

Princeton High School



Protein Modeling 19-20 Captains' Tryouts

Written by John Yang

Score: ___ / 359

Names:

Part 1: Amino Acids

In which direction are proteins synthesized? (4 pts)

What term describes the flexibility of the third base pair in tRNA anticodon binding? (4 pts)

What charge is arginine at a pH of 12.3 according to the pKa table below? (18 pts)

	Amino Acid	pKa Value		
	Name	Alpha Carboxy	+Alpha Amino	Side Chain
Non-Polar Amino Acids	Glycine	2.34	9.60	
	Alanine	2.34	9.69	
	Valine	2.32	9.62	
	Leucine	2.36	9.60	
	Isoleucine	2.36	9.68	
	Methionine	2.28	9.21	
	Phenylalanine	1.83	9.13	
	Tryptophan	2.38	9.39	
	Proline	1.99	10.60	
Polar Amino Acids	Serine	2.21	9.15	
	Threonine	2.63	9.10	
	Cysteine	1.71	10.78	8.33
	Tyrosine	2.2	9.11	10.07
	Asparagine	2.02	8.84	
	Glutamine	2.17	9.13	
Acidic Amino Acids	Aspartic Acid	2.09	9.82	3.86
	Glutamic Acid	2.19	9.67	4.25
Basic Amino acids	Lysine	2.18	8.95	10.79
	Arginine	2.17	9.04	12.48
	Histidine	1.82	9.17	6.04

©Leah4sci.com

Amino Acid Tutorials + Cheat Sheet Leah4sci.com/AminoAcids

What is the term for the pH at which the alpha amino group and the alpha carbon group is charged? What chemical term describes an amino acid at this pH? (12 pts)

What stereoisomeric form are biological amino acids commonly in? (8 pts)

What type of acid is glycine? (think titration) (6 pts)

What are proteins that have permanently attached chemical groups other than amino acids called? What is this attached chemical group called? (8 pts)

What amino acids are helix-breakers? (4 pts)

What special amino acid is present in collagen? What vitamin is important for collagen synthesis? (6 pts)

Part 2: Protein Chemistry

If I wanted to separate two proteins different in size but both hydrophobic, which type of chromatography would I use and which protein would elute first, the smaller or the larger? (18 pts)

During protein purification, low salt concentrations increase the solubility of proteins but high salt concentrations cause elution. Give the term for these effects and describe why it occurs. (30 pts)

What does sodium dodecyl sulfate (SDS) do and how does it work? (5 pts)

What two properties does 2D-electrophoresis use to separate proteins? (8 pts)

Describe the purpose and procedure of Edman degradation. (18 pts)

What three amino acids are in the catalytic triad? (6 pts)

What character does the peptide bond have and why? (10 pts)

Part 3: Protein Folding

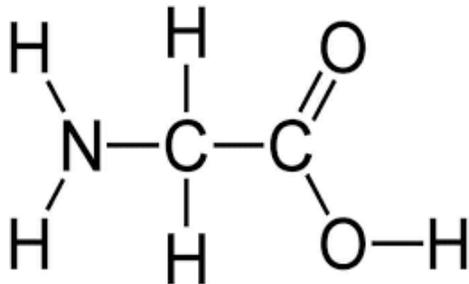
What is the primary thermodynamic force driving protein folding? (3 pts)

What are two simple rules exhibited in protein folding patterns? (8 pts)

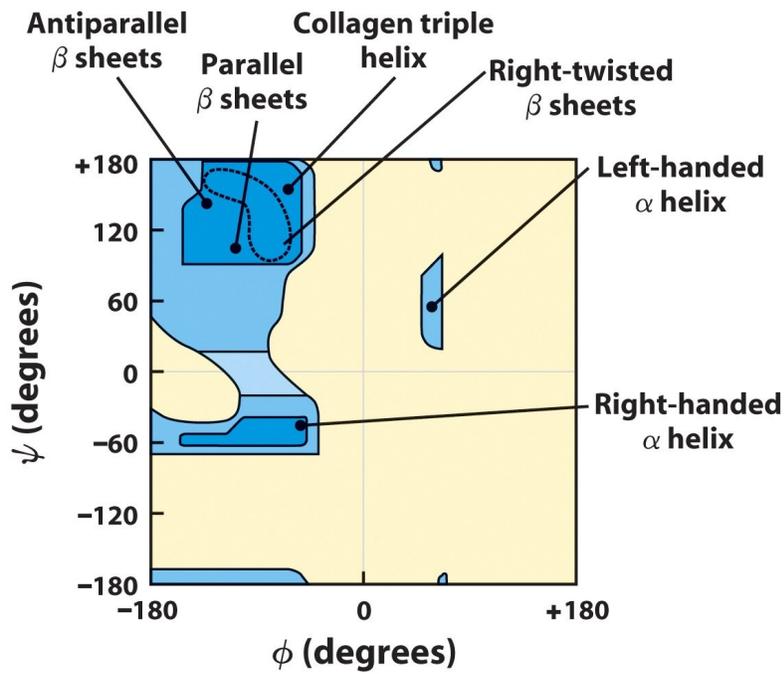
What is the common handedness of the alpha helix? (6 pts)

