Name:_____ Major/Exp.Grad Year_____S17BioE11 Biochem Midterm 3/23/17

Formal charges not necessarily drawn in given structures.

1. Evolution favors blueprints that are able to effectively compete for survival. Multicellular Eukaryotes have many advantages through specialization (on the cellular level: organelles, on the organism level: tissues). What is the major advantage of bacteria in their competition with these multicellular Eukaryotes? (*4 pts.*)

Short generation time (outgrow)

2. What three things must an organism do at a minimum to be considered living? (*6 pts.*)

1) Ability to extract energy (in the form of high energy chemical bonds whose hydrolysis can be harnessed for desired work).
2) Rapidly respond to its environment.
3) Reproduce

2pts each

3. The ability of water to form a solid (ice) that is less dense than the liquid form is critical for sustaining life on our planet. Explain, on the atomic level, why ice is less dense than water. (*5 pts.*)

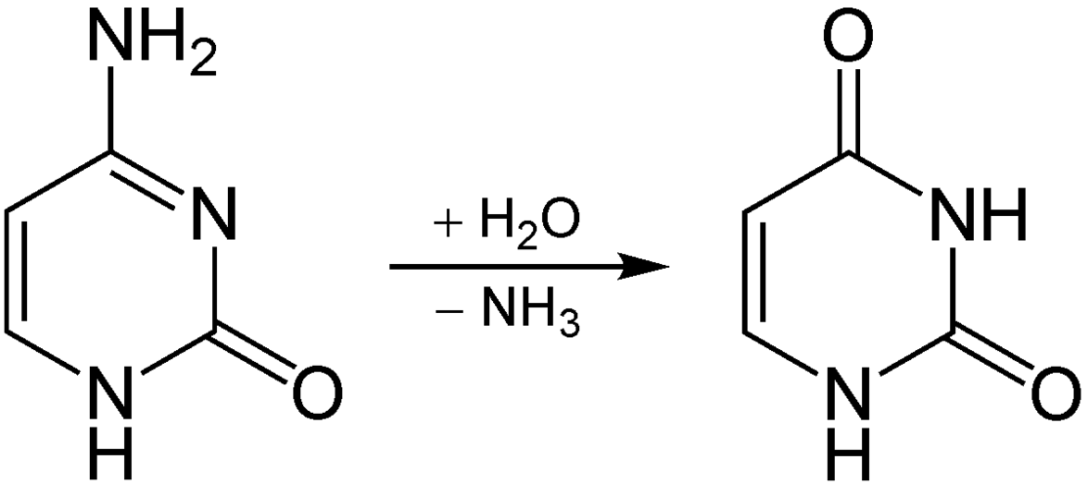
Open lattice structure through H-bonding

4. A. Name the polymers involved in Central Dogma (*3 pts.*) and B. the cellular machinery that are involved in the information flow through Central Dogma. (*3 pts.*) Extra credit (need to get 100% correct to get any of the (*4 pts.*): What polymers are these cellular machineries made of themselves?

A. DNA, RNA, protein
B. (DNA polymerase - but not required for credit), RNA polymerase, ribosome
C. Protein and (in the case of ribosome) RNA [must get BOTH protein AND RNA to get any of the 4 pts - all or nothing]

5. RNA uses uracil to base pair with adenine, whereas DNA uses thymine. What did you find in your homework assignment to explain why the cell invests additional energy to use thymines for DNA instead of also using uracil? (*6 pts.*)

To edit errors. Uracil can be produced from chemical degradation of cytosine. If this happens as an undesired reaction, the cell wouldn't know if the resultant uracil was incorrect or its mismatched G base on the other strand. By spending the energy to methylate the uracil to make thymine, the cell knows the mutation of deamination is indeed the thymine.



