

Exam #1 INFORMATION THAT MAY BE USEFUL FOR THE EXAM

Abbreviations for Amino Acids				Ionizable Group	pKa
Amino Acid	3-Letter Abbreviation	Amino Acid	3-Letter Abbreviation		
Alanine	Ala	Leucine	Leu	α -COOH of any aa	2
Arginine	Arg	Lysine	Lys	β -COOH of Asp	4
Asparagine	Asn	Methionine	Met	γ -COOH of Glu	4
Aspartic Acid	Asp	Phenylalanine	Phe	imidazole of His	6
Cysteine	Cys	Proline	Pro	SH of Cys	8
Glutamine	Gln	Serine	Ser	α -NH ₂ of any aa	9
Glutamic Acid	Glu	Threonine	Thr	phenolic OH of Tyr	10
Glycine	Gly	Tryptophan	Trp	ϵ -NH ₂ of Lys	10
Histidine	His	Tyrosine	Tyr	guanidino of Arg	12
Isoleucine	Ile	Valine	Val		

Tables of Logarithmic Relationships

Number	Decimal									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1.	.00	.04	.08	.11	.15	.18	.20	.23	.26	.28
2.	.30	.32	.34	.36	.38	.40	.41	.43	.45	.46
3.	.48	.49	.51	.52	.53	.54	.56	.57	.58	.59
4.	.60	.61	.62	.63	.64	.65	.66	.67	.68	.69
5.	.70	.71	.72	.72	.73	.74	.75	.76	.76	.77
6.	.78	.79	.79	.80	.81	.81	.82	.83	.83	.84
7.	.85	.85	.86	.86	.87	.88	.88	.89	.89	.90
8.	.90	.91	.91	.92	.92	.93	.93	.94	.94	.95
9.	.95	.96	.96	.97	.97	.98	.98	.99	.99	1.00
10.	1.00									

E.g. $\log 3.5 = 0.54$

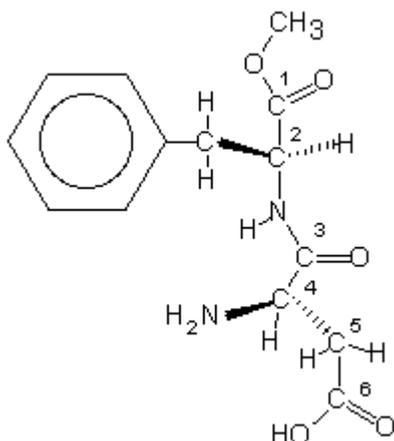
Reminder: How to form logs of multiples

$$\log 35 = \log (3.5 \times 10^1) = (\log 3.5 + \log 10^1) = (0.54 + 1) = 1.54$$

$$\log 350 = \log (3.5 \times 10^2) = (\log 3.5 + \log 10^2) = (0.54 + 2) = 2.54$$

$$\log 0.35 = \log (3.5 \times 10^{-1}) = (\log 3.5 + \log 10^{-1}) = (0.54 - 1) = -0.46$$

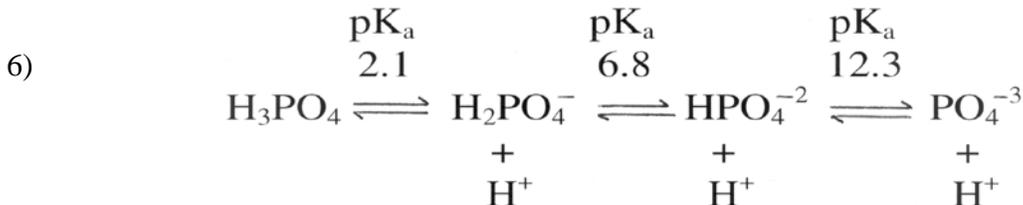
Questions 1-3: The structure of the sweetener Aspartame, consisting of a methyl ester of a dipeptide, is shown below. Some of the carbon atoms in the molecule are numbered, 1 through 6. Use this structure and the numbering system to answer questions 1 - 3.



