

Biochemistry 5700
Fall, 2007
Exam 2
October 24, 2007

INSTRUCTIONS:

Do not begin until 10:30 AM. The exam must be turned in by 11:20 AM. This exam should have 16 questions and 8 pages. Answer **all** questions completely, concisely, and legibly in the spaces provided. Good Luck!!

Are you keeping up on current events?? If so, answer this question while waiting to take the exam:

What famous scientist discussed in the last section of the course was recently suspended from his position at Cold Spring Harbor Laboratory and forced to cancel a series of upcoming lectures and appearances for making some very controversial comments?

ANSWER:

(1) 15 points Pot pourri of definitions.

When relatively high concentrations of fatty acids are placed in water they form structures known as _____	<u>micelles</u>
When relatively high concentrations of glycerophospholipids are placed in water they form structures known as _____.	<u>liposomes</u>
Name a carbohydrate that is achiral	<u>dihydroxyacetone</u>
Linear sugars that are structurally identical except for the orientation of the hydroxyl and hydrogen at one position are called what?	<u>epimers</u>
The compound resulting from the nucleophilic addition of an alcohol to a ketone is called a _____	<u>hemiketal</u>
Name the unbranched form of starch	<u>α-amylose</u>
What molecule is a membrane plasticizer?	<u>cholesterol</u>
Which nitrogenous base is present in RNA but not DNA?	<u>uracil</u>
Which hexopyranose sugar contains all bulky groups in equatorial positions?	<u>β-D-glucopyranose</u>
What vitamin is associated with regulating calcium uptake for bone formation?	<u>D</u>
What conformation does double stranded RNA form in solution?	<u>A</u>
Soap is formed from the hydrolysis of what type of lipid?	<u>triacylglycerol (fat)</u>
What is the name of the family of derivatized polysaccharides that associate with proteins in the extracellular matrix of animal cell tissue	<u>glycosaminoglycans</u>
What specific two types of sugar linkages are found in glycogen?	<u>α1,4-glc + α1,6-glc</u>
What is the repeating sugar unit and linkage in peptidoglycan?	<u>β(1,4) NAM-NAG</u> <u>N-acetyl</u> <u>N-acetylmuramic acid</u> <u>glucosamine</u>

(2) 5 points What type of functional groups will be present at the indicated position of the following lipids?

(a) on C2 of glycerol in a triacylglycerol

ester

(b) on C3 of glycerol in phosphatidylcholine

phosphodiester

(c) on C1 of sphingosine in sphingomyelin

phosphodiester

(d) on C2 of glycerol in a glycerophospholipid

ester

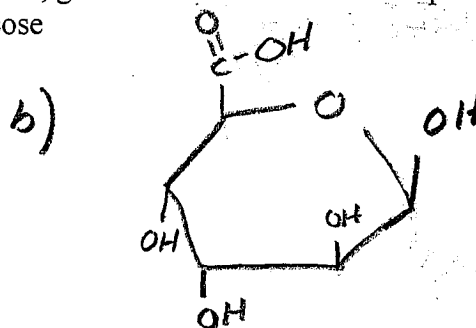
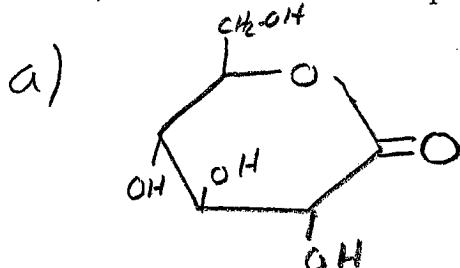
(e) on C2 of sphingosine in sphingomyelin

amide

(3) 6 points Draw the Haworth projections (ring-cyclized forms) of the compounds formed from

(a) two-electron oxidation of α -D-glucopyranose at C1

(b) four-electron oxidation of β -D-altropyranose at C6, given that D-altrose is a C3 epimer of D-mannose, and D-mannose is a C2 epimer of D-glucose



(4) (4 points) Predict whether the formation of the following O-glycosidic linkages between two sugars would result in the production of a reducing or nonreducing disaccharide

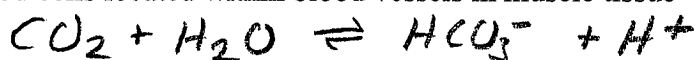
Linkage	Reducing or nonreducing?
C1 of D-glucose and C1 of D-glucose	<u>nonreducing</u>
C1 of D-glucose and C4 of D-glucose	<u>reducing</u>
C1 of D-glucose and C1 of D-fructose	<u>reducing</u>
C1 of D-glucose and C2 of D-fructose	<u>nonreducing</u>

(5) 5 points. The glycosylation of the following amino acid side chains would form what specific organic functional groups (e.g. ester, thioester, thioether, N-ether, amide, ester, O-ether)?

