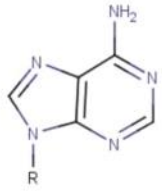
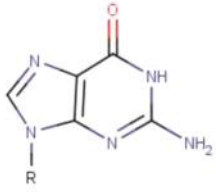
Exam3Key

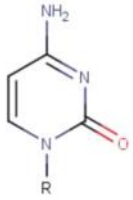
Thursday, December 01, 2016 8:37 AM

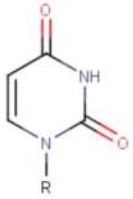
Name

This exam is schedule for 75 minutes and I anticipate it to take the full time allotted. You are free to leave if you finish. The exam is split into two sections. Part 1 is multiple choice – select the ONE correct answer in each question. Part 2 is composed of several fill in the blank questions with answers that should be selected from the provided answer pool. Part 3 is composed of several more involved questions.









Part 1. Clearly circle ONE answer per question.

1. Which of the following DNA sequences is the anticodon for a 5'-GAC-3' codon?

5'-GAC-3' 5'-GTC-3' 5'-CAG-3'

2. Which of these are NOT important for RNA Polymerase interacting with DNA?

Shine-Delgarno Region -10 Region -35 Region UP Elements TATA Box

3. Which of the following are high energy phosphate compounds that can convert ADP to ATP? Select all that apply.

Phosphoenolpyruvate (PEP) 1,3-bisphosphoglycerate (BPG) Fructose-1,6-bisphosphate (FBP)

4. Which of these proteins is not important for replication on the ***leading*** strand? Select all that apply.

SSB Helicase Pol I Pol III Primase

5. Consider the conversion of glucose to pyruvate in the glycolysis pathway. Which of the following is/are NOT products of the reaction? Select all that apply.

ATP Glucose-6-phosphate ADP NADH Lactate NAD+

6. Which of these enzymes require an energy source? Select all that apply.

Exonucleases domains DNA Ligase SSB Aminoacyl-tRNA synthetase

7. Which arm of tRNA molecules contain the 5' end?

Variable Acceptor D TΨC Anticodon

8. Which of the following is not a DNA repair strategy?

BEER MMR NER SOS Response BER

9. Which arm(s) of tRNA molecules are the most involved in stabilizing the non-traditional RNA structure? Select all that apply.

Variable Acceptor D TΨC Anticodon

10. Which helix form is found in the active site of DNA and RNA Polymerases?

A-form B-form Z-form

11. Which of the following correspond to the initial point of contact between transcription factors and promoter DNA in eukaryotes?

Shine-Delgarno Region -10 Region -35 Region UP Elements TATA Box

12. Which step in translation is not energy dependent?

Decoding Translocation Transpeptidation

Part 2 – Matching Complete the following statements from the list of terms below – you may make any of these plural if necessary. You MAY deviate from the word-bank if you think there is another word that accurately fits into the blank. Each word is used only once.

Riboswitch, replication fork, A-site, P-site, E-site, aminoacyl, omega, thumb, DNA, RNA, A-form, B-form, Pol I, Pol III, MerR, processive, abortive, exonuclease, sigma, endonuclease, 3'→5', 5'→3', -10, -35, UP elements, nucleophile, electrophile, hand, thumb, fingers, palm, lariat, template, BER, NER, DnaA, DnaB, template, bridge, trigger, leading, lagging, terminal, phosphate, formyl, acetyl, α, β, γ, right, left, carboxy, amino, transcription bubble, backbones, bidirectional, Shine-Delgarno, Pribnow, scrunching, AP sites, exons, introns, ribosome, okazaki, semi-conservative

13. The "thumb" domain is responsible for processivity in DNA Polymerase.

14. The trigger helix is responsible for facilitating NTP sampling in RNA Polymerase.

15. DNA and RNA Polymerases always read the template strand in the 3'→5' direction.

16. aaRS enzymes catalyze the production of aminoacyl-tRNA molecules. The bond that is formed links the 3'-OH of the tRNA and the carboxy terminus of an amino acid.

17. DNA replication is semi-conservative meaning that the dsDNA produced contains one new strand and one strand from the template.

18. Okazaki fragments are produced on the lagging strand during replication.

19. Ejection of the sigma factor from RNA Polymerase is necessary to avoid abortive initiation.

20. DnaA proteins bind to DNA just downstream of the origin of replication. When bound, dsDNA wraps around these proteins resulting in unwinding of adjacent DNA.

21. The 5'→3' exonuclease activity of Pol I is critical for removal of RNA primers.

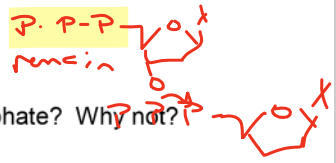
22. In bacteria, proteins are synthesized with a formyl modification on the N-terminus.

23. Base pairing between codons on mRNA and anti-codons on tRNA is the most selective in the A-site of the ribosome.

Part 3 – Not so short answer.

