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|  | An organism’s \_\_\_\_\_\_\_\_\_\_\_\_\_ transforms matter and energy, subject to the laws of thermodynamics.  Metabolism is:  A metabolic pathway:  Catalyzed at each step of the pathway by:  \_\_\_\_\_\_\_\_\_ pathways \_\_\_\_\_\_\_\_\_\_\_\_\_ energy by breaking down complex molecules to simpler compounds.  Examples:  \_\_\_\_\_\_\_\_\_ pathways, also called \_\_\_\_\_\_\_\_\_\_ pathways, \_\_\_\_\_\_\_\_\_\_\_\_\_ energy to build complicated molecules from simpler compounds.  Examples: |
| Organisms transform \_\_\_\_\_\_\_\_\_\_\_\_.  Energy is:  Kinetic energy  Ex.  Thermal energy  Ex. |
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|  | Heat  Ex.  Light  Ex.  Potential energy  Ex.  Chemical energy is a term used by biologists to refer to the \_\_\_\_\_\_\_\_\_ energy available for release in a chemical reaction.  Ex.  Energy can be converted from:  Ex. |
| Energy transformations of life are subject to:  Thermodynamics:  *System* refers to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and the *surroundings* include \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (everything outside the system).  An *isolated system:*  An *open system:*  Organisms are open or closed systems? How do you know? |
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|  | 1st law of thermodynamics  Energy can be \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_, but it cannot be *\_\_\_\_\_\_\_\_\_\_\_\_* or *\_\_\_\_\_\_\_\_\_\_\_\_*.  Also known as the *principle of \_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_\_.*  Example of Plants…  During \_\_\_\_\_\_\_\_\_\_\_ transfer or transformation of energy, some energy is converted to \_\_\_\_\_\_\_\_\_\_\_, which is the energy associated with the random movement of atoms and molecules.  When can a system use heat to do work?  Energy transfers and transformations make the universe more \_\_\_\_\_\_\_\_\_\_ due to the loss of usable energy.  \_\_\_\_\_\_\_\_\_\_\_\_\_ is a measure of disorder or randomness.  2nd law of thermodynamics  Every energy transfer or transformation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the universe.  mostly takes the form of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  Examples:  For a process to occur on its own, without outside help in the form of energy input, it must \_\_\_\_\_\_\_\_\_\_\_ the entropy of the universe.  Spontaneous processes:  They always occur quickly – True or False. explain.  Examples:  Why does an increase in biological organization not violate the second law of thermodynamics? |
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|  | Free-energy change of a reaction tells us:  The concept of free energy (symbolized by the letter *\_\_\_\_\_\_\_\_\_\_\_*)  The change in free energy, *\_\_\_\_\_\_\_\_\_\_\_\_*, can be calculated for any specific chemical reaction by applying the following equation:  *∆H* symbolizes:  *∆S* symbolizes:  For a process to occur spontaneously, the system must   1. Give up \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (*H* must \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) 2. Give up \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(*T∆S* must \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) 3. Or both.   ∆*G* must have a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ value (∆*G* < 0) in order for a process to be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  Examples of -∆*G:*  A system at equilibrium is at maximum stability and has a ∆*G* of \_\_\_\_\_\_\_\_\_\_. Why?  *A process is spontaneous and can perform work only when it is moving towards \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.* |
| What powers cellular work? \_\_\_\_\_\_\_\_\_\_\_\_\_\_  How? By \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ exergonic reactions to endergonic reactions.  A cell does three main kinds of work. List with examples. |
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|  | ATP (adenosine triphosphate) is a nucleotide triphosphate consisting of the sugar ribose, the nitrogenous base adenine, and a chain of three phosphate groups. Draw its general structure below:  ATP acts as the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ source of energy that powers cellular work. Why is it needed?  The bonds between the phosphate groups on ATP can be broken by \_\_\_\_\_\_\_\_\_\_\_\_\_.  The release of energy during the hydrolysis of ATP comes from:  The chemical change to a state of lower \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, NOT from the phosphate bonds.  Why does the hydrolysis of ATP yield so much energy?  In the cell, the energy from the hydrolysis of ATP is directly coupled to endergonic processes by the \_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ group to another molecule.  ATP hydrolysis leads to a change in a protein’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and often its ability to bind another molecule.  Examples of ATP driving work in the cell.  1  2  3  Regeneration of ATP - Where does the energy come from? |
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|  | Enzymes speed up metabolic reactions by:  Rate of spontaneous reactions?  An \_\_\_\_\_\_\_\_\_\_\_\_ is a macromolecule or typically a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (made of \_\_\_\_\_\_\_\_\_\_\_\_\_) that acts as a catalyst.  Define catalyst:  Every chemical reaction involves bond \_\_\_\_\_\_\_\_\_\_\_\_\_ and bond \_\_\_\_\_\_\_\_\_\_\_\_\_\_.  Sucrose breaking down into glucose and fructose example.    Bonds broken:  Bond formed: |
| Free energy of activation, or activation energy (EA) –  Where does Activation energy come from?  Draw the hypothetical exergonic reaction that swaps portions of two reactant molecules:  AB + CD → AC + BD  Proteins, DNA, and other complex organic molecules are RICH or POOR in free energy? Their hydrolysis is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, with the release of large amounts of energy.  Enzymes speed reactions by:  Enzymes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ change Δ*G*; they hasten reactions that would occur eventually. |
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|  | Enzymes are \_\_\_\_\_\_\_\_\_\_\_\_\_ specific.  Substrate:  What accounts for this molecular recognition?  The active site of an enzyme is:  Usually formed by only a few \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_.  Induced fit?    Substrates are held in the active site by \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_  Enzymes use a variety of mechanisms to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the activation energy and speed up a reaction.        The rate at which a specific number of enzymes convert substrates to products depends on: |
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|  | A cell’s physical and chemical environment affects enzyme activity.  The activity of an enzyme is affected by:               What are *optimal conditions* for enzyme activity?  Examples:  What are cofactors and what do they do? |
| Binding by inhibitors prevents enzymes from catalyzing reactions.  Reversible vs. Irreversible inhibitors  Competitive inhibition. What is it and how can it be overcome?  Noncompetitive inhibitors:  Toxins and poisons are often \_\_\_\_\_\_\_\_\_\_\_\_\_ enzyme inhibitors.  Examples: |
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|  | Metabolic control often depends on allosteric regulation.  In allosteric regulation, a protein’s \_\_\_\_\_\_\_\_\_\_\_\_\_ at one site is affected by the \_\_\_\_\_\_\_\_\_\_\_\_\_ of a regulatory molecule to a separate site.  Most allosterically regulated enzymes are constructed of:  The complex oscillates between two shapes, one catalytically \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.  Examples:  In enzymes with multiple catalytic subunits, binding by a *substrate* molecule to one active site in a multi-subunit enzyme triggers a shape change in all the subunits.  This mechanism, called cooperativity, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the response of enzymes to substrates, priming the enzyme to accept additional substrates.  The vertebrate oxygen-transport protein hemoglobin is a classic example of cooperativity. How does it work?  A common method of metabolic control is \_\_\_\_\_\_\_\_\_\_\_ inhibition.  Feedback inhibition prevents a cell from:  Draw feedback pathway.  The localization of enzymes within a cell helps order metabolism. How? |
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