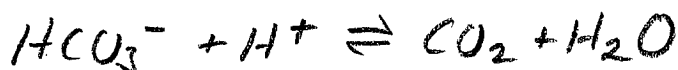
Amino acid	Organic functional group created
cysteine	thioether (S-ether)
serine	O-ether (ether)
lysine	N-ether
asparagine	amide
glutamate	ester

(6) (6 points) Write the balanced chemical reaction catalyzed by carbonic anhydrase in the direction it will occur predominantly:

(a) in red blood cells located within blood vessels in muscle tissue



(b) in red blood cells located within blood vessels in the lung



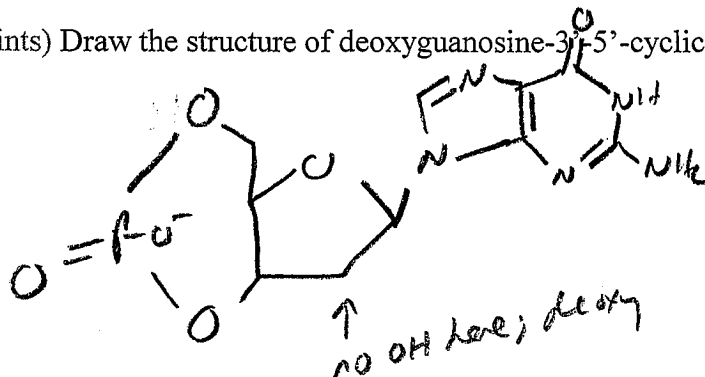
(c) In one or two sentences, what is the role of zinc in carbonic anhydrase?

bind substrate water, lowering pKa of water so it can serve as nucleophile to attack CO_2

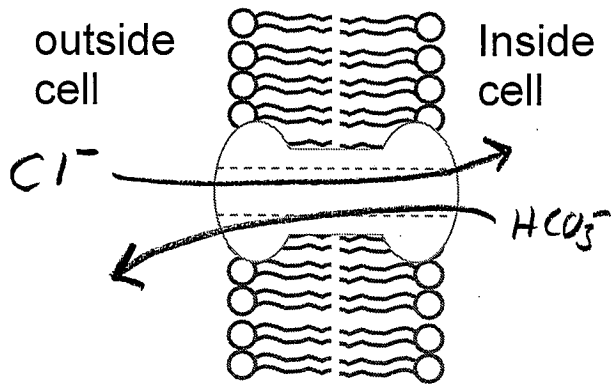
(7) 8 points. Complete the information in the table below for the indicated transporters

Transporter	passive or active	Uniport, synport or antiport
$\text{Na}^+ \text{K}^+$ ATPase	active	antiport
Bacteriorhodopsin	active	uniport
Lactose permease	passive	synport
Glucose permease	passive	uniport

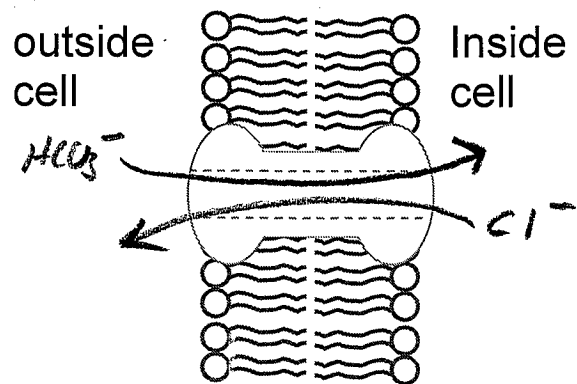
(8) (4 points) Draw the structure of deoxyguanosine-3',5'-cyclic-monophosphate



(9) (4 points) On the figures below, diagram the molecules transported, indicating in which direction transported, for the chloride-bicarbonate exchanger