24. Why do most *bacterial* RNA molecules have a 5' triphosphate?

the 1st nucleotide on the chain does not have the NTP hydrolyzed
– the rest of them are monophosphates

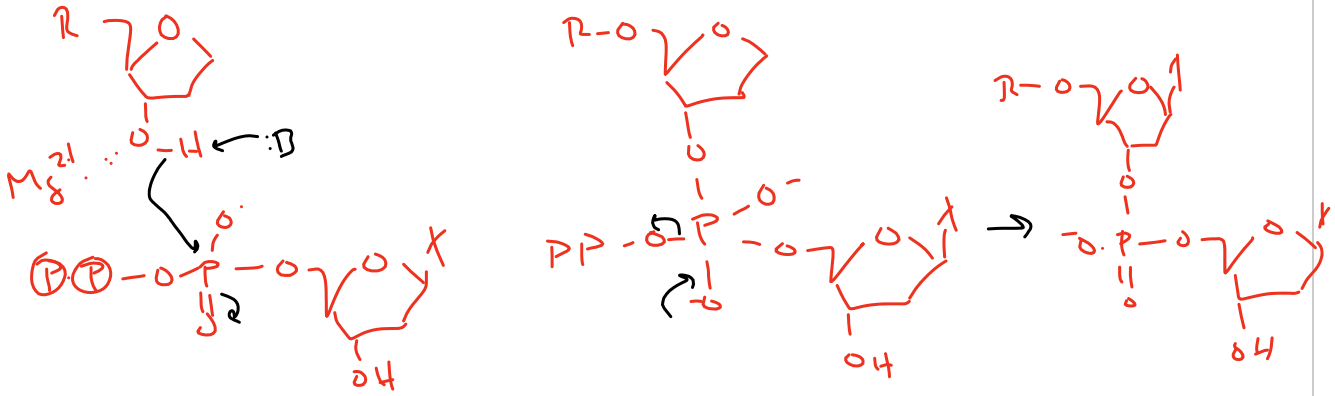


What is one example of a bacterial RNA polymer that does **not** contain a 5' triphosphate? Why not?

rRNA & tRNA
they are transcribed in a long RNA chain that gets processed into smaller fragments

25. Please provide a chemical rational for why DNA and RNA polymerization is polarized (*i.e.* proceeds in a specific direction). A complete answer should include a mechanism.

3' end is the nucleophile



26. Describe one way that a transcription factor can activate transcription in prokaryotes. Provide enough detail to make it clear that you understand how activation is achieved.

① correcting a crappy promoter → -10 + -35 need to be spaced so that both are on the same side of dsDNA. If not, then σ-factor can't bind. Some activators will bind to these poor promoters and twist the DNA so that -10 & -35 are correct.

② Increase affinity of RNAP for promoter → CAP does this, by binding to UP elements & RNAP.

27. Inorganic pyrophosphatase is an enzyme that catalyzes the hydrolysis of pyrophosphate (or the diphosphate anion) to inorganic phosphate; in the process, 33 kJ/mol of energy is released. Inhibition of this enzyme also prevents DNA replication and RNA synthesis. Explain this observation – feel free to include any sketches/structures/reactions that you find helpful.

Pyrophosphate is a product of the polymerization rxns. If this enzyme hydrolyzes PP_i & provides energy, then inhibiting it could remove the energetic driving force associated with polymerization.

Also acceptable: not removing PP_i would lead to an accumulation of products ... according to LeChatelier's Principle, the rxn will shift to reactants.

28. The mutation abundance in the *E. coli* genome is 1 in every ~10^8 nucleotides. However, Pol I and Pol III each have error rates of 1 in every ~10^7 nucleotides. How is this possible that there are fewer errors in the final product than what is produced during the process?

There are other cellular strategies to fix errors in DNA

BER, MER, NER, etc.

29. Please discuss the role of 3'→5' **and** 5'→3' exonuclease activities in the replication process. You are encouraged to use an image to clarify your answer.

proofreading. removes error @ the growing end of the DNA molecule

5'→3' → used to remove RNA primer at the 5' end of Okazaki fragments

30. One regulatory strategy that cells have adopted is to produce small pieces of RNA that are complementary to certain regions of mRNA. Describe how translation would be effected if the following small RNA molecules are present.

a. Interfering RNA is complementary to the first 22 nucleotides at 5' end of the mRNA.

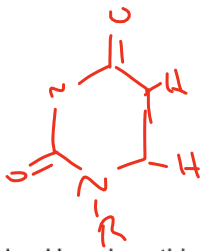
Shine-Delgarno sequence + possible start codon are masked. mRNA won't make contact with ribosome. no translation

b. Interfering RNA (25mer) is complementary to an internal section of the mRNA.

tRNA can't pair with mRNA. Translation terminates prematurely

31. Dihydrouridine (D) is a common base modification in tRNAs.

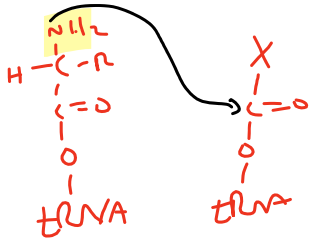
a. Draw the structure of this molecule (abbreviate the Ribose as R).



b. How does this modification modify the chemical properties of the molecule?

removes sp^2 hybridization no longer planar

32. The rate of peptidyl transfer reaction in translation increase as the pH changes from 6 to 8. Why? You may want to include a mechanism to support your answer.



Need NH_2 to be deprotected

more likely @ basic pH.

33. We discussed how some DNA Ligase enzymes can use NADH as an energy source for catalysis.

a. What role does DNA Ligase play in replication? seals Okazaki fragments together

b. This reaction is initiated with a lysine form the enzyme forming a covalent bond with the alpha phosphate of AMP. In the next step, the 5' phosphate of DNA attacks the covalent intermediate and releases the lysine residue – this forms a diphosphate linkage between the DNA and adenosine. In the final step, AMP is released and the phosphodiester bond of the DNA strand is formed. Draw this mechanism. You are welcome to make use abbreviations to save space.