***Unit 03 AP Biology HyperDoc of Expectations and Resources***

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**Cellular Energetics: 12-16% of AP Exam**

**Big Ideas~ 1: Evolution *(EVO)*, 2: Energetics *(ENE)*, 3: Information Storage & Transmission *(IST)*, 4: System Interactions *(SYI)***

**EXPECTATIONS:**

| **Topic** | **Learning Targets (I can …) and** Success Criteria (I am learning how …)  *Learning targets are in bold with their success criteria listed beneath* | **✔** |
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| **3.1** | **Enzyme Structure** |  |
|  | **Describe the properties of enzymes. *ENE-1.D*** |  |
| The structure of enzymes includes the active site that specifically interacts with substrate molecules. |  |
| For an enzyme-mediated chemical reaction to occur, the shape in charge of the substrate must be compatible with the active site of the enzyme. |  |
| **3.2** | **Enzyme Catalysis** |  |
|  | **Explain how enzymes affect the rate of biological reactions. *ENE-1.E*** |  |
| The structure and function of enzymes contribute to the regulation of biological processes-   1. Enzymes are biological catalysts that facilitate chemical reactions in cells by lowering the activation energy. |  |
| **3.3** | **Environmental Impacts on Enzyme Function** |  |
|  | **Explain how changes to the structure of an enzyme may affect its function. *ENE-1.F*** |  |
| Change to the molecular structure of a component in an enzymatic system may result in a change of the function or efficiency of the system- |  |
| 1. Denaturalization of an enzyme occurs when the protein structure is disrupted, eliminating the ability to catalyze reactions. |  |
| 1. Environmental temperatures and pH outside the optimal range for a given enzyme will cause changes to its structure, altering the efficiency with which it catalyzes reactions. |  |
| In some cases, enzyme denaturation is reversible, allowing the enzyme to regain activity. |  |
|  | **Explain how the cellular environment affects enzyme activity. *ENE-1.G*** |  |
|  | Environmental pH can alter the efficiency of enzyme activity, including through disruption of hydrogen bonds that provide enzyme structure.  RELEVANT EQUATION  pH = -log[H+]  *Exclusion Statement: Students must understand the underlying concepts and applications of this equation, but performing calculations using this equation or beyond the scope of the course and the AP exam.* |  |
| The relative concentrations of substrates and products determine how efficiently an enzymatic reaction proceeds. |  |
| Higher environmental temperatures increase the speed of movement of molecules in a solution, increasing the frequency of collisions between enzymes and substrates and therefore increasing the rate of reaction. |  |
| Competitive inhibitor molecule can bind reversibly or ever reversibly to the active site of the enzyme. Noncompetitive inhibitors can bind allosteric sites, changing the activity of the enzyme. |  |
| **3.4** | **Cellular Energy** |  |
|  | **Describe the role of energy in living organisms. *ENE-1.H*** |  |
| All living systems require constant input of energy. |  |
| Life requires a highly ordered system and does not violate the second law of thermodynamics-   1. Energy input must exceed energy loss to maintain order in to power cellular processes. 2. Cellular processes that release energy may be coupled with cellular processes that require energy. 3. Loss of order or energy flow results in death.   *Exclusion Statement: Students will need to understand the concept of energy, but the equation for Gibbs free energy is beyond the scope of the course and the AP exam.* |  |
| Energy-related pathways in biological systems are sequential to allow for a more controlled and efficient transfer of energy. A product of a reaction in a metabolic pathway is generally the reactant for the subsequent step in the pathway. |  |
| **3.5** | **Photosynthesis** |  |
|  | **Describe the photosynthetic processes that allow organisms to capture and store energy. *ENE-1.I*** |  |
| Organisms capture and store energy for use in biological processes-   1. Photosynthesis captures energy from the sun and produces sugars.    1. Photosynthesis first of all and prokaryotic organisms.    2. Scientific evidence supports the claim that prokaryotic (cyanobacterial) photosynthesis was responsible for the production of an oxygenated atmosphere.    3. Prokaryotic photosynthetic Pathways were the foundation of eukaryotic photosynthesis |  |
| The light dependent reactions of photosynthesis in eukaryotes involve a series of coordinated reaction pathways that capture energy present in light to yield ATP and NADPH, which power the production of organic molecules. |  |
| **Explain how cells capture energy from light and transfer it to biological molecules for storage and use. *ENE-1.J*** |  |
| During photosynthesis, chlorophyll absorb energy from light, boosting electrons to a higher energy level in photosystems I and II. |  |