Give an example of another type of alpha helix, denoting its $i + x$ hydrogen bonding. (4 pts)

Identify phi and psi on the amino acid below: (6 pts)



What is the name of the below graph? What is its purpose? (8 pts)



How many amino acids apart are positively and negatively charged residues or two aromatic residues? (6 pts)

Name the five different kinds of constraints on the stability of an α -helix. (15 pts)

What type of protein is keratin? (4 pts)

What was the first protein to have its structure determined by X-ray crystallography? (5 pts)

Describe how NMR spectroscopy works and how it can be used to determine protein structure: (12 pts)

Describe what a molten globule is. (4 pts)

What enzyme catalyzes the formation of disulfide bonds in the ER? (4 pts)

Part 4: CRISPR-Cas9

What does CRISPR stand for? (8 pts)

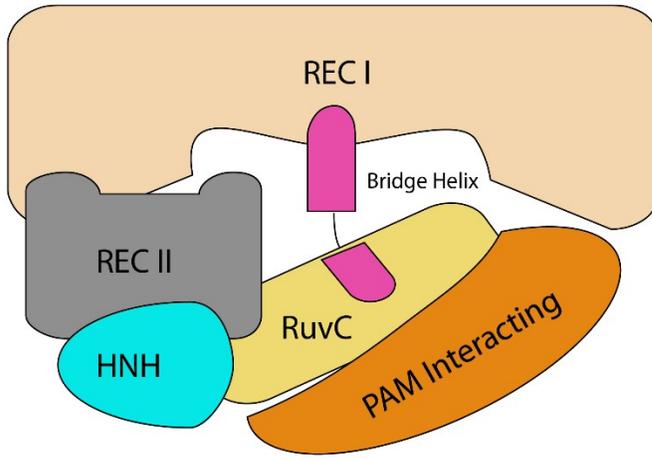
What is the original purpose of CRISPR in bacteria? (4 pts)

What does CRISPR induce in the genomic DNA? (6 pts)

What two types of repair can CRISPR perform and what are they important for? (6 pts)

What does PAM stand for? (2 pts)

Identify the functions of each domain: (20 pts)

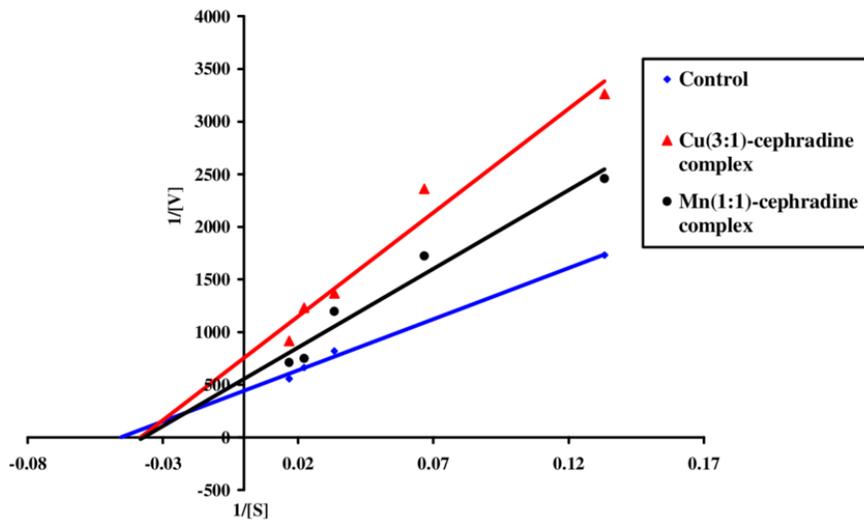


What type of DNA sequence are the repeats? (hint it's in the name) What structure does the spacer form that is important for recognition by Cas1 and Cas2? (6 pts)

Part 5: Biochemistry

What (infamous) equation describes the relationship between V_{max} , K_m , and substrate concentration? (5 pts)

According to the Lineweaver-Burk Plot below, what is the K_m and V_{max} of “Control”? (12 pts)



Derive the Michaelis-Menten Equation starting from $v_0 = k_{\text{cat}}[\text{ES}]$ (36 pts):