- Which numbered carbon is directly linked in a peptide bond?
 - 1
 - 2
 - 3
 - 4
 - 5
- This molecule, containing naturally occurring amino acids, is in which optical configuration?
 - D, D
 - D, L
 - L, D
 - L, L
- At pH 3 (common pH of soda) what would be the charge of this molecule?
 - +2
 - +1
 - 0
 - 1
 - 2
- Which of the following statements about protein structure is correct?
 - The α -helix is stabilized primarily by ionic interactions between the side chains of amino acids.
 - The formation of the disulfide bond in a protein requires that the two participating cysteine residues be adjacent to each other in the primary sequence of the protein.
 - The stability of quaternary structure in proteins is mainly due to covalent bonds among the subunits.
 - The denaturation of proteins always leads to irreversible loss of secondary and tertiary structure.
 - The information for the correct folding of a protein is contained in the specific sequence of amino acids along the polypeptide chain.

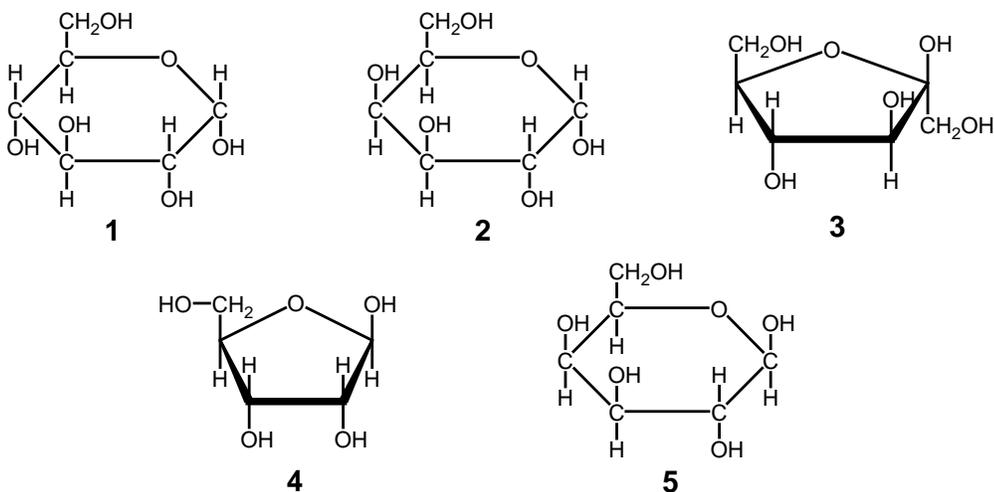
5) Which of the following best illustrates hydrophobic forces that stabilize the conformation of some proteins?

- A) clustering of nonpolar amino acid side chains in the interior of globular proteins.
- B) heat denaturation of globular proteins.
- C) the unfolding of proteins at low pH.
- D) the formation of α -helices.
- E) the formation of β -pleated sheets.



As shown above, phosphoric acid has three ionizable protons, with the pK_a values indicated. The buffering capacity of phosphoric acid is **LEAST** at pH:

- A) 2.1
- B) 4.6
- C) 6.8
- D) 7.4
- E) 12.3

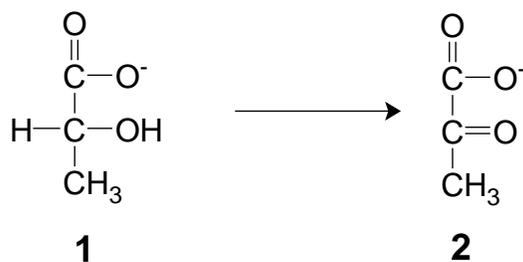


7) Which of the above molecules are anomers?

- A) molecules 1 and 2
- B) molecules 2 and 5
- C) molecules 1 and 5
- D) molecules 3 and 4
- E) molecules 1 and 4

8) Which of the above molecules is a component of ribonucleotides?