| Photosystems I and II are embedded in the internal membranes of chloroplasts and are connected by the transfer a higher energy electrons through an electron transport chain(ETC). |  |
| When electrons are transferred between molecules and a sequence of reactions as they pass through the ETC, and electrochemical gradient of protons (hydrogen ions) is established across the internal membrane. |  |
| The formation of the proton gradient is linked to the synthesis of ATP from ADP and inorganic phosphate via ATP synthase. |  |
| The energy captured in the light reactions and transferred to ATP and NADPH powers the production of carbohydrates from carbon dioxide in the Calvin cycle, which occurs in the stroma of the chloroplast.  *Exclusion Statement: Memorization of the steps in the Calvin cycle, the structure of the molecules, and the names of enzymes (with the exception of ATP synthase) are beyond the scope of the course and the AP exam.* |  |
| **3.6** | **Cellular Respiration** |  |
|  | **Describe the processes that allow organisms to use energy stored and biological macromolecules. *ENE-1.K*** |  |
| Fermentation and cellular respiration use energy from biological macromolecules to produce ATP. Respiration and fermentation or characteristic of all forms of life. |  |
| Cellular respiration in eukaryotes involves a series of coordinated enzyme-catalyzed reactions that capture energy from biological macromolecules. |  |
| The electron transport chain transfers energy from electrons in a series of coupled reactions that establish an electrochemical gradient across membranes-   1. Electron transport chain reactions occur in chloroplasts, mitochondria, and prokaryotic plasma membranes. 2. In cellular respiration, electrons delivered by NADH and FADH2 are passed to a series of electron acceptors as they move toward the terminal electron acceptor, oxygen. In photosynthesis, the terminal electron acceptor is NADP+. Aerobic prokaryotes use oxygen as a terminal electron acceptor, while anaerobic prokaryotes use other molecules. 3. The transfer of electrons is accompanied by the formation of a proton gradient across the inner mitochondrial membrane or the internal membrane of chloroplast, with the membrane(s) separating a region of high protein proton concentration from a region of low proton concentration. In prokaryotes the passage of electrons is accompanied by the movement of protons across the plasma membrane. 4. The flow of protons back through the membrane-bound ATP synthase by chemiosmosis drives the formation of ATP from ADP and inorganic phosphate this is known as oxidative phosphorylation in cellular respiration and photophosphorylation in photosynthesis. 5. In cellular respiration, oxidative phosphorylation from electron transport generates heat. This heat can be used by endothermic organisms to regulate body temperature.   *Exclusion Statement: The names of the specific electron carriers in the electron transport chain are beyond the scope of the course and the AP exam.* |  |
|  | **Explain how cells obtain energy from biological macromolecules in order to power cellular functions. *ENE-1.L*** |  |
|  | Glycolysis is a biochemical pathway that releases energy in glucose to form ATP from ADP and inorganic phosphate, NADH from NAD+ and pyruvate. |  |
| Pyruvate is transported from the cytosol to the mitochondrion, where further oxidation occurs. |  |
| In the Krebs cycle, carbon dioxide is released from organic intermediate, ATP is synthesized from ADP and inorganic phosphate, and electrons are transferred to the coenzymesNADH and FADH2. |  |
| Electrons extracted in glycolysis and Krebs cycle reactions are transferred by NADH and FADH2 to the electron transport chain in the inner mitochondrial membrane. |  |
| When electrons are transferred between molecules in a sequence of reactions as they pass through the ETC, an electrochemical gradient of protons (hydrogen ions) across the inner mitochondrial membrane is established. |  |
| Fermentation allows glycolysis to proceed in the absence of oxygen and produces organic molecules, including alcohol and lactic acid, as waste products. |  |
| The conversion of ATP to ADP releases energy, which is used to power many metabolic processes.  *Exclusion Statement: Specific steps, names of enzymes, and intermediates of the pathways for these processes are beyond the scope of the course in the AP exam.*  *Exclusion Statement: Memorization of the steps in glycolysis and the Krebs cycle, and of the structures of the molecules and the names of the enzymes all involved, are beyond the scope of the course and the AP exam.* |  |
| **3.7** | **Fitness** |  |
|  | **Explain the connection between variation and the number and the types of molecules within cells to the ability of the organism to survive and/or reproduce in different environments. *SYI-3.A*** |  |
| Variation at the molecular level provides organisms with the ability to respond to a variety of environmental stimuli. |  |
| Variation in the number and types of molecules within cells provides organisms a greater ability to survive and or reproduce in different environments**.** |  |

