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Chem 3511  
Exam 2

The exam starts on the next page. It has 15 questions, worth a total of 100 points. Please write legibly and don't assume that long answers are required if there is a lot of space left for your response. No calculators are allowed.

*A test-taking tip: go through the whole exam and do the easy questions first. Then tackle the ones you find to be more difficult. Good luck.*

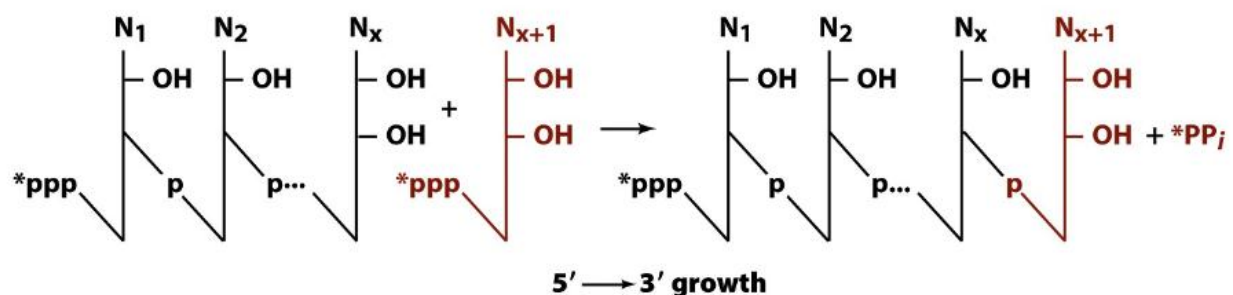
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1. (10 points) Draw the key step in the synthesis of RNA, in which a new nucleotide is added to an RNA string by RNA polymerase.

4pts: 3-Pi to 1-Pi

4pts: correct direction (5'→3')

2pts: chain extension



**3'-OH group acts as a nucleophile, attacking the α-phosphate group, with subsequent release of inorganic pyrophosphate**

2. (4 points) How does transcription termination occur?
- a) The RNA polymerase recognizes the stop codon TAA
  - b) The RNA polymerase recognizes the stop codon UAA
  - c) The RNA polymerase recognizes the termination sequence because the rRNA forms a hairpin
  - d) The RNA polymerase recognizes the termination sequence because the mRNA forms a hairpin**
  - e) The RNA polymerase recognizes the termination sequence because the tRNA forms an B-type double helix
3. (4 points) How does translation initiation occur?
- a) The RNA polymerase recognizes the -35 and -10 regions
  - b) The ribosome recognizes the -35 and -10 regions
  - c) The RNA polymerase recognizes the Shine-Dalgarno sequence
  - d) The ribosome recognizes the Shine-Dalgarno sequence**
  - e) The ribosome recognizes the stop codon UAA
4. (4 points) Which peptide contains one nonpolar amino acid?
- a) SYACTE**
  - b) KDRIZB
  - c) WRYSJQ
  - d) CNTSQK
  - e) ZJQATE

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5. (4 points) Why might a point mutation in DNA make a difference in the level of a protein's activity?

- a) It might change the N terminus of the polypeptide to the C terminus.
- b) **It might change an amino acid.**
- c) It might exchange one serine codon for a different serine codon.
- d) It might exchange one stop codon for another stop codon.
- e) It might result in a frame shift mutation.

6. (17 points) Peptides

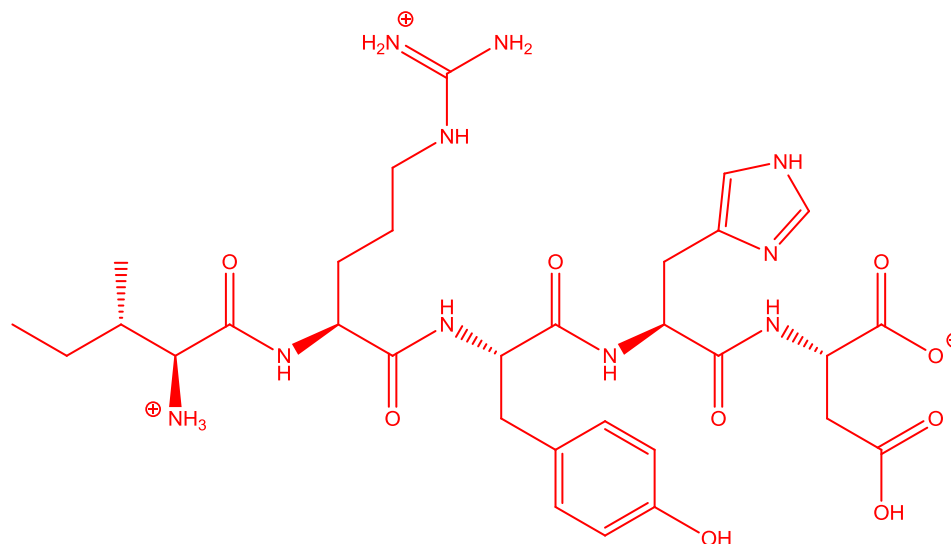
- a) Draw the polypeptide IRYHD in the form that it would be at pH=7.5 (12 points)
- b) Write the three letter code of the peptide IRYHD (5 points)