- A) molecule 1
- B) molecule 2
- C) molecule 3
- D) molecule 4
- E) molecule 5



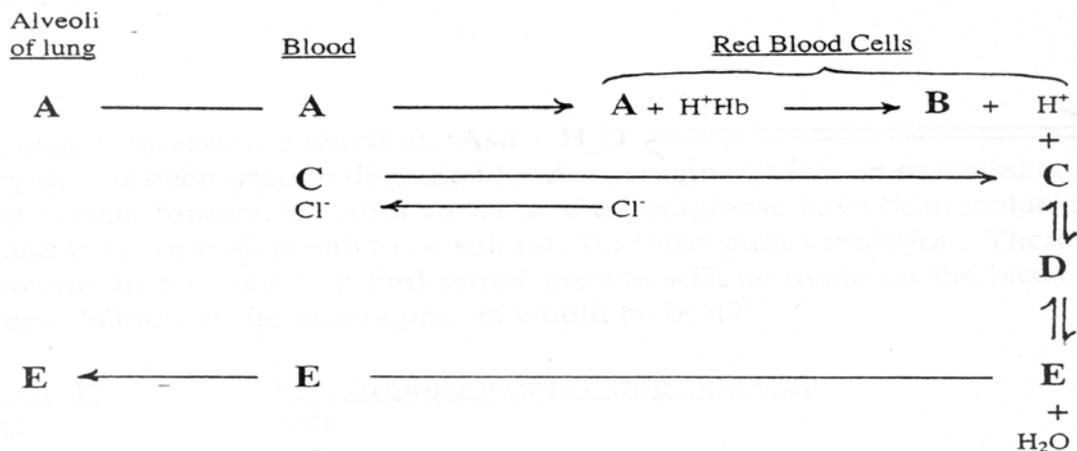
9) In the reaction drawn above, what has happened to molecule 1 to convert it to molecule 2?

- A) Phosphorylation
- B) Oxidation
- C) Isomerization
- D) Dehydration
- E) Reduction

10) For the reaction drawn above, what type of enzyme would carry out this reaction?

- A) Epimerase
- B) Isomerase
- C) Hydrolase
- D) Kinase
- E) Dehydrogenase

Questions 11-14 refer to the diagram below. Identify the letters A - E in the diagram with chemical names. Then, match the chemical name in each question with the appropriate letter.



- 11) Carbon dioxide
- 12) Bicarbonate
- 13) Oxygenated hemoglobin
- 14) Carbonic acid

- 15) The differences between hemoglobin and myoglobin include
- A) hemoglobin is a tetramer whereas myoglobin is a monomer.
 - B) hemoglobin exhibits a sigmoidal O₂ saturation curve while myoglobin exhibits a hyperbolic curve.
 - C) hemoglobin exhibits O₂ binding cooperativity while myoglobin does not.
 - D) hemoglobin exhibits a lower degree of O₂ saturation at all physiologically relevant partial pressures of O₂ than does myoglobin.
 - E) all of the above
- 16) What effect does alkalemia due to hyperventilation have on the oxygen binding affinity of hemoglobin?
- A) P₅₀ and oxygen affinity decrease.
 - B) P₅₀ and oxygen affinity increase.
 - C) P₅₀ decreases and oxygen affinity increases.
 - D) P₅₀ increases and oxygen affinity decreases.
 - E) P₅₀ and oxygen affinity remain the same.
- 17) A common practice of competitive short-distance runners is to breathe rapidly and deeply for about half a minute before running in a 100-meter dash. The purpose of this hyperventilation is to achieve:
- A) Metabolic Acidosis
 - B) Metabolic Alkalosis
 - C) Respiratory Acidosis
 - D) Respiratory Alkalosis
 - E) Acid-base Normalcy
- 18) A 27-year old male is rushed into the emergency room in a coma and experiencing respiratory depression. Data from the clinical biochemistry lab are compared with normal values below. Additional case history indicates the patient is suffering from a narcotic overdose. What is the immediate cause for the low pH value of the blood?

	<u>Patient</u>	<u>Normal</u>
pH	7.1	7.4
Total CO ₂ content	26.4	26 mM
pCO ₂	?	40 mm Hg
[HCO ₃ ⁻]	?	24 mM

(For calculations, use 6.1 for the pK_a of bicarbonate buffer and 0.03 mM/mm Hg for the solubility coefficient of CO₂ at 37 °C.)

- A) The narcotic overdose affected the kidney's ability to adjust to an increased [HCO₃⁻].
- B) The narcotic overdose affected the kidney's ability to adjust to a decreased [CO₂ (d)].
- C) The narcotic overdose led to a decreased respiratory rate, which in turn led to an increase in [CO₂ (d)].
- D) The narcotic overdose led to an increased respiratory rate, which in turn led to a decrease in [CO₂ (d)].
- E) Utilizing the value of total CO₂ content and the Henderson-Hasselbalch equation, one can conclude that there is an increase in [HCO₃⁻].

