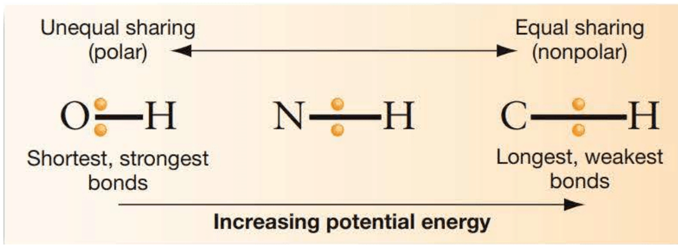
Good luck!

Energy and enzymes

Potential energy and heat ΔH



- more non-polar covalent bonds, more potential energy
- more electronegative atoms

Exothermic - a reaction with heat as a product (releases heat), $\Delta H < 0$
Endothermic - a reaction with heat as a reactant (absorbs heat), $\Delta H > 0$

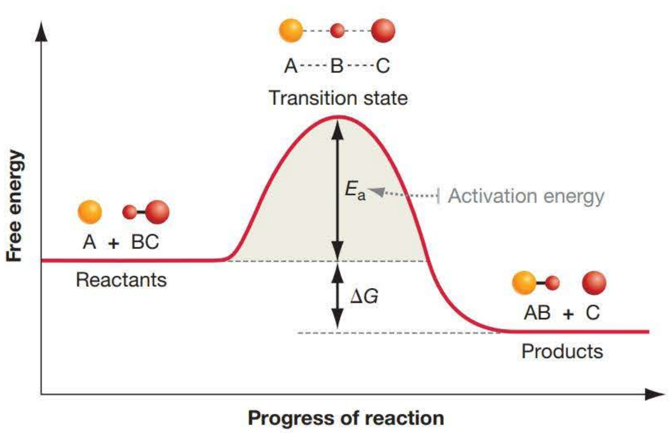
Entropy: disorder and mixing ΔS

Entropy S - the amount of disorder in a system. The universe trends to more entropy.

Gibbs free energy and spontaneous reactions $\Delta G = \Delta H - T\Delta S$

Gibbs free energy is change in enthalpy minus temperature * change in entropy
Enthalpy H - total energy in a molecule

Exergonic - $\Delta G < 0$, spontaneous reaction
Energonic - $\Delta G > 0$, non-spanteous
Equilibrium - $\Delta G = 0$



Coupling of reactions in anabolic processes

Energetic coupling allows endergonic reactions to proceed using free energy from exergonic reactions.

Anabolic pathway - any set of chemical reactions that synthesies large molecules form smaller ones. generally requires an input of energy
Catabolic pathway - breaks down large molecules into smaller ones, releases energy

Exergonic ATP hydrolysis (catabolic) is coupled with endergonic reactions (anabolic) through a shared intermediate.
Example: Sodium-potassium pump, ATP phosphoralyzes a protein pump

Enzymes

Enzymes (usually end in *-ase*) lower the activation energy of a reaction (E_a)
Specificity - an enzyme can "recognize" a specific substrate from a group of similar ones based on its structure (lock and key model)

Regulation:

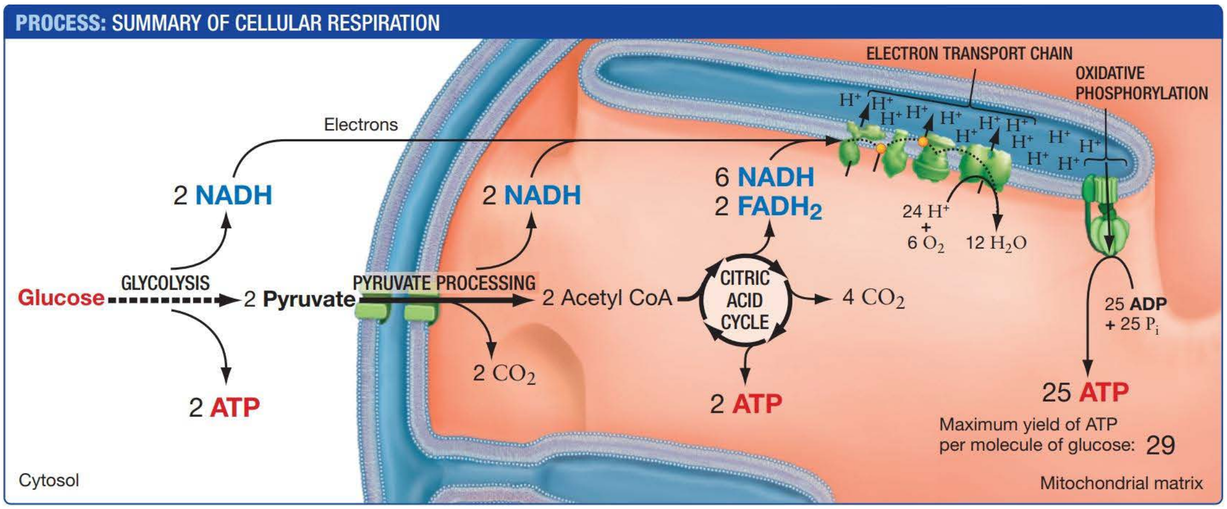
- Competitive inhibition - a regulatory molecule with similar shape to substrate sits in an enzymes active site and blocks it from binding
- Allosteric activation - a regulatory molecule attatches to the enzyme and causes a shape change, making the active site available. (putting a key in a car to start it)
- Allosteric inhibition - a regulatory molecule attatches to the enzyme and causes a shape change, making the active site UNavailable (giving a child a lollypop so they shut up)
- Phosphorylation - an added phoshpate group adds a negative charge to enzyme causing the shape change