**1pts per correct side chain, 1 pts for correct charge (10pts total)**

**2pts for correct orientation of N to C termini**

	pK <sub>1</sub>	pK <sub>2</sub>	pK <sub>R</sub>
Amino acid	$\alpha$ -COOH	$\beta$ -NH <sub>2</sub>	R-group
I	2.3	9.8	
R	1.8	9.0	12.5
Y	2.2	9.2	10.5
H	1.8	9.3	6.0
D	2.0	9.9	3.9

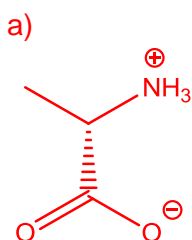
a)



c) **IleArgTyrHisAsp**

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7. (4 points) A mutant bacterial cell has a defective aminoacyl synthetase that attaches a lysine to tRNAs with the anticodon AAA instead of a phenylalanine. The consequence of this for the cell will be that:
- a) none of the proteins in the cell will contain phenylalanine.
  - b) proteins in the cell will include lysine instead of phenylalanine at amino acid positions specified by the codon UUU.
  - c) the cell will compensate for the defect by attaching phenylalanine to tRNAs with lysine-specifying anticodons.
  - d) the ribosome will skip a codon every time a UUU is encountered.
  - e) None of the above will occur; the cell will recognize the error and destroy the tRNA.
8. (4 points) Which linkage best describes the covalent bond between an amino acid (AA) and its cognate tRNA?
- a) amino group of AA linked to 5' -OH of tRNA
  - b) amino group of AA linked to 5' phosphate of tRNA
  - c) carboxyl group of AA linked to 3' -OH of tRNA
  - d) carboxyl group of AA linked to 3' phosphate of tRNA
  - e) none of the above
9. (9 points) Amino acids
- a) Draw the stereoisomer of Alanine as found in nature (3 points)  
(1.5 pts for correct R group, 1.5 for correct stereochemistry)
  - b) Draw the **R-group** of one hydrophobic amino acid, one charged amino acid and one polar amino acid at pH=7 (2 points per amino acid)



- c) The R-group of any hydrophobic, charged or polar amino acid

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**10. (4 points)** Approximately 1.6% of patients with cystic fibrosis have an amino acid mutation from Glu to Asp at position 551. The normal sequence is: GCAUGGAC....UGUGAGGGU... Which of the following sequences would constitute this amino acid mutation?

- a) **GCAUGGAC.....UGUGAUGGU...**
- b) GCAUGGAC.....UGUGAAGGU...
- c) GCAUGGAC.....UGUGGGGGU...
- d) GCAUGGAC.....UGUGUGGGU...
- e) GCAUGGAC.....UGUUAAGGU...

**11. (4 points)** While proteins are usually composed of linear chains of amino acids, internally cross-linked chains can be found in certain proteins. Polypeptide chains are most commonly cross-linked to each other through

- a) hydrogen bonds.
- b) glycosidic bonds.
- c) peptide bonds.
- d) **disulfide bonds.**
- e) ester linkages.

**12. ( 9 points)** Most amino acids have more than one triplet nucleotide codon assigned to them. For example, histidine is coded by both CAU and CAG. Isoleucine is coded by AUU, AUC, and AUA. Alanine is coded by CGA, CGC, CGU and CGG. Yet, there are only 32 tRNA's. How can one tRNA respond to more than one codon for the same amino acid?

Unusual nucleotide bases are incorporated into the third tRNA anticodon position to establish "wobble" base pairing with more than one nucleotide in the third codon position on the mRNA template strand. The codons for each amino acid all have the same first two bases (for specific Watson-Crick base-pairing), and the third has a wobble interaction to accommodate variability in that position. Inosine is a good example of a modified base with the power to hydrogen bond to more than one complementary base.

