Practice Questions for Midterm Exam 2
October 2013

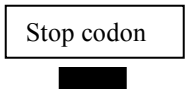
1. Which of the following *distinguishes* bacterial mRNAs from human mRNAs?

A. Human mRNAs have 5' untranslated regions, but bacterial mRNAs do not.
B. Human mRNAs are spliced before translation but bacterial mRNAs are not.
C. Human mRNAs have several open reading frames, but bacterial mRNAs have only one.
D. Human mRNAs are transcribed by many RNA Pols but bacterial mRNAs by one RNA Pol.
E. Human mRNAs have several ribosomes binding to them, but bacterial mRNAs do not.

2. Operons allow bacteria to express genes that encode proteins with related functions quickly. Which of the following would be a good reason Eukaryotes don't have operons?

A. Eukaryotes don't express genes with related functions.
B. In eukaryotes, genes with related functions are translated from one mRNA by alternate splicing.
C. Translation of a coding region requires a 5'cap structure.
D. Genes with related functions are likely to be found on different chromosomes.
E. Translation and transcription take place separately in eukaryotes.

3. The following nucleotide sequence encodes the C terminus region of a Wild type protein.



5'-GCCTCTAAAATCAGGAGAACACACGCCGCCATGTAA-3'
3'-CGGAGATTTTAGTCCTCTTGTGTGCGGCGGTACATT-5'

In the mutant form of this gene in this region, a single base is changed from A to T as shown below:
5'-GCCTCT**A**A-'3 changed to 5'-GCCTCT**T**A-3' – Note: only the coding strand is shown here, but a corresponding complementary base mutation is on the template strand too.
Using the *genetic code table in the textbook for this (chapter 15, Fig. 15.6),* predict the consequence of this base change from A to T on the protein produced:

A. The mutation would result in a shorter protein.
B. The mutation would result in a different amino acid being inserted into the protein.
C. The mutation would result in a longer protein.
D. The mutation would not change the amino acid sequence of the protein.
E. The mutation would change all the amino acid sequence in this region.

4. The fact that translation is not simultaneous with transcription in eukaryotes is primarily due to:

A. the fact that introns are spliced from eukaryotic mRNAs before translation.
B. the fact that eukaryotic mRNAs need a polyA tail to be translated.
C. the fact that eukaryotic mRNAs need a 5' cap to be translated.
D. the fact that the processed mRNA needs to be exported to the cytoplasm for translation.
E. the fact that the DNA must be decondensed in the nucleus before transcription.

5. A mutation in MalT (the activator) protein caused a change in its tertiary structure. The mutated protein can bind to the operator without binding maltose. What would be the result?

A. The mutated protein would prevent MalPQ from ever being expressed.
B. There would be a decrease in expression of MalPQ and maltose would need to be present to cause expression of MalPQ.
C. MalPQ would be expressed all the time.
D. There would be an increase in expression of MalPQ but only when maltose is present.
E. This mutation would have no effect on MalPQ expression.

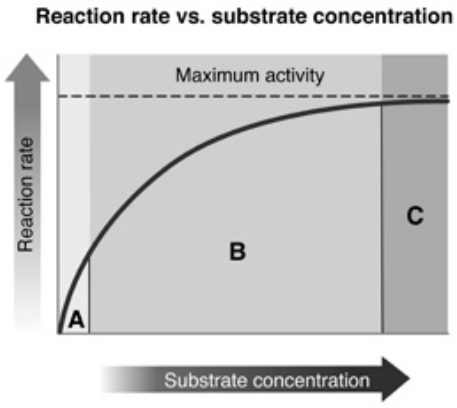
6. Choose the *BEST* answer that explains the stable nature of double-stranded DNA structure compared to an RNA structure.