Cellular Respiration

Purpose of celluar respiration: Using energy in glucose to make ATP

1. Glycolysis - one six-carbon molecule of glucose is broken into two molecules of the three-carbon compound pyruvate. ATP is produced from ADP and P_i, and (NAD+) is reduced to form NADH.
   Occurs in cytosol
2. Pyruvate processing - each pyruvate produced by glycolysis is processed to release one molecule of CO_2, and the remaining two carbons are used to form the compound acetyl CoA. The oxidation of pyruvate results in more NAD+ being reduced to NADH.
   Occurs in matrix of mitochondria or cytosol in prokaryotes
3. Citric acid cycle - the two carbons from each acetyl CoA produced by pyruvate processing are oxidized to two molecules of CO_2. During this sequence of reactions, more ATP and NADH are produced, and (FAD) is reduced to form $FADH_2$

4. Electron transport chain - Electron Electrons from the NADH and FADH2 produced by pyruvate processing and the citric acid cycle move through a series of electron carriers, the ETC. The energy obtained from this chain of redox reactions is used to create a proton gradient across a membrane, the ensuing flow of protons back across the membrane makes ATP



Substrate-Level Phosphorylation - creates ATP, enzyme catalyzes the transfer of a phosphate group from a phosphorylated substrate to ADP (coupled reaction)
Oxidative Phosphorylation - creates ATP, links oxidation of NADH and $FADH_2$ with phosphorylation of ADP

phosphofructokinase - regulates glycolysis, when too much ATP is produced this enzyme uses ATP to phosphorylate fructose-6-phosphate (allosteric inhibition)

Fermentation

Role of fermentation for the cell: Regenerate NAD+ - only needed to keep glycolysis going so that we can power the proton gradient to produce ATP
occurs when there isn't enough oxygen

fermentation oxidizes stockpiles of NADH to regenerate NAD+
lactic acid fermentation - regenerates NAD+ by reducing pyruvate to form lactate
fermentation is inefficient - produces only 2 ATP per glucose metabolized, while aerobic cellular respiration produces 29

Central dogma

DNA to RNA to Proteins to Phenotype

triplet genetic code - codon - 3 bases code for our 20 amino acids. we need to have 3 to code for all of them, and the extra coding is used for redundency. each coding is unique
reading frame - if our reading frame is off by even 1 base, it messes up everything and we just produce gibberish

template strand -RNA polymerase reads this strand from 3' to 5' and adds base pairs to make

mRNA
coding strand - has the same sequence of the newly synthesized mRNA

DNA to mRNA is transcription, uses RNA polymerase
mRNA to proteins is translation, uses ribosomes n shit

Transcription

synthesis of RNA from a DNA template

prokaryotes

in bacteria sigma protein must bind ot core enzyme to recognize site$s$ where transcription should begin. These sites are promoters. bacterial RNA polymerase core enzyme and sigma form a holoenzyme (beads on a string)

transcription and translation can occur at same time, bacteria can translate mRNA even before its transcription is complete

eukaryotes

in eukaryotes, there are 3 major polymerases, RNA polymeras I, II, and III, which produce only certain types of RNA

eukaryotic RNA polymerase recognizes promoters using transcription factors - proteins
poly(A) signal - DNA sequence near the end of each gene, marks the end where enzyme cuts

translation and transcription are separated in time and space

exons and introns - introns are removed from growing RNA by splicing

mRNA processing

Splicing of introns and alternative splicing

5' cap and 3' poly-A tail addition - helps mRNA not desolve (protects it) and marks the end of transcription

Translation

Additional control of gene expression

mRNA stability (miRNA)

Prokaryotic regulation of gene expression

Biotechnology

Restriction enzymes - purpose and mechanism of action
Creating a recombinant DNA plasmid using restriction enzymes
Using bacteria to produce proteins