen is needed to bind with the free protons to maintain the hydrogen gradient, resulting in the formation of water.
* The structure of the mitochondrion is adapted to the function it performs.

Applications and Skills:

* Electron tomography used to produce images of active mitochondria.
* Analysis of diagrams of the pathways of aerobic respiration to deduce where decarboxylation and oxidation reactions occur.
* Annotation of a diagram of a mitochondrion to indicate the adaptations to its function.

**Topic 8.3 – Photosynthesis**

* Light-dependent reactions take place in the intermembrane space of the thylakoids.
* Light-independent reactions take place in the stroma.
* Reduced NADP and ATP are produced in the light-dependent reactions.
* Absorption of light by photosystems generates excited electrons.
* Photolysis of water generates electrons for use in the light-dependent reactions.
* Transfer of excited electrons occurs between carriers in thylakoid membranes.
* Excited electrons from Photosystem II are used to contribute to generate a proton gradient.
* ATP synthase in thylakoids generates ATP using the proton gradient.
* Excited electrons from Photosystem I are used to reduce NADP.
* In the light-independent reactions a carboxylase catalyses the carboxylation of ribulose bisphosphate.
* Glycerate 3-phosphate is reduced to triose phosphate using reduced NADP and ATP.
* Triose phosphate is used to regenerate RuBP and produce carbohydrates.
* Ribulose bisphosphate is reformed using ATP.
* The structure of the chloroplast is adapted to its function in photosynthesis.

Applications and Skills

* Calvin’s experiment to elucidate the carboxylation of RuBP.
* Annotation of a diagram to indicate the adaptations of a chloroplast to its function.

**Key Concepts/Big Picture Items to Help Guide You:**

* Describe how enzymes speed up reactions in terms of activation energy (and on a graph)
* Compare and contrast competitive vs. noncompetitive inhibitors
* Describe end-product inhibition.
* How do enzymes aid the progression of metabolic pathways
	+ Enzyme-substrate specificity (lock and key)
	+ Multiple enzyme either found in a cycle or linear pathway that produce a series of intermediates before final product is produced. Allows for tighter control of product production – multiple steps along pathway that can be inhibited to stop the process if needed
* Draw and label a picture of a mitochondria (REMEMBER: It has two membranes, so label each)
* State how the mitochondria is adapted for its function
	+ Cristae maximize surface area
	+ Small intermembrane space to create proton gradient quickly
	+ Correct conditions (pH, etc.) for enzymes for link reaction and Krebs Cycle in matrix
	+ Etc.
* Look back over your cellular respiration posters. Know where each step happens, what goes in and comes out, if oxygen is needed.
* Know how to pick out when each of the following happens in respiration and photosynthesis: oxidation/reduction, carboxylation, decarboxylation, phosphorylation
* Describe the steps of glycolysis
	+ Occurs in cytoplasm
	+ Split 6C glucose into 2 3C pyruvate
	+ Uses 2 ATP, but produces 4, so get 2 ATP
	+ Also produces NADH
	+ Anaerobic
* Know how link reaction and Krebs Cycle are related
	+ Both occur in matrix of mitochondria
	+ Require oxygen (aerobic)
	+ Link reaction produces the acetyl CoA that goes through Krebs cycle
	+ Get more high energy electron carriers from each
	+ Know role of oxaloacetate in Krebs (what we start with and what is regenerated at end)
* Describe the steps of the ETC
* Occurs on inner mitochondrial membrane (cristae)
* Electron carriers drop off high-energy electrons that fuel active transport of H+ ions to generate proton motive force
* Chemiosmosis – diffusion of H+ ions through ATP synthase to generate ATP
* Oxygen as final electron acceptor – forms water when combines with H+ and electrons
* Compare and contrast the two types of fermentation (lactic acid and alcoholic) as a result of anaerobic respiration.
* Draw and label a picture of a chloroplast (REMEMBER: It has two membranes, so label each)
* State how the chloroplast is adapted for its function
	+ Stacks of thylakoids maximize surface area
	+ Small space inside thylakoids to create proton gradient quickly
	+ Correct conditions (pH, etc.) for enzymes for Calvin Cycle in stroma
	+ Etc.
* Look back over your online drag-and-drop activity. Know where each step (light dependent and light independent) happens, what goes in and comes out.
* Describe the steps of the light dependent reactions (aka photosphosphorylation)
	+ Occurs on thylakoid membranes
	+ Photoactivation
	+ ETC and Chemiosmosis
	+ Photolysis of Water
	+ PS II generates ATP and PS I reduces NADPH
	+ Where electrons come from to replace ones lost by PS II and PS I
* Describe the light independent reactions (Calvin Cycle)
	+ Occurs in the stroma
	+ Carbon Fixation by Rubisco
	+ Reduction of G3P into triose phosphate by oxidizing NADPH and ATP from light dependent reactions
	+ What happens to each of the 6 triose phosphates
	+ How many turns needed to make one sugar molecule
	+ Know role of RuBP in cycle (what we start with and what is regenerated)
* Describe the lollipop experiment by Calvin using radioactive 14C and 2D chromatography along with X-ray imagery to figure out order of carbon compounds in the cycle
* Explain the absorption/action spectrum of chlorophyll – what it is good at absorbing, and not so great at absorbing to convert into sugars
* Explain factors affecting the rate at which photosynthesis can occur, and why

**Ultimately why should I care about this unit?**

**1. Most biological processes are driven by enzymes, and we need to be aware of how different environmental influences can affect them.**

 -Exposure to mutagens can alter amino acid sequence in enzymes, changing its function or causing it to lose function entirely. This leads to many genetic disorders we see, and could cause death depending on which process the enzymes are involved in.

 -Why is it bad to have a high fever for too long? – Heat denatures enzymes (or at least causes them not to be able to work at optimum levels). This could lead to death if enzymes for all major metabolic processes are not functioning fast enough to keep up with the energy demands, toxin filtration, cell replacement (division), etc. your body needs.

 -Alternatively, why is hypothermia bad? – Enzymes cannot work at their optimum rates when cold. This could lead to death if vital processes slow too much.

 -Many (but not all) poisons and drugs act as competitive/noncompetitive inhibitors that alter the functioning of many metabolic pathways.

 -Many cancers are caused by mutations in enzymes/proteins that regulate how fast our cells divide.

 -SO MUCH MORE!!!!!!!!!!!

**2. Photosynthesis is the ONLY process through which the initial flow of energy through many ecosystems can begin. It may not be obvious in everyday life, but if plants go, so does EVERYTHING ELSE. We CANNOT get sugars to use as a precursor to making ATP without them! Without energy (ATP), all things would die. Let’s protect our environment!**

-This process is also regulated by enzymes, along with respiration.

**3. Photosynthesis and Aerobic Respiration in and of themselves are a cycle that fuel each other. Coincidentally, the reactants of one, are the products of the other one! (You just have to swap out light energy for chemical energy – ATP- in the equation). Energy flow is connected in so many ways!**



I highly encourage you to think big picture for this unit. Look at Overview slides and the Sentence Summaries of each process that are sprinkled throughout the lectures to get a “big picture” understanding of what happens in each step of respiration and photosynthesis. I know this is a unit where it can be very easy to get bogged down in the details, but really, it is the big picture concepts that count in the long run. After the IB exam has come and gone, it is these three things I mentioned above that are most important to know that I hope stay with you for years to come.

**Mrs. Tyler’s Words of Encouragement:**

Remember – Life is more than a test, even if it may not seem that way right now. It is what you do with the knowledge and skills you gain from your education after school is over that counts!!!!!!! You’ve got this!