A. The sugar-phosphate backbone provides greater stability to DNA structure.
B. The H-bonds between complementary bases of the two strands is the reason for stability in DNA.
C. The strands are twisted around each other and can't get apart and this fact holds DNA in a stable manner.
D. Stacking interactions between neighboring bases of the same strands and H-bonds between complementary bases of the two strands make DNA more stable.
E. Covalent bonds between the nucleotides of the two strands in DNA are strongest bonds, making DNA structurally more stable than RNA.

7. What is a transition state in an enzyme-catalyzed reaction?

A. The complex formed as covalent bonds are being broken and re-formed during the reaction.
B. The place where an allosteric regulatory molecule binds to an enzyme.
C. An interaction between reactants with high kinetic energy, due to high temperature.
D. The shape adopted by an enzyme that has an inhibitory molecule bound at its active site.
E. The state that has the most stable delta G value compared to the reactants and products.

8. Look at the graph of reaction rate versus substrate concentration for an enzyme.



In which region is the enzyme saturated with substrate?

9. Enzymes work by _____.

A. increasing the potential energy difference between reactant and product.
B. decreasing the potential energy difference between reactant and product.
C. decreasing the overall delta G of the reaction.
D. decreasing activation energy.
E. increasing the stability of the products.

10. A(n) _____ inhibitor has a structure similar to the substrate of an enzyme, where as a(n) _____ inhibitor does not need to have a structure similar to the substrate.

A. competitive; reversible
B. competitive; non-competitive
C. non-competitive; irreversible
D. reversible; irreversible
E. non-competitive; competitive

11. You have found that a particular protein binds to a specific sequence of bases in the DNA of a bacterial cell. There are six possible sequences for this binding site.

The sequences where it binds are:

Position	**1 2 3 4 5 6**
	T A G T C A
	A A G A C A
	T T A A G A
	T G T C A T
	C T G A A C
	T A A T C A
	T C G G C A
	T T T A C A

Which of the following is the consensus base in position 4?

A. A
B. G
C. C
D. T
E. There is no consensus.

12. A defect occurs during replication where DNA replication proceeds without the RNA primers being removed and replaced with DNA. Which enzyme is most likely to be defective in this system?

A. RNA primase
B. helicase
C. single strand binding protein
D. DNA polymerase
E. DNA ligase

13. When we say that DNA replication is semiconservative, we mean that:

A. only half of an organism's DNA is replicated during each cell division.
B. when DNA is replicated, each new double helix contains one parental strand and one newly synthesized daughter strand.
C. when DNA is replicated, one double helix contains both parental strands and one contains two newly synthesized daughter strands.
D. parental DNA stays in the parent cell and daughter DNA ends up in the daughter cell.
E. None of the answer options is correct.

14. The leading strand is the daughter strand that has its ___ end pointed toward the replication fork and is therefore synthesized _____.

A. 3'; in a series of segments
B. 3'; continuously
C. 5'; in a series of segments
D. 5'; continuously
E. 5'; away from the fork

15. One of the DNA replication proteins/enzymes is altered in a way that it results in an increased rate of mismatched bases in the newly synthesized DNA strand. Which function is most likely to be disrupted?

A. the unwinding function of helicase
B. the winding stress relief function of topoisomerase II
C. the fragment joining function of DNA ligase
D. the proofreading function of DNA polymerase
E. the strand separation function of single-stranded binding protein

16. The DNA sequence below (the template strand) is part of the coding region of a gene. What would be the sequence of amino acids for this portion of DNA (the reading frame is indicated by the vertical lines)? *Refer to the genetic code table in the textbook.*

3' – ACGA|TTC|TTT|GC - 5'

A. N - alanine - lysine - asparagine - arginine - C
B. N - cysteine - asparagine - valine - serine - C
C. N - Threonine - Isoleucine - leucine - cysteine - C
D. N - cysteine - C

E. More information is needed to answer this question.

17. In a bacterium, 14% of the DNA nucleotides were found to be Thymine. What proportions of the other bases would you expect to be present in this particular DNA?