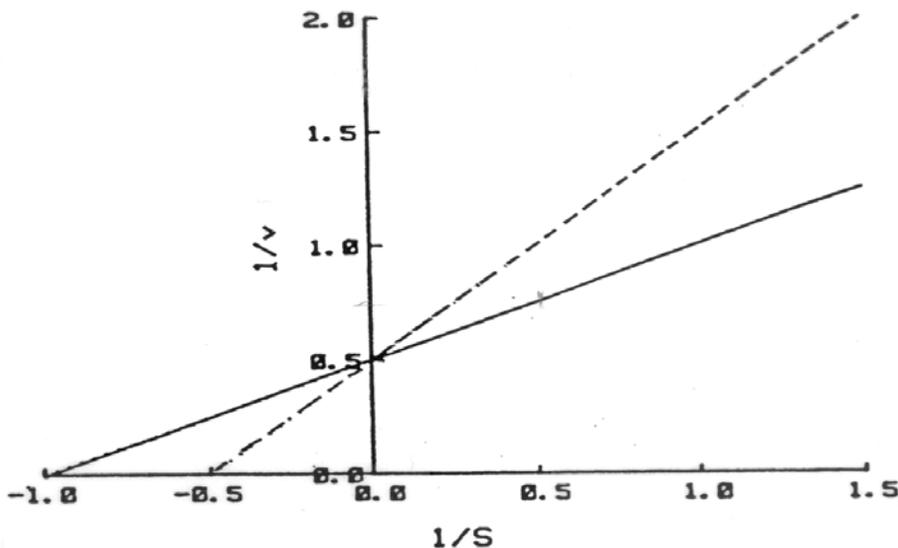
19) Repeated laboratory results over the past three weeks suggest that your patient suffers from acidemia. In the most recent visit, blood tests yielded the following results (normal values in parenthesis):

pH = 7.34 (7.4)
pCO₂ = 60 mm Hg (40 mm Hg)
[HCO₃⁻] = 31 mM (24 mM)

The problem is most likely due to:

- A) hyperventilation due to hypoxia
 - B) vomiting and nasogastric suction
 - C) chronic respiratory center depression and central hypoventilation
 - D) diabetic ketoacidosis
 - E) none of the above
- 20) A substrate S can be degraded by two different isozymes (#1 and #2), both obeying Michaelis-Menten kinetics. The K_m for isozyme #1 is 0.1 mM and the corresponding value for isozyme #2 is 10 mM. Both isozymes have the same V_{max}. If [S] = 5 mM, which of the following statements is correct?
- A) Isozyme #1 will degrade S faster than isozyme #2.
 - B) Isozyme #2 will degrade S faster than isozyme #1.
 - C) Isozyme #1 will degrade S at a rate equal to half of its maximal velocity.
 - D) Isozyme #2 will degrade S at a rate equal to half of its maximal velocity.
 - E) Isozyme #2 will degrade S at its maximal velocity.

In the figure below, the solid line shows the dependence of the rate of an enzyme catalyzed reaction v (μmol/min) as a function of the substrate concentration [S] (mM). Also shown (dotted line) is the dependence of the rate on substrate concentration in the presence of an inhibitor (at a concentration of 2 mM). **Questions 21-23 refer to this figure.**



21) Regarding the activity of the enzyme in the absence of the inhibitor (solid line), which of the following conclusions is correct?

- A) The V_{\max} of the enzyme is $0.5 \mu\text{mol}/\text{min}$.
- B) The K_m of the enzyme is 2 mM .
- C) When $[S] = 2 \text{ mM}$, $v = 2 \mu\text{mol}/\text{min}$.
- D) $V_{\max}/K_m = 0.5 \mu\text{mol}/\text{min} (\text{mM})^{-1}$
- E) When $[S] = 1 \text{ mM}$, $v = 1 \mu\text{mol}/\text{min}$.