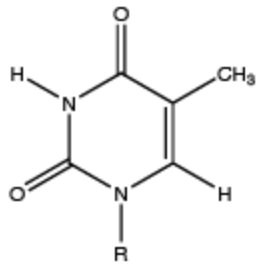
Cytosine deaminates to uracil

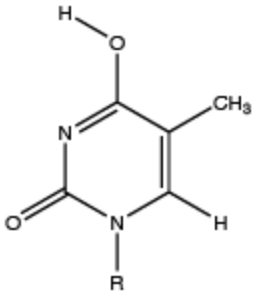
6. The phosphate backbone of DNA presents a potential problem for the cell, a plethora of anionic charge in close proximity. How is this potential problem ameliorated? (*4 pts.*)

Chelates Mg+2 to shield change

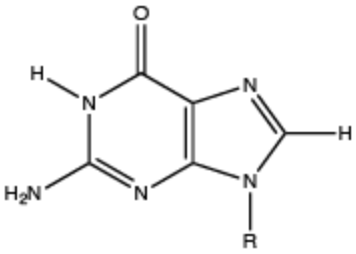
7. Watson and Crick (for whom Watson-Crick base pairing is named) had an officemate who provided a critical insight for deriving the double helix model: that both purine and pyrimidine bases are predominantly in the keto form. Circle which of the below structures is the keto form and explain why is this was a critical insight for their model? (*6 pts.*)

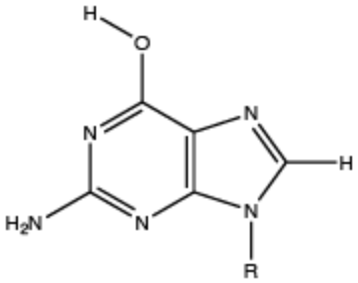
thymine
(a pyrimidine)





guanine
(a purine)





Left structures (2pts), H-bonding (4pts)

8. From where does the energy for driving RNA polymerization extracted/coupled? (*4 pts.*)

Hydrolysis of high energy triphosphate bonds (P-P-P → P-P + Pi and then P-P → 2Pi)

9. A. Peptide bond is rigid. Draw a peptide bond and explain why this bond is rigid. (*2.5 pts.*)
Amide bond in resonance structure.

B. Draw the structure of the following peptide at pH=7: MEG (*6 pts.*)

Need to have amino terminus (protonated or deprotonated), carboxy terminus (must be deprotonated). All one molecule with peptide bonds!

10. What type of force is most responsible for stabilizing protein folds? (*6 pts.*)
hydrophobic

11. Name the three things all enzymes must do to catalyze a reaction. (*7.5 pts.*)

1. Bind to substrate

2. stabilize transition state

3. dissociate from product.

(2.5pts each)

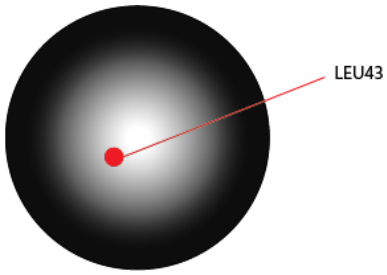
12. Draw a plot of Free energy as a function of reaction coordinate (i.e., proceeding from starting substrate to product) with and without an enzyme to describe how an enzyme catalyzes a reaction. (*6 pts.*)

lowered deltaG for transition state. Rest of the plot is unchanged (i.e., substrate and product stays the same delta G).

13. True or False: An Enzyme increases the fraction of product to substrate (i.e., [product]/[substrate] is greater when enzyme is added after a long period of time)? (*5 pts.*)

False

14. Which would you predict to be a more deleterious mutation in the below protein: LEU43ASP (leucine at the 43rd position mutated to an aspartic acid) or LEU43VAL? Explain your reasoning. (*4 pts.*)



LEU43ASP is a more dramatic change and hydrophobic to charge is likely to pertub the hydrophobic core.

15. Name 3 of the 4 mechanisms by which enzymes catalyze reactions. (*3 pts.*)

any 3 of these 4: metal ion catalysis, covalent catalysis, electrostatic catalysis, and proximity and orientation effects

16. The following duplex DNA is transcribed right to left as printed here:

phosphate-CTGCCCTTACACAATCATTTTCATAATGCG-OH
OH-GACGGGAATGTGTTAGTAAAAGTATTACGC-phosphate

What is the resultant amino acid sequence of the polypeptide that this DNA sequence encodes assuming that translation starts at the first initiation codon (AUG)? (*7 pts.*)

5' CGCAUUAUG AAA AUG AUU GUG UAA GGGCAG 3'

