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|  | **Energy flow and chemical recycling in ecosystems**  Energy flows into the ecosystem as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and leaves as \_\_\_\_\_\_\_\_\_\_\_\_\_. However, in the cell:  Photosynthesis generates \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_ molecules that the mitochondria of eukaryotes (including plants and algae) use as fuel for cellular respiration.  Respiration has three key pathways:  1.  2.  3. |
| **Catabolic pathways yield energy** by:   1. \_\_\_\_\_\_\_\_\_\_\_ leads to the partial degradation of sugars without the use of oxygen. 2. \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ consumes oxygen as a reactant to complete the breakdown of a variety of organic molecules. 3. Some prokaryotes use compounds other than oxygen as reactants in a similar process called \_\_\_\_\_\_\_\_\_\_\_ respiration.   Define respiration in your own words. How does it relate to breathing?  The overall catabolic process is: **Respiration** |
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|  | Redox reactions release energy when \_\_\_\_\_\_\_\_\_\_\_\_\_ move closer to electronegative atoms.  Catabolic pathways \_\_\_\_\_\_\_\_\_\_\_\_\_\_ the electrons stored in food molecules, releasing energy that is used to synthesize ATP.  Reactions that result in the transfer of one or more electrons (e−) from one reactant to another are oxidation-reduction reactions, or \_\_\_\_\_\_\_\_\_\_\_\_\_ reactions.  The loss of electrons from a substance is called \_\_\_\_\_\_\_\_\_\_\_\_\_.  The addition of electrons to another substance is called \_\_\_\_\_\_\_\_\_\_\_\_.  Explain oxidation/reduction in your own words.  ***Redox reactions also occur when the transfer of electrons is not complete but involves a change in the degree of electron sharing in covalent bonds***.  Example: **Combustion of methane.** What happens to the electrons in relation to carbon? |
| **Stages of Cellular Respiration** |
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|  | Glycolysis harvests chemical energy by \_\_\_\_\_\_\_\_\_\_\_ glucose to \_\_\_\_\_\_\_\_\_.  During glycolysis, glucose, a six-carbon \_\_\_\_\_\_\_\_\_\_\_\_\_, is split into two \_\_\_\_\_\_\_\_\_\_\_\_ sugars.  These smaller sugars are then oxidized and rearranged to form two molecules of \_\_\_\_\_\_\_\_\_\_\_\_, the ionized form of pyruvic acid.  These steps can be divided into two phases.  1.  2.  The net yield from glycolysis is \_\_\_\_\_\_\_\_ ATP and \_\_\_\_\_\_\_\_\_\_ NADH per glucose.  How much CO2 is released? How much oxygen is used? |
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|  | **The Citric Acid Cycle**  More than \_\_\_\_\_\_\_\_\_\_\_\_\_ (how much?) of the original energy in glucose is still present in the two molecules of pyruvate.  Where does pyruvate oxidation and the Citric Acid cycle occur in eukaryotes? In prokaryotes?  Alternate names of this cycle?  After pyruvate enters the mitochondrion via active transport, it is converted to a compound called:  Three reactions:   1. A carboxyl group is removed as \_\_\_\_\_\_\_\_\_\_\_\_\_\_. 2. The remaining two-carbon fragment is oxidized to form acetate. An enzyme transfers the pair of electrons to NAD+ to form \_\_\_\_\_\_\_\_\_\_\_\_. 3. Acetate combines with coenzyme A to form the very reactive molecule \_\_\_\_\_\_\_\_\_\_\_\_.   **The citric acid cycle** oxidizes organic fuel derived from pyruvate.  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ CO2 molecules are released, including the one released during the conversion of pyruvate to acetyl CoA.  The cycle generates \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (how many ATP?) per turn by \_\_\_\_\_\_\_\_\_\_\_\_ phosphorylation.  Most of the chemical energy is transferred to \_\_\_\_\_\_\_\_\_\_ and a related electron carrier, the coenzyme \_\_\_\_\_\_\_\_\_\_\_\_, during the redox reactions.  Explain the role of NADH and FADH2 up to this point. |
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| Oxidative Phosphorylation and Electron Transport  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ account for most of the energy extracted from glucose.  During \_\_\_\_\_\_\_\_\_\_\_\_\_ phosphorylation, chemiosmosis \_\_\_\_\_\_\_\_ electron transport to ATP synthesis.  Draw a mitochondria and show where the following occurs. Citric Acid Cycle. ATP Synthesis. |
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|  | **Electron Transport Chain**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ drop in free energy as they pass down the electron transport chain.  During electron transport along the chain, electron carriers alternate between \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ states as they accept and donate electrons.  Why are the electrons carried by FADH2 added at a different place than NADH electrons?  The electron transport chain generates how many ATP?  What does the electron transport chain actually do? |
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|  | **Fermentation and Anaerobic Respiration**  In the absence of \_\_\_\_\_, glycolysis couples with fermentation or anaerobic respiration to produce \_\_\_\_.  Anaerobic respiration uses an electron transport chain with an:  Fermentation consists of \_\_\_\_\_\_\_\_\_\_\_\_ plus reactions that regenerate \_\_\_\_\_\_\_\_\_, which can be reused by glycolysis.  Two common types are:   1. **Alcohol Fermentation**   \_\_\_\_\_\_\_\_ is released from \_\_\_\_\_\_\_\_\_\_\_\_ which is then converted into acetaldehyde.  Acetaldehyde reduced by \_\_\_\_\_\_\_\_\_ to ethanol.   1. **Lactic Acid Fermentation**   Pyruvate is reduced by NADH, forming \_\_\_\_\_\_\_\_\_ as an end product, with no release of \_\_\_\_\_\_\_\_\_  Human \_\_\_\_\_\_\_\_\_\_\_\_ cells use lactic acid fermentation to generate ATP when O2 is scarce |
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| **Process** | **Function and Location** | **Inputs** | **Outputs** |
| Glycolysis |  |  |  |
| Pyruvate to Acetyl-CoA |  |  |  |
| Citric Acid Cycle |  |  |  |
| Oxidative Phosphorylation |  |  |  |
| Fermentation |  |  |  |