A. 28% G, 28% C, 28% A
B. 36% G, 36% C, 14% A
C. 14% G, 58% C, 14% A
D. 58% G, 14% C, 28% A
E. Cannot be determined.

18. What determines where the *E. coli* RNA Pol initiates transcription?

A. The binding of the RNA Pol to the single unique origin of transcription downstream on the *E. coli* chromosome.
B. The binding of the sigma subunit to the consensus sequences upstream of the transcription start site.
C. The binding of the sigma subunit to the consensus sequences downstream of the transcription start site.
D. At the RNA stem loop that forms at a consensus sequence 5' of the transcription start site.
E. RNA Pol initiates transcription at the first AUG codon of each gene.

19. Given that there are 61 codons for the 20 amino acids, which of the following is good evidence for the wobble hypothesis?

A. The genetic code is a triplet.
B. There are three different termination codons but only one start codon.
C. The tRNAs are the main translators of protein synthesis.
D. Wobble controls the number of proteins translated from each mRNA.
E. The fewer than 60 different types of tRNA in a cell.

20. What is the function of aminoacyl-tRNA synthetases?

A. They catalyze the folding of the tRNA into a cloverleaf structure.
B. They catalyze the modification of the bases in tRNAs.
C. They catalyze the correct alignment of the mRNA codon with a tRNA anticodon.
D. They catalyze peptide-bond formation between two amino acids.
E. They catalyze the covalent attachment of an amino acid to the correct tRNA.

21. Which of the following describes what happens *during* peptide bond formation on the ribosome?

A. The amino acid attached to the tRNA in the P site is transferred to the amino acid attached to the tRNA in the E site.
B. The amino acid attached to the tRNA in the P site is transferred to the amino acid attached to the tRNA in the A site.
C. The amino acid attached to the tRNA in the p site is covalently linked to the amino acid attached to the tRNA in the E site.
D. The amino acid attached to the tRNA in the P site is covalently linked to the amino acid attached to the tRNA in the A site.

22. Which of the following statements about translation in bacteria are true?

1) Proteins called initiation factors contribute to the interaction between the RNA in ribosome small subunit and the ribosomal binding site on the mRNA.
2) Initiation factors mediate the interaction between the N-formylmethionine aminoacyl tRNA and the AUG codon on the mRNA.
3) During elongation, tRNAs enter at the A site, move to the P site, then exit from the E site.
4) The RNA in the ribosome catalyzes formation of peptide bonds.
5) A release factor ends protein synthesis by binding to the stop codon and preventing the ribosomes from moving on the mRNA anymore.

A. 1, 3 and 5.
B. 1, 3 and 4.
C. 2 and 4.
D. 2, 3 and 5.
E. 2, 3, 4 and 5.

23. Cells use a two-step process (transcription and translation) to synthesize proteins from the information carried in the DNA, instead of directly translating information in the DNA to proteins. Which of the following features result from the two-step process?

1) There are more places to control protein synthesis.
2) More proteins can be produced in a given time period.
3) Resolves the problem of the ribosomes being too large to interact with DNA.
4) DNA does not need to have the sequence for the ribosome binding sites (RBS).

A. 1 and 2.
B. 2 and 3.
C. 3 and 4.
D. 1, 2 and 3.
E. 2, 3 and 4.

24. Complete the following sentence.

An intron is _____; and an exon is _____.

A. RNA that is removed during the processing of an mRNA molecule and degraded in the nucleus; part of an intact, mature mRNA that leaves the nucleus.
B. a peptide sequence that is spliced out post-transcriptionally; a peptide sequence spliced out post-translationally.
C. part of a tRNA that binds to the codon during translation; part of mRNA that has the ORF.
D. RNA that is removed during the processing of an mRNA molecule and leaves the nucleus; part of an intact, mature mRNA that stays in the nucleus.
E. part of an rRNA that becomes part of the ribosomes; part of the mRNA that has the ORF.