22) In the presence of the inhibitor (dotted line), the K_m' (apparent K_m) of the enzyme, in units of mM , is:

- A) 0.25
- B) 0.5
- C) 1.0
- D) 2.0
- E) 4.0

23) On the basis of the graphs shown above, which of the following statements correctly describes the nature of the inhibitor/inhibition?

- A) The inhibitor is competitive.
- B) The inhibitor is non-competitive.
- C) The inhibitor acts as a positive effector.
- D) The inhibitor is likely to bind to a site distinct from the active site of the enzyme.
- E) The inhibitor is likely to act as an allosteric effector.

24) All of the following statements about allosteric enzymes are true **except**:

- A) allosteric enzymes usually contain more than one subunit
- B) allosteric enzymes display Michaelis-Menten kinetics
- C) allosteric enzymes are often subject to feedback inhibition
- D) allosteric enzymes are often regulated by ligands binding to sites different than the active sites
- E) allosteric effectors can act to either increase or decrease affinity for substrate at the active sites

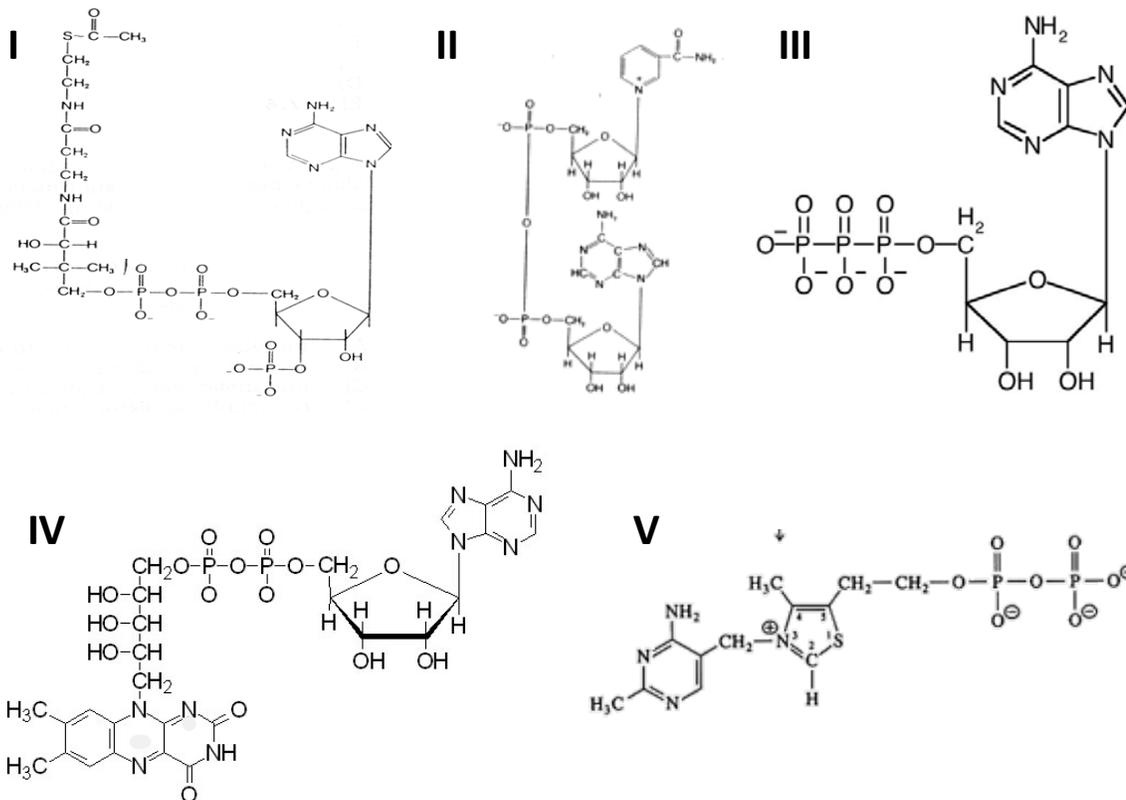
25) Using the table to the right, what would be the classification of a medical student who weighs 130 lbs and is 5'10"?

$$\text{BMI} = (\text{weight in lbs} \times 704) / (\text{Height in inches})^2$$

- A) Underweight
- B) Normal
- C) Overweight
- D) Obese

Classification	BMI
Underweight:	below 18.5
Normal:	18.5 - 24.9
Overweight:	25 - 29.9
Obese:	above 30

Questions 26 -28 refer to the following five structures (I – V)



26) Which of the structures is not a B vitamin?