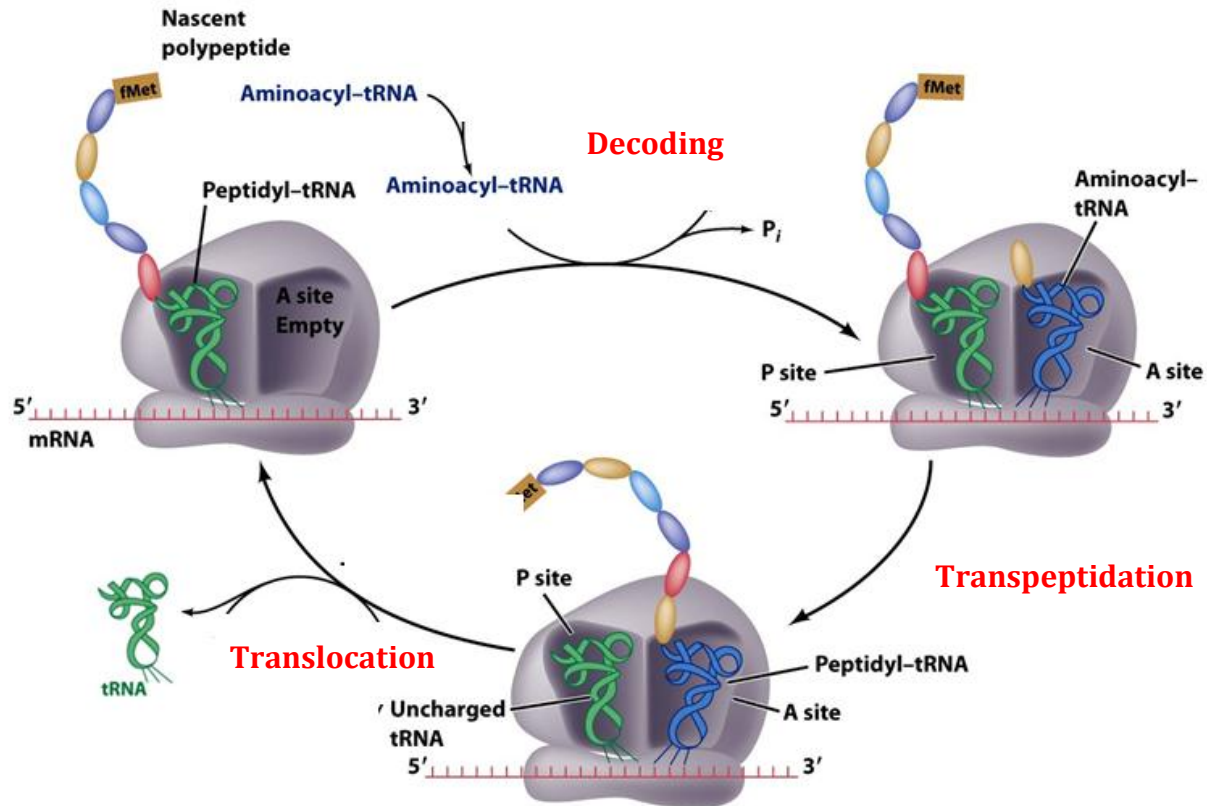
(See the section on the "wobble hypothesis" in your text.)

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**13. (12 points)** Below is a schematic of the ribosomal protein synthesis elongation process.

- Label the three key steps in the process (**3 points**)
- Explain briefly (**3 sentences max**) what happens in each of the steps (**9 points total, 3 points per step**)

a)



b)

**Decoding:** The anticodon region of the aminoacyl-tRNA recognizes the codon in the mRNA. Recognition of the mRNA codon by the tRNA takes place in the small ribosome subunit.

**Transpeptidation:** The free amino group of the aminoacyl-tRNA acts as a nucleophile and attacks the ketone group of the peptidyl-tRNA, making a peptide bond. This reaction results in the peptide chain being transferred from the peptidyl-tRNA to the aminoacyl-tRNA.

The peptidyl-tRNA is now an uncharged tRNA which the aminoacyl-tRNA is the new peptidyl-tRNA.

The transpeptidation reaction takes place in the large ribosome subunit.

**Translocation:** The uncharged tRNA (moves to the Exit site) and leaves the ribosome. The newly formed peptidyl-tRNA moves from the A site to the P site.

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14. (6 points) Consider these five tripeptides:

A) Tyrosine-Lysine-Methionine

B) Glycine-Proline-Arginine

C) Aspartate-Tryptophan-Tyrosine

D) Aspartate-Histidine-Glutamate

E) Leucine-Valine-Phenylalanine

Which is most negatively charged at pH 7?   **D**  

Which contains the largest number of nonpolar R groups?   **E**  

Which contains sulfur?   **A**  

15. (5 points) Non ribosomal peptides (NRPs) are made of amino acids using enzymes other than the ribosome to link the amino acids together. Below is the structure tyrosidine, an NRP that has antibacterial properties.

Identify the ten amino acids in tyrosidine by circling each amino acid and writing its **one letter** amino acid code.