25. Shown below is a portion of an mRNA stretch, starting at the start codon:

AUG GGG AGU AAA UUU

The DNA encoding this region would be correctly written as:

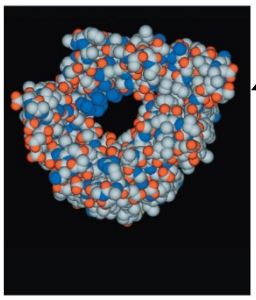
A. 3' ATGGGGAGTAAATTT 5'
5' TACCCCTCATTTAAA 3'

B. 5' ATGGGGAGTAAATTT 3'
3' TACCCCTCATTTAAA 5'

C. 5' TTTAAATGAGGGGAT 3'
3' AAATTTACTCCCCTA 5'

D. 3' TTTAAATGAGGGGAT 5'
5' AAATTTACTCCCCTA 3'

26. The picture below represents the tertiary structure of an outer membrane protein porin, from a Gram negative bacteria, that forms a water channel.



[Fig. 3.9 (b)]

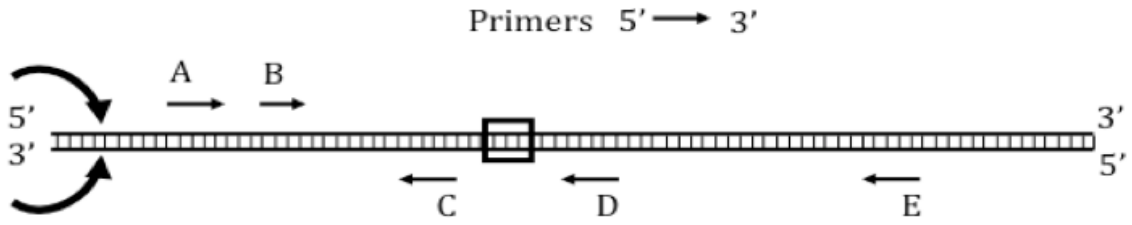
The R-groups of the amino acids lining the outer surface of the porin spanning the lipid bilayer and making contact with the lipid tails, are likely to be:

A. mainly charged R groups.
B. an equal mix of charged and uncharged R groups.
C. mainly polar R groups.
D. mainly non-polar R groups.

27. The R-groups of the amino acids lining the inner surface of the porin water channel (in the Q), are likely to be:

A. an equal mix of polar and non-polar R groups.
B. mainly polar R groups.
C. mainly non-polar R groups.

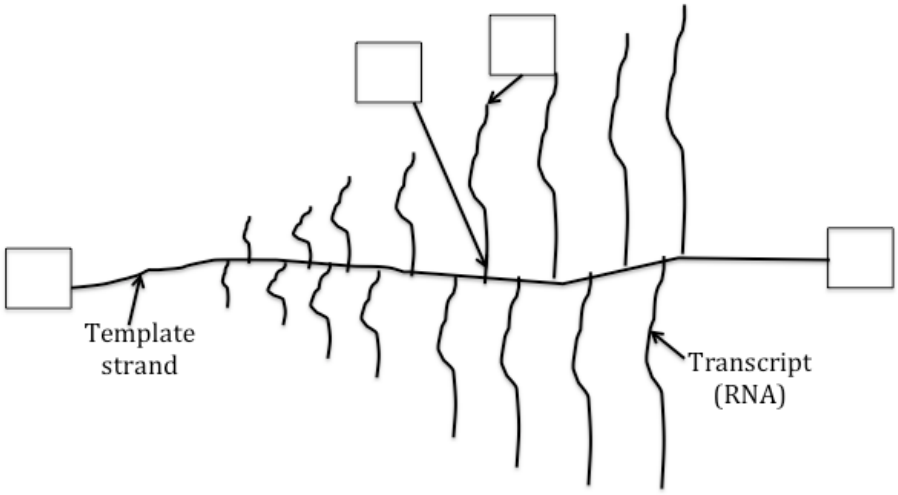
28.