**RESOURCES: *(Tip: add your own (GSN) and helpful resources in the table below to a copy of this document)***

| **AP Bio Topics** | **Classroom Discussions (GSN), Labs, Activities & Assignments:** | **Additional Materials:**  [**Khan Academy: Cellular Energetics**](https://www.khanacademy.org/science/ap-biology/cellular-energetics) |
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| **3.1-3** | * [**06: Metabolism: Energy and Enzymes (GSN)**](https://docs.google.com/document/d/1MrSmo2KZjDmbCDLEm1XlvLMxOrZiXK_7Z5fJFgYmr-Y/edit?usp=sharing) & [**Presentation**](https://drive.google.com/open?id=1napfY0ROJH4WSBOX1_vq5ZzICPkzcT2E) .pdf * [Potential Activity: Toothpickase Activity](https://drive.google.com/open?id=1zQGAffcJhA1ZRhjGSp9v78zRq-VAb-m8P3wHerDCGJU) * **POGIL**: **Enzymes and Cellular Regulation** * **POGIL: ATP - The Free Energy Carrier** * [**Investigation 13: Enzyme Activity**](https://docs.google.com/document/d/1AsFtNdjcHPMaA-jbektw_giJ7sX9GGtlRCCCeuG9KYg/edit?usp=sharing) | MsLitten’s 7th Period Reviews:   * [MsLitten’s 7th Period Review Ch 06](https://www.youtube.com/watch?v=JfXJM3i3jD4&t=27s) * [AP Bio Investigation 13: Enzyme Activity](https://www.youtube.com/watch?v=zj2N7eOlml0&t=151s)   Bozeman:   * [Life Requires Free Energy](http://www.bozemanscience.com/012-life-requires-free-energy) * [Enzymes](http://www.bozemanscience.com/048-enyzmes) * [ATP: Adenosine Triphosphate](http://www.bozemanscience.com/atp-adenosine-triphosphate) * [Gibbs Free Energy](https://paul-andersen.squarespace.com/gibbs-free-energy) * [Lab: Enzyme Catalysis](http://www.bozemanscience.com/ap-bio-lab-3-enzyme-catalysis)   Knuffke Prezis: Cellular Energetics: [Theory](https://prezi.com/u5kt8ftfvc3k/ap-bio-energy-1-cellular-energetic-theory/) and [Practice](https://prezi.com/eev4gdo5qeeg/ap-bio-energy-3-cellular-energetic-practice/) ***\*\*OUTSTANDING RESOURCE\*\****  Quizizz:   * [Energy and Enzymes](https://quizizz.com/admin/quiz/5bd759de344998001bbe0ff8) * [Enzyme Review AP Bio](https://quizizz.com/admin/quiz/5ad604805a1f42001b33576a) |
| **3.4-5** | * [**07: Photosynthesis (GSN)**](https://drive.google.com/open?id=1hdZR_O1aUU3V6A3bkl2SGYsvKP2RmJO17Sc097-4seU) & [**Presentation**](https://drive.google.com/file/d/0B1kdFzBe787hczlabzNCSkFGUUE/view?usp=sharing).pdf * **POGIL: Photosynthesis** * [**Investigation 5: Photosynthesis**](https://docs.google.com/document/d/19U779aJ6N1ntknwGUFXwQwwIozWOWMnTcidRMGCfbyU/edit?usp=sharing) **or** [**TEAM Investigation 5**](https://docs.google.com/document/d/1Hi37MgDoe3CqDE-vuJcWdqukVl7zcaAsGkkfLRRlecY/edit?usp=sharing) | MsLitten’s 7th Period Reviews:   * [MsLitten’s 7th Period Review Ch 07](https://www.youtube.com/watch?v=Cv91xoZa9HA) * [Photosynthesis “Song”](https://www.youtube.com/watch?v=rInEHjVYMSE) * [AP Bio Investigation 5: Photosynthesis](https://youtu.be/l2YCtNl_BfY)   Bozeman:   * [Plant Pigments and Photosynthesis](http://www.bozemanscience.com/ap-bio-lab-4-plant-pigments-photosynthesis) * [Finding Stomata](http://www.bozemanscience.com/finding-stomata) * [Photosynthesis Lab Walkthrough](http://www.bozemanscience.com/photosynthesis-lab-walkthrough)   Knuffke Prezis: [Photosynthesis](https://prezi.com/odmifdasxk6e/ap-bio-energy-4-photoautotrophic-nutrition/)  Quizizz:   * [Photosynthesis](https://quizizz.com/admin/quiz/5ba471a6660635001a650be4) |
| **3.6** | * [**08: Cellular Respiration (GSN)**](https://docs.google.com/document/d/1oIGDdJipz47Pb_HnzabD-4Lzh4m7zqeH1BhWcKwD0s8/edit?usp=sharing)& [**Presentation**](https://drive.google.com/open?id=1_0l8L4DwAQnq3RR0Br7pIL3Onh4y-JHu) .pdf * **POGIL: Cellular Respiration - An Overview** | MsLitten’s 7th Period Reviews:   * [MsLitten’s 7th Period Review Ch 08](https://www.youtube.com/watch?v=nbwnU_JjrSI) * [Cellular Respiration “Song](https://www.youtube.com/watch?v=pcY0uKHjA34)”   Bozeman:   * [Photosynthesis and Respiration](http://www.bozemanscience.com/013-photosynthesis-and-respiration) * [Cellular Respiration Lab Walkthrough](http://www.bozemanscience.com/cellular-respiration-lab-walkthrough)   Knuffke Prezis: [Chemoheterotrophic Energy Processing](https://prezi.com/m9s0caebmwdu/ap-bio-energy-5-chemoheterotrophic-nutrition/)  Quizizz:   * [AP Bio Cellular Respiration](https://quizizz.com/admin/quiz/5baa5219cb2d400019255d72) * [Cellular Respiration](https://quizizz.com/admin/quiz/5baa512f164f390019cf693d) |
| **3.7** | [**An introduction to cells and cellular diversity**](https://www.open.edu/openlearn/science-maths-technology/science/biology/introduction-cells-and-cellular-diversity)*I have incorporated this topic at the end of the Chapter 8 (GSN)* | Bozeman:   * [Cellular Variation](http://www.bozemanscience.com/052-cellular-variation) |
| **Check** | **College Board: Personal Progress Check 3** |  |

