

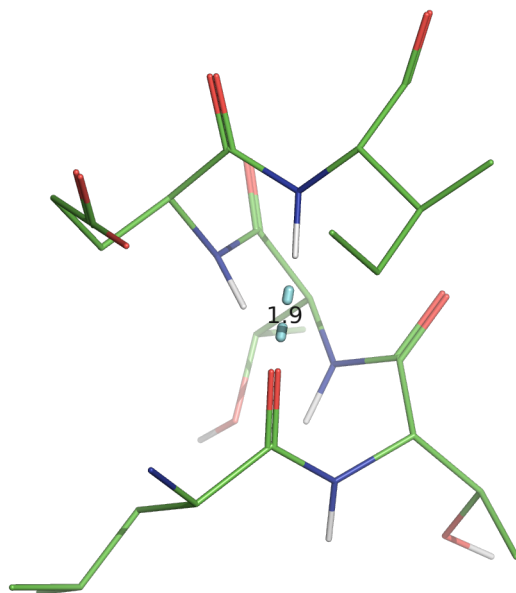
MDCM601 2022 Exam 3

Zarko V. Boskovic

October 17, 2022

1 Problems

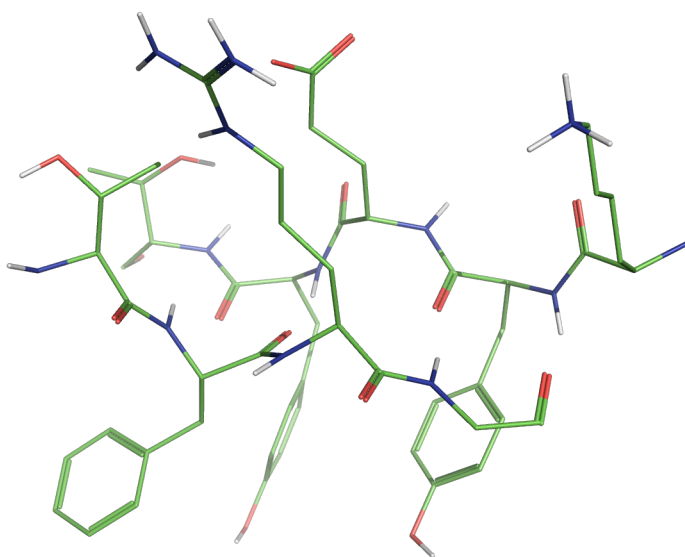
Problem 1. Segment of keratin protein is shown below (carbon, green; nitrogen, blue; oxygen, red; hydrogen, white). Answer the following questions about this structure.



1. Which amino acid is at the N-terminus?
2. Which amino acid is at the C-terminus?
3. Considering the peptide backbone, the amino end of which amino acid is hydrogen bonded (H-bond shown as a dashed cyan line) with the carbonyl of the amino acid at the N-terminus?
4. The length of this hydrogen bond is shown in Angstroms. What is its length in nanometers?

5. Is this segment a right-handed or a left-handed helix?
6. This segment contains several amino acid residues that have a β -stereocenter. Name these amino acids?
7. Name an amino acid in this segment whose sidechain is negatively charged at the physiological pH.
8. Helices are sometimes named by indicating how many amino acids are needed to make a full circle (3.6 for α -helix) followed by the number of all the backbone atoms that form the ring closed by the hydrogen bond (including the polar H). How big of a ring is formed through the drawn hydrogen bond?

Problem 2. Consider two strands of a β -sheet below and answer the following questions about this structure.

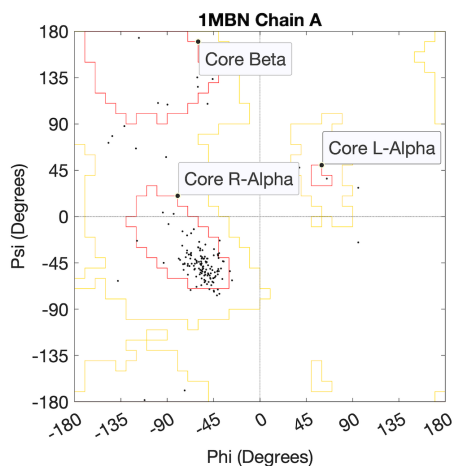


1. Are these strands parallel or antiparallel?
2. Which amino acid on the front chain is paired with the glutamate on the back chain?
3. The side chains in β -sheets are parallel or perpendicular to the plane of the sheet?
4. Is the lysine side chain protonated or deprotonated?
5. Name two different aromatic amino acids in this segment?

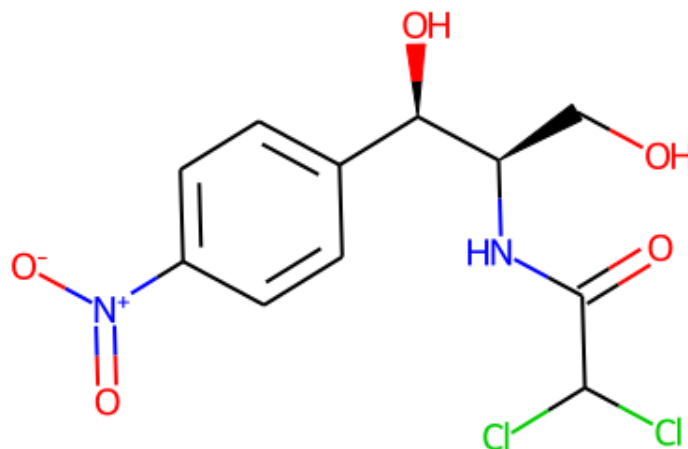
Problem 3. True or false?