In a PCR reaction, you want to amplify the region shown in the box above.
If you use primer B, adding which of the other primers will produce the smallest DNA product?

29. For the PCR reaction in Q 28 using primer B, adding which of the other primers will not produce an amplified product?

30. The cartoon below represents the process of transcription and translation as observed in an electron micrograph. On the diagram below indicate the directionality (5' or 3') in the boxes against the structure.



31. Lack of telomerase activity limits what?

a. the rate of DNA replication.
b. the number of replication bubbles that form during replication.
c. the number of times a cell can divide.
d. the number of Okazaki fragments that can be linked together.
e. the rate of meiosis.

32. The diagram below represents part of a genome of a bacterial cell. The light blue lines represent double stranded DNA. The boxed areas represent two different genes (gene 1, gene 2) that code for two different proteins. Recall in BIOL 112, a "gene" is defined as the DNA sequence from the promoter to the terminator.

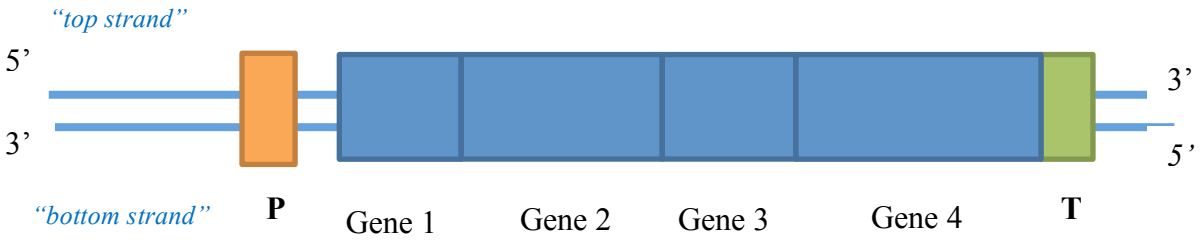
P_1 = promoter for gene 1
T_2= terminator for gene 2
"top strand" orientation: 5' –> 3' strand.
"bottom strand" refers to the 3' –> 5' strand.

For each statement, indicate true or false (T or F).

T or F	Statement
	The direction of transcription for both gene 1 and gene 2 is 3' –> 5'.
	The template strand for gene 2 is represented by the bottom strand.
	The +1 site (start of transcription) for gene 2 is downstream of its "T" (terminator).
	For gene 2, the top strand sequence is identical to its mRNA except T's will be U's.
	If the two genes above (gene 1, gene 2) were being transcribed simultaneously, the RNA polymerases would be moving towards each other (convergent).
	The coding strand for gene 1 is the top strand (5' –> 3')
	When considering the direction of transcription for gene 1, the promoter for gene 2 (P_2) is upstream from the promoter (P_1) for gene 1.
	The top strand will always be the coding strand for all genes in this bacterium.
	The -10 box of the promoter sequence for gene 1 will be located towards the 3' end of the bottom strand than towards its 5' end.
	The +1 site for gene 2 can be found upstream of T_2 considering direction of transcription for gene 2.
	Both genes would share a ribosomal binding site.
	The template strand for gene 1 is represented by the top strand.
	For both genes 1 and 2, movement of RNA polymerase depends the orientation of two different consequences sequences (-35 box and -10 box) on the promoter.

33. Operons: The diagram below represents an operon found on the genome of a bacterial cell. The light blue lines represent double stranded DNA. The boxed areas represent 4 different genes (gene 1, gene 2, gene 3 and gene 4) within an operon that code for four different proteins. In an operon, a set genes share a promoter and terminator. A single mRNA transcript is made by RNA polymerase, and there are 4 ribosomal binding sites (rbs) to translate 4 different polypeptides (1, 2, 3 and 4) which subsequently fold into protein 1, protein 2, protein 3 and protein 4.

P = promoter (orange)
T= terminator (green)
"top strand" refers to the 5' –> 3' strand.
"bottom strand" refers to the 3' –> 5' strand.