- A) I
- B) II
- C) III
- D) IV
- E) V

27) Which of the above structures depicts a coenzyme derivative performing its role as a carrier of carbon chains?

- A) I
- B) II
- C) III
- D) IV
- E) V

28) A patient is brought into the clinic and has been diagnosed with suffering from a severe deficiency of the vitamin that gives rise to the coenzyme derivative depicted in V. What symptoms would you expect to see in this patient?

- A) Pernicious anemia
- B) Scaly dermatitis and glossitis of the tongue
- C) Pellagra presented as dermatitis, diarrhea, and dementia
- D) Scurvy presented as loss of teeth and bleeding gums and mucus tissues
- E) Beri Beri presented as cardiovascular abnormalities, muscle weakness, and mental confusion

29) Which of the following statements regarding catabolic and anabolic processes is **true**?

- A) Anabolic processes create ATP
- B) Muscle contraction and ion transport are types of anabolic processes
- C) Carbohydrates and proteins are broken down in anabolic processes
- D) Catabolism is considered the utilization phase of the energy cycle
- E) Absorption, breakdown, and oxidation are the three phases of anabolic processes

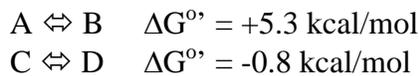
30) What is the ΔG° of the reaction:



If the equilibrium concentrations are $[\text{ATP}] = 10 \text{ M}$, $[\text{Pi}] = 0.1 \text{ M}$, $[\text{ADP}] = 10 \text{ M}$ and given that $\Delta G' = \Delta G^{\circ} + 1.4 \log[\text{products}]/[\text{reactants}]$

- A) -1.4 kcal/mol
- B) -2.8 kcal/mol
- C) +2.8 kcal/mol
- D) -0.14 kcal/mol
- E) +1.4 kcal/mol

31) Consider the following reactions:



If a single enzyme is capable of coupling the two reactions what would the free energy change ($\Delta G'$) of the reaction: $\text{A} + \text{C} \rightleftharpoons \text{B} + \text{D}$ be if $[\text{A}] = 1.0 \text{ M}$, $[\text{B}] = 0.1 \text{ M}$, $[\text{C}] = 10 \text{ M}$ and $[\text{D}] = 0.1 \text{ M}$
 $\Delta G' = \Delta G^{\circ} + 1.4 \log[\text{products}]/[\text{reactants}]$

- A) +0.3 kcal/mol
- B) -1.7 kcal/mol
- C) +1.7 kcal/mol
- D) +8.7 kcal/mol
- E) +1.1 kcal/mol

32) All of the following statements about metabolism are correct **except**?

- A) Insulin, glucagon, and epinephrine play central roles in metabolic control
- B) Your basic metabolic rate (BMR) is dependent upon your age and gender
- C) Your kidneys are the primary organ of metabolism
- D) Acetyl CoA is produced from the breakdown of carbohydrates, fats, and protein
- E) Daily energy expenditures are comprised of BMR, physical activity, and diet-induced thermogenesis

END OF EXAMINATION

Tear off this sheet and save to check your answers.

Please remember to:

- Write the letter corresponding to your **FORM** in the appropriate place on the **answer sheet**.
- SIGN AND RETURN YOUR EXAMINATION** to an instructor **before leaving the exam room.**

FORM: A

- | | | | |
|-----------|-----------|-----------|-----------|
| 1. _____ | 11. _____ | 21. _____ | 31. _____ |
| 2. _____ | 12. _____ | 22. _____ | 32. _____ |
| 3. _____ | 13. _____ | 23. _____ | |
| 4. _____ | 14. _____ | 24. _____ | |
| 5. _____ | 15. _____ | 25. _____ | |
| 6. _____ | 16. _____ | 26. _____ | |
| 7. _____ | 17. _____ | 27. _____ | |
| 8. _____ | 18. _____ | 28. _____ | |
| 9. _____ | 19. _____ | 29. _____ | |
| 10. _____ | 20. _____ | 30. _____ | |