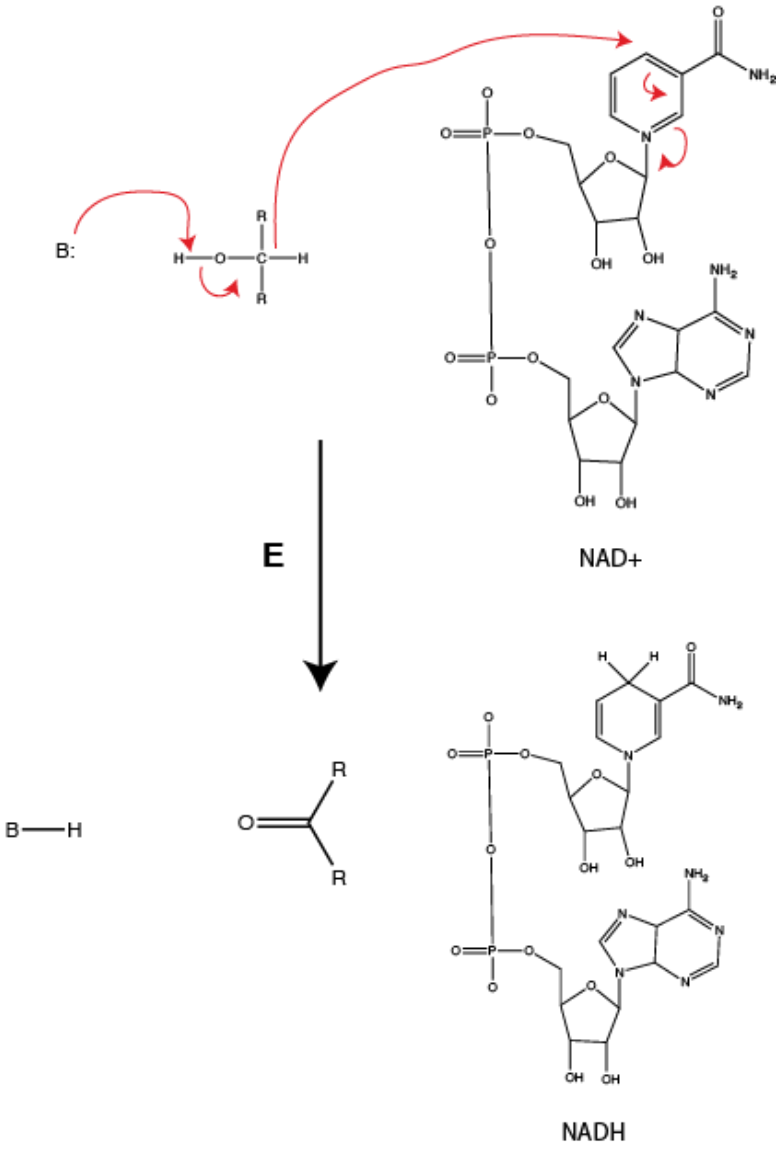
MET LYS MET ILE VAL STOP

2pts for mRNA, 2pts for correctly reading 5'à3' RNA, 3pts for AAs. 7 pts if AA sequence is correct (assume that the mRNA must have been made correct to arrive at the correct answer.

17. What types of bases do you think are highly enriched in promoters (the sequences of DNA that encode for the transcription initiation site)? Hint: the limiting step of transcription is forming the initiation DNA bubble to allow RNA polymerase to bind. (*6 pts.*)

As and Ts because these are easier to melt.

18. For the following reaction, is enzyme E an oxidase or reductase (i.e., is the substrate being oxidized or reduced)? (*3 pts.*). Draw the arrow-pushing mechanism and the structure of NADH. (*3 pts.*)



Codon Table

Seconed Position

First Position	U code	U Amino Acid	C code	C Amino Acid	A code	A Amino Acid	G code	G Amino Acid	Third Position
U	UUU	phe	UCU	ser	UAU	tyr	UGU	cys	U
	UUC		UCC		UAC		UGC		C
	UUA	leu	UCA		UAA	STOP	UGA	STOP	A
	UUG		UCG		UAG	STOP	UGG	trp	G
C	CUU	leu	CCU	pro	CAU	his	CGU	arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	ile	ACU	thr	AAU	asn	AGU	ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	lys	AGA	arg	A
	AUG	met	ACG		AAG		AGG		G
G	GUU	val	GCU	ala	GAU	asp	GGU	gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	glu	GGA		A
	GUG		GCG		GAG		GGG		G

Amino Acid Table