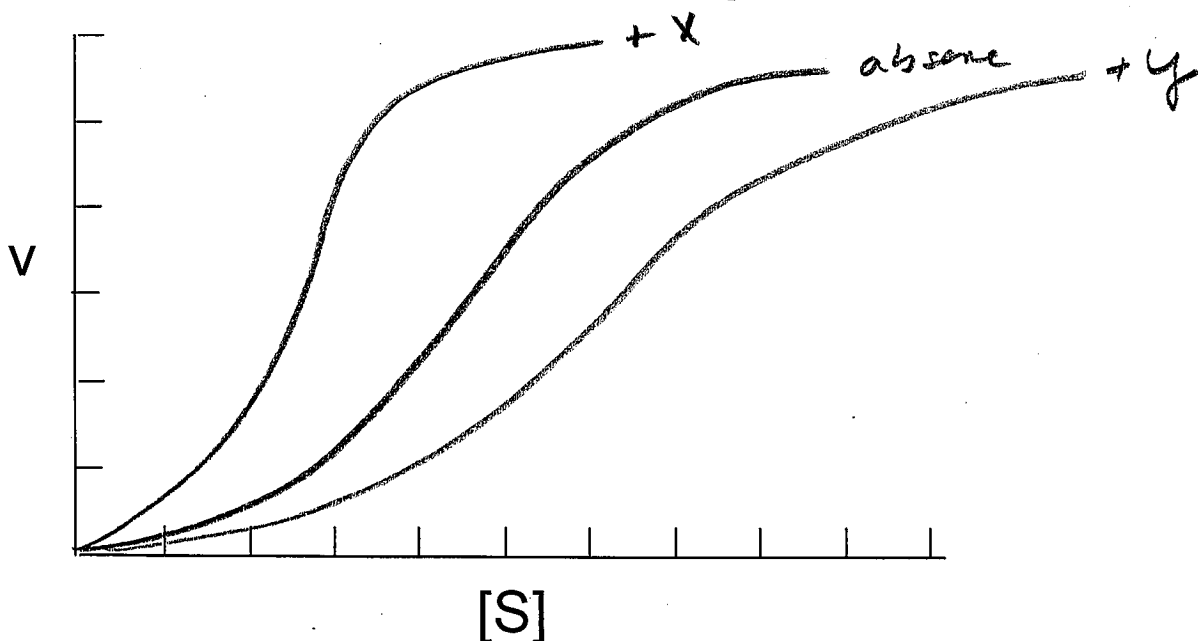


(a) In erythrocyte
in blood vessels
in muscle tissue



(b) In erythrocyte
in blood vessels
in the lung

(10) 4 points. You have a multimeric allosteric enzyme for which molecule "X" is a positive heterotropic modulator and molecule "Y" is a negative heterotropic modulator. Both modulators perturb $K_{1/2}$ but not V_{max} . Draw and label the plots that would be observed for the enzyme in the absence of modulator, in the presence of "X", and in the presence of "Y".



(11) (3 points) Briefly explain the difference between "feedback inhibition" and "product inhibition".

Feedback - end product of a metabolic pathway inhibits an enzyme early in the pathway (inhibitor not product of enzyme)

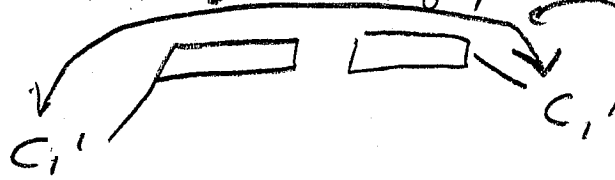
product - immediate product of an enzyme-catalyzed reaction inhibits that enzyme (acts on same enzyme)

(12) 8 points. Briefly define the following terms as they relate to DNA structure:

(a) major groove

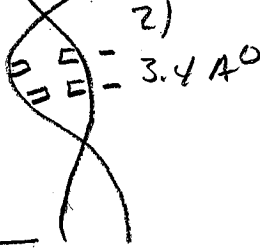
the side of DNA formed by the larger angle connecting the C_1' carbons of paired bases & the helix axis