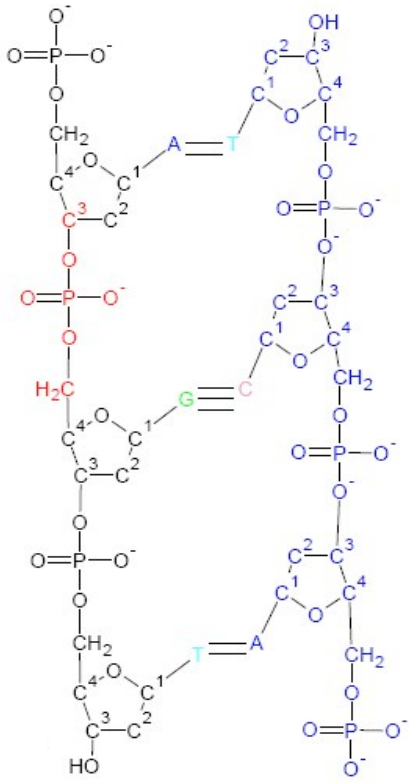


Considering the operon shown above, for each statement, indicate true or false (T or F).

T or F	Statement
	The template strand for this operon is 3'- 5' on the bottom strand.
	Each gene within the operon will have its own +1 site.
	Each gene within the operon will have its own start codon.
	The terminator sequence will stop translation for all 4 genes.
	There is only one ribosomal binding site for all 4 genes.
	The space between the promoter for this operon and gene 1 could account for a ribosomal binding site on the mRNA.
	Four different RNA polymerases are required to transcribe the operon.
	Translation of the genes further downstream (e.g. gene 3, gene 4) depends on the successful translation of the upstream genes (e.g. gene 1 and gene 2).
	All four genes can be translated simultaneously as each have their own ribosomal binding site.

Example Open response questions

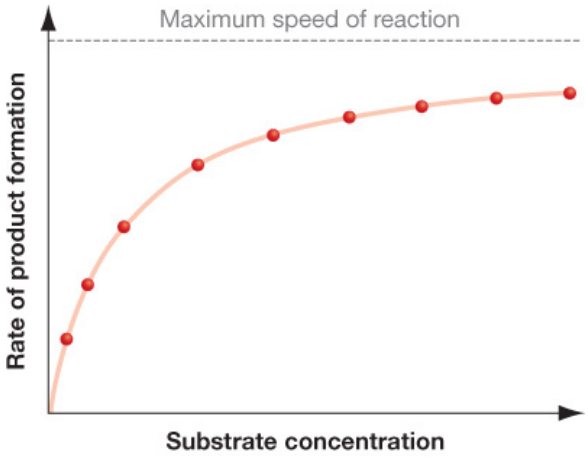
Q1a. Label the ends of the two strands of DNA below to indicate their directionality (2 points)



1b. Indicate where a new nucleotide would be added if either of these strands were to be extended further. (1 point)

Q2. If a given tRNA has an anticodon of 5'-ACU-3', what is the mRNA codon, what is the template strand DNA sequence, and which amino acid does it carry? (3points)

Q3. The graph below shows the typical (Michaelis-Menten) curve for enzyme-catalyzed reactions. Beyond a certain substrate concentration, the increase in the rate of the reaction is no longer linear, instead the reaction rate plateaus close to a maximum speed. This is referred to as the saturation kinetics of enzyme-catalyzed reactions. What is the reason for this saturation kinetics?



Q4. What effect does an enzyme have on (Fig 3.18 from textbook). (2 points)

a) the activation energy (Ea)

b) free energy (ΔG) of this system?

Q5. DNA replication of small circular molecules usually starts at a single origin of replication and proceeds bidirectionally (that is, with two replication forks proceeding in opposite directions from the origin of replication). How would the time required for replication be affected if replication of such a molecule were unidirectional rather than bidirectional?