Histidine is in its protonated form when it coordinates cationic metals in protein structures.

Problem 4. Use the Ramachandran plot of myoglobin below to determine which secondary structure is F43 found in. Values for its dihedral angles are: $\Phi = -99$ and $\Psi = 110$.



Problem 5. Structure of chloramphenicol is shown. It is a bacterial translation inhibitor. Answer the following question about its structure.



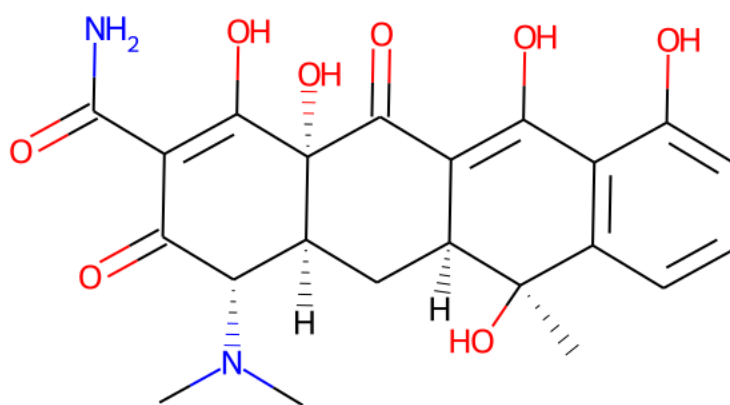
1. Carbon with the secondary alcohol is *R* or *S*?
2. Carbon with hydroxymethyl is *R* or *S*?

3. Which nucleophilic amino acid side chain can react and substitute one of the chlorides from the dichloroacetamide group?

Problem 6. What is the functional group through which amino acyl group is attached to the tRNA molecule?

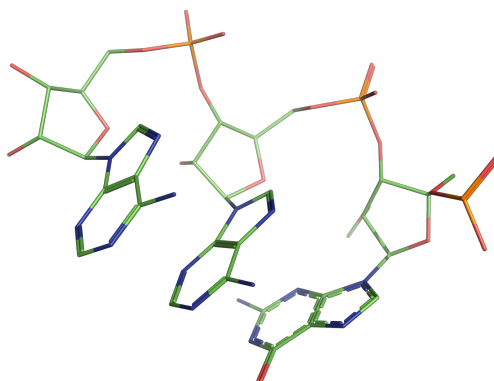
Problem 7. What is the functional group that is made when amino acid is activated in reaction with ATP?

Problem 8. Consider the structure of tetracycline below.



1. How many phenols are there?
2. How many enols?
3. How many tertiary alcohols?

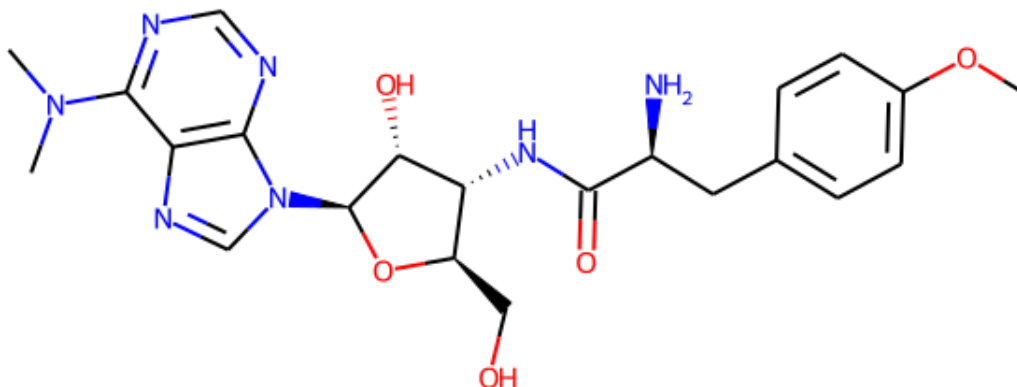
Problem 9. Consider the anticodon region of a tRNA molecule below.



		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G

1. Read off the nucleotide sequence in the 3' to 5' direction.
2. Translate this to a sequence on the mRNA.
3. What is the direction in which we read the mRNA sequence?
4. Use the codon chart to answer which amino acid does this tRNA carry?
5. Which nucleotide is it attached to?
6. Which atom in the tRNA is the amino acyl group attached to?
7. What is the non-covalent interaction between nucleotides that reinforces the parallel orientation of the bases?

Problem 10. Puromycin (structure shown) is very similar to the structure of amino acyl group attached to the adenine of the tRNA with one key difference.



1. What is the functional group in puromycin that is different from the attachment of an amino acyl to the tRNA?
2. Puromycin halts translation by covalently capturing the activated amino acyl tRNA bound to the ribosome. What is the nucleophilic group responsible for this capture?
3. Which amino acid is puromycin a methylated derivative of?

Problem 11. Calculate the average molecular weight of a nucleotide in tRNA if its molecular weight is 24976.7 Da and it contains 76 nucleotides.

Problem 12. Knowing that nucleotides in tRNA are often methylated, do you expect the average molecular weight of nucleotides in tRNA to be smaller or larger than the average molecular weight of a nucleotide calculated by knowing the molecular formula and how many nucleotides there are in a long stretch of DNA.

2 Solutions

1. Leu; Ile; Ile; 0.19; right; Ile, Thr; Glu; 13
2. anti-parallel; Arg; perpendicular; protonated; Tyr, Phe
3. False
4. β -sheet
5. *R*; *R*; Cys
6. ester
7. mixed anhydride
8. 1; 2; 2
9. AAG; UUC; 5' to 3'; Phe; A; O; H-bonds or π -stacking
10. amide; amine; Tyr
11. 328.6
12. larger