Structures OK in explaining



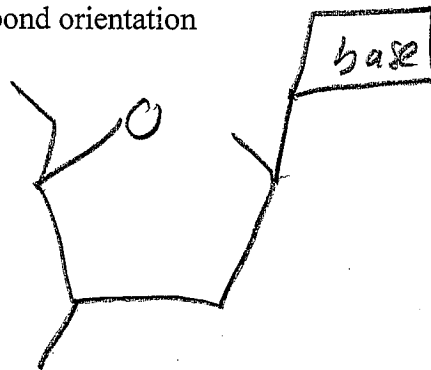
(b) two periodicities

1) 360° for one complete turn of helix axis



Base pair - base pair distance between adjacent base pairs in helix = 3.4 Å

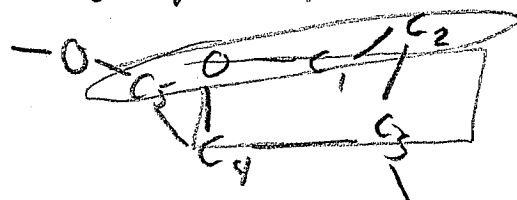
(c) glycosidic bond orientation



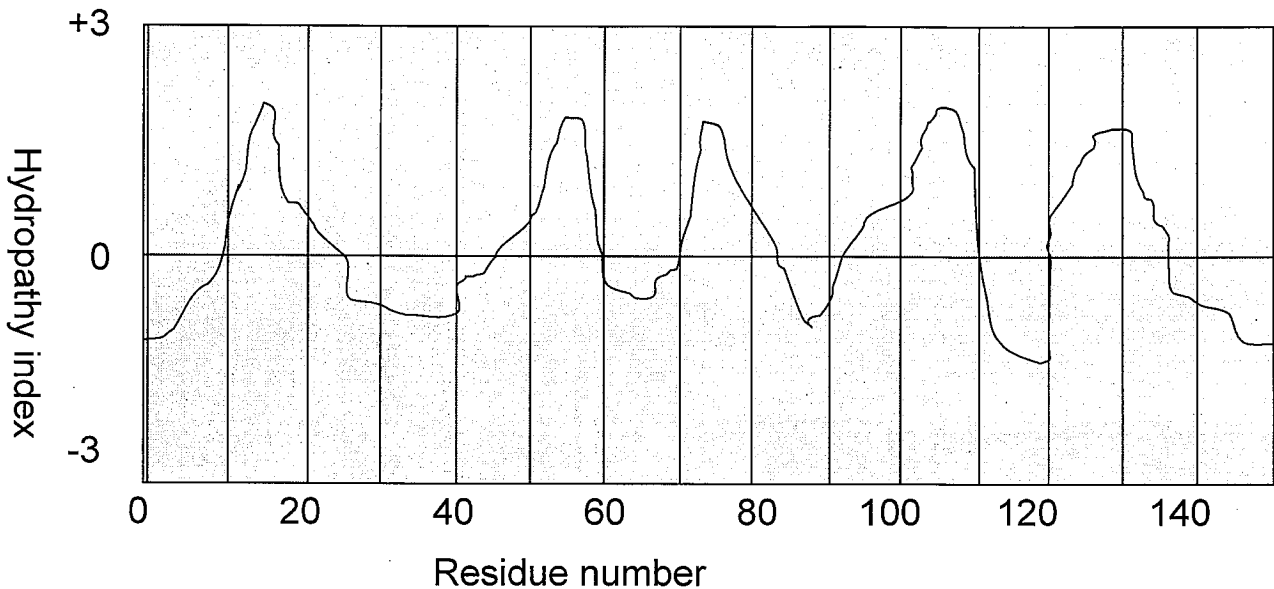
Orientation about the sugar / base at glycosidic bond, anti in B-DNA with base pointing away from the sugar

(d) sugar pucker

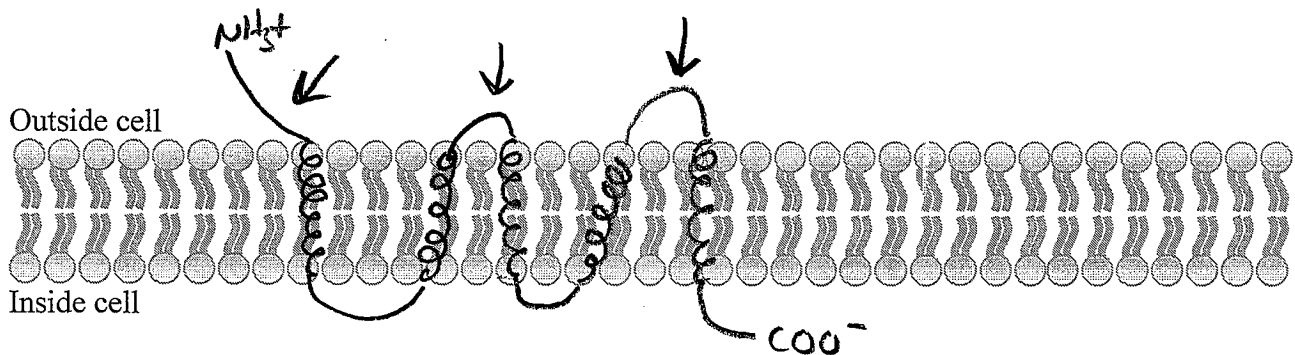
1 of 4 C atoms of sugar ring in deoxyribose is out of plane of remaining atoms. in DNA, it is C_2' endo: C_2 is out of plane, on same side as C_5



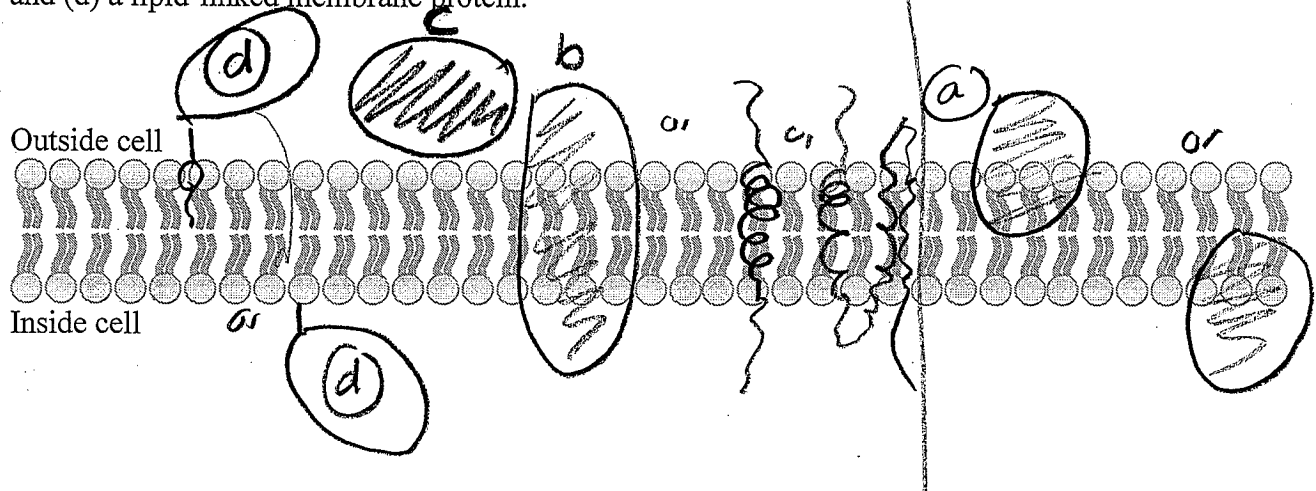
(13) Shown below is the hydropathy plot for a membrane protein. The N-terminus of the enzyme is known to be outside the cell.



(a) (6 pts) Diagram your protein on the lipid bilayer template provided below. Clearly indicate the N- and C-terminus of your protein on the diagram and clearly show each transmembrane spanning domain and the loops connecting them. With arrows, indicate portion(s) of your polypeptide that might be glycosylated.



(b) (4 pts) On the lipid bilayer template shown below, draw examples of (a) an asymmetrically oriented integral membrane protein, (b) a transmembrane protein, (c) a peripheral membrane protein and (d) a lipid-linked membrane protein.

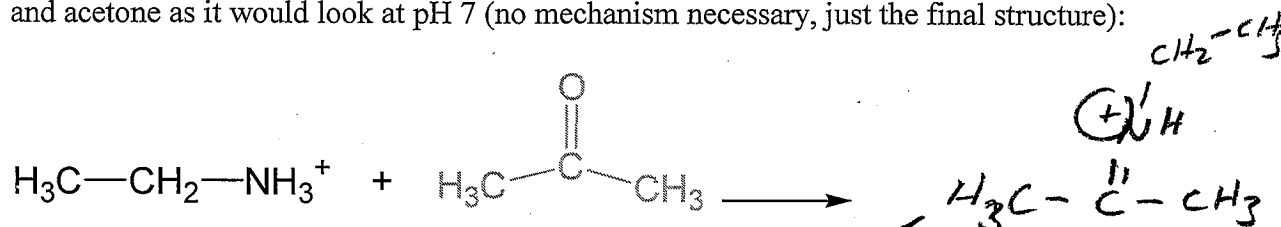


(14) (3 points). For metal ion catalysis in general, what is the difference between charge shielding and charge stabilization?

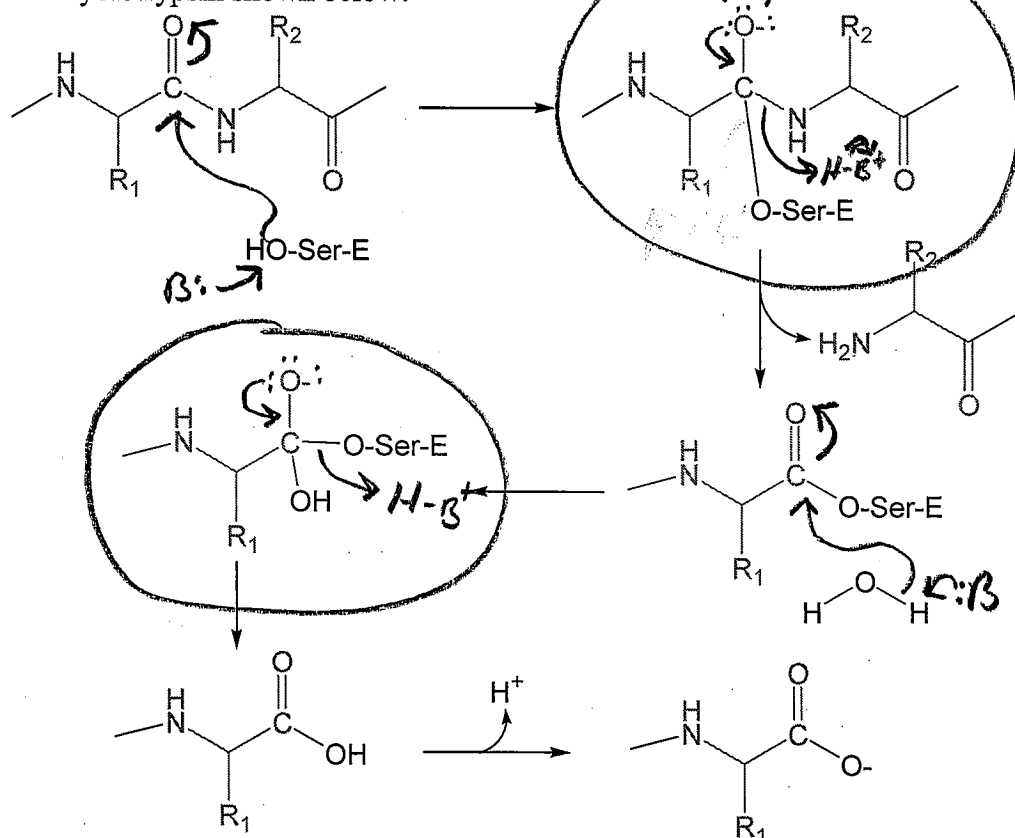
Shielding - the metal ion shields charges on a substrate molecule

stabilization - the metal ion stabilizes charges on a reaction intermediate or transition state

(15) (3 points). Draw the structure of the Schiff Base adduct formed by the reaction of ethylamine and acetone as it would look at pH 7 (no mechanism necessary, just the final structure):



(16) Consider the mechanistic scheme for chymotrypsin shown below:



(a) (6 points) add all necessary electron pushing arrows and general acids/bases (abbreviate bases as "B" and acids as "HB⁺") required to complete the mechanism.

(b) (4 points) Circle any species that would be stabilized by the "oxyanion hole" of the enzyme. For one of these, add a drawing showing the features of the oxyanion hole and how it stabilizes the species.

(c) (2 points) The identity of which of the following: R1 or R2 (circle one) is important in substrate specificity for chymotrypsin. What specific amino acid residues would be located at this position?

phe, Tyr, Trp
 F Y W