Exam #1 BMB 514 – Medical Biochemistry 9/17/10

STEP 1 - NAME (*Print clearly*) _____ _____
(first) *(last)*

Circle your college and campus:
301 --- CHM-EL
302 --- CHM-GR
303 --- COM-EL
304 --- COM-DMC
305 --- COM-MUC

STEP 2 – Fill in your answer sheet with a #2 scoring pencil, as follows:

- ☑ Print your first and last name on the line provided
- ☑ Code in your Student Number (PID)
- ☑ Your section is already coded on your scantron.
- ☑ Code in the correct FORM ..... This is Form **A**
- ☑ Sign your name in the signature box. By signing the answer sheet for this exam, the student certifies that he/she has adhered to the policies of academic honesty in the performance of this exam.

STEP 3 - Read these instructions:

- ☑ Page 2 of this exam contains information that may be useful to you: (a) abbreviations for the amino acids; (b) pKa values of functional groups; and (c) table of logarithms.
- ☑ A simple calculator is supplied for your use during this exam. No other electronic or computational devices are to be used. Turn off cell phones; keep them out of sight.
- ☑ The proctors have the authority/responsibility to assign any student a different seat at any time, without implication and without explanation, before or during the examination, as they deem necessary. Accomplish any relocation quietly and without discussion.
- ☑ Make sure your exam has 32 questions.
- ☑ We will not answer questions of clarification. However, if you think there is an error on your exam, summon an exam proctor.
- ☑ Read each question very carefully. Choose the single, best answer and mark this answer on your answer sheet. No points will be added for correct answers which appear on the exam page but not on the answer sheet.
- ☑ When you finish, carefully follow the instructions at the end of the exam. When you leave the exam room, please turn in your answer sheet AND your exam to the proctors standing by the doors INSIDE the auditorium. Once you exit the auditorium, please leave the building. Hallway conversations disturb those still taking the exam.
- ☑ There will be answer keys to this exam posted on the course website by 5:00 p.m. the day of the exam. You may wish to copy your responses from your answer sheet onto the answer grid on the LAST page of this exam so that you can check your results. You can tear off the last page and take it with you.
- ☑ You have 70 minutes to complete this exam. No additional time will be allowed for transfer of answers from the exam to the answer sheet. We will close the exam promptly at 9:10 a.m. Once we withdraw the boxes for the answer sheets from the doors, no additional answer sheets will be accepted.

STEP 4 – Wait until instructed to proceed with the exam!

INFORMATION THAT MAY BE USEFUL FOR THE EXAM

Abbreviations for Amino Acids			
Amino Acid	3-Letter Abbreviation	Amino Acid	3-Letter Abbreviation
Alanine	Ala	Leucine	Leu
Arginine	Arg	Lysine	Lys
Asparagine	Asn	Methionine	Met
Aspartic Acid	Asp	Phenylalanine	Phe
Cysteine	Cys	Proline	Pro
Glutamine	Gln	Serine	Ser
Glutamic Acid	Glu	Threonine	Thr
Glycine	Gly	Tryptophan	Trp
Histidine	His	Tyrosine	Tyr
Isoleucine	Ile	Valine	Val

Ionizable Group	pKa
α-COOH of any aa	2
β-COOH of Asp	4
γ-COOH of Glu	4
imidazole of His	6
SH of Cys	8
α-NH_2 of any aa	9
phenolic OH of Tyr	10
ϵ-NH_2 of Lys	10
guanidino of Arg	12

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					logs				

E.g. log 3.5 = 0.54

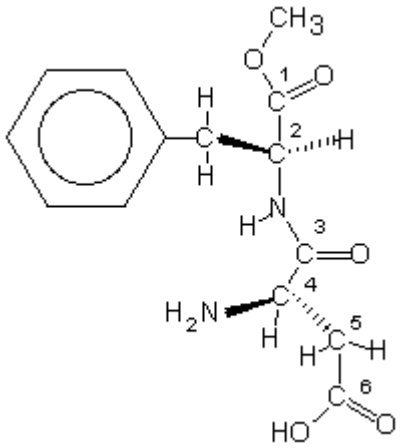
Reminder: How to form logs of multiples .....

log 35 = log (3.5×10^1) = (log 3.5 + log 10^1) = (0.54 + 1) = 1.54

log 350 = log (3.5×10^2) = (log 3.5 + log 10^2) = (0.54 + 2) = 2.54

log 0.35 = log (3.5×10^{-1}) = (log 3.5 + log 10^{-1})= (0.54 - 1) = - 0.46

<u>Questions 1-3</u>: The structure of the sweentener 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.



1) Which numbered carbon is directly linked in a peptide bond?
   A) 1
   B) 2
   C) 3
   D) 4
   E) 5

2) This molecule, containing naturally occurring amino acids, is in which optical configuration?
   A) D, D
   B) D, L
   C) L, D
   D) L, L

3) At pH 3 (common pH of soda) what would be the charge of this molecule?
   A) +2
   B) +1
   C) 0
   D) -1
   E) -2

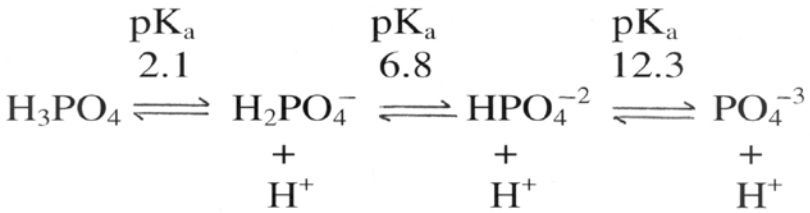
4) Which of the following statements about protein structure is correct?

   A) The α-helix is stabilized primarily by ionic interactions between the side chains of amino acids.
   B) 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.
   C) The stability of quaternary structure in proteins is mainly due to covalent bonds among the subunits.
   D) The denaturation of proteins always leads to irreversible loss of secondary and tertiary structure.
   E) 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?

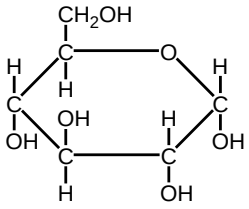
A) clustering of nonpolar amino acid side chains in the interior of globular proteins.
B) heat denaturation of globular proteins.
C) the unfolding of proteins at low pH.
D) the formation of α-helices.
E) the formation of β-pleated sheets.

6)

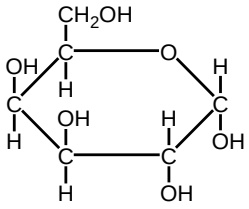


As shown above, phosphoric acid has three ionizable protons, with the pK_a values indicated. The buffering capacity of phosphoric acid is **LEAST** at pH:

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



1



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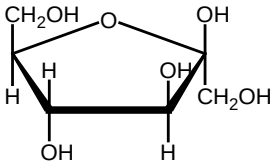

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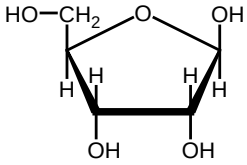

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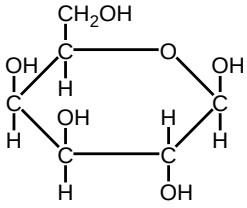