**CONNECTIONS: *A Step Further (Choose one connection below and take a step further for assessment)***

| **Sustainability** | [UN Sustainability Goal #2 Update](https://sustainabledevelopment.un.org/sdg2): Ensure access to affordable, reliable, sustainable and modern energy for all  [UN Sustainability Goal #7 Update](https://sustainabledevelopment.un.org/sdg7): End hunger, achieve food security and improved nutrition and promote sustainable agriculture  [Scaling Up Nutrition (SUN)](https://scalingupnutrition.org/) |
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| **NGSS** | [HS-LS1-5](https://www.nextgenscience.org/pe/hs-ls1-5-molecules-organisms-structures-and-processes)  [HS-LS1-7](https://www.nextgenscience.org/pe/hs-ls1-7-molecules-organisms-structures-and-processes)  Identify which [Science Practices](https://ngss.nsta.org/PracticesFull.aspx) you have “practiced” this unit - provide evidence  Identify which [Cross-Cutting Concepts](https://www.nextgenscience.org/sites/default/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf) you can identify in this unit - provide evidence |
| **Careers** | [Careers in Cell and Molecular Biology](https://study.com/articles/Careers_in_Molecular_Cell_Biology_Job_Options_and_Requirements.html)  [Metabolism Jobs](https://jobs.newscientist.com/jobs/metabolism/)  [Cell Metabolism Jobs](https://www.indeed.com/q-Cell-Metabolism-jobs.html)  [Top 20 Sustainable Agriculture Degree Programs by Net Price](https://www.collegevaluesonline.com/rankings/sustainable-agriculture-degrees-net-price/)  [Academic Degree Programs: Sustainable Agriculture](http://www.sustainableaged.org/projects/degree-programs/)  [Careers for Green Thumbs](https://www.learnhowtobecome.org/career-resource-center/careers-with-plants/)  [Careers in Plant Biology: Job Options and Degree Requirements](https://study.com/articles/Careers_in_Plant_Biology_Job_Options_and_Degree_Requirements.html) |
| **Interesting Information** | [Scientific American: Scrubbing Carbon from the Sky](https://www.scientificamerican.com/article/scrubbing-carbon-from-the-sky/) Can we remove enough CO2 from the atmosphere to slow or even reverse climate change?  [Biomimicry: using nature's designs to transform agriculture](https://www.theguardian.com/sustainable-business/2015/oct/30/biomimicry-institute-sxsw-eco-agriculture-bioinspired)  [The Land Institute: Transforming Agriculture, Perennially](https://landinstitute.org/) |

| **Big Idea** | **Enduring Understandings:** | **Topic** |
| --- | --- | --- |
| ENE-1 | **The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.** | 3.1-6 |
| SYI-3 | **Naturally occurring diversity among and between components within biological systems affects interactions with the environment** | 3.7 |

Document framework provided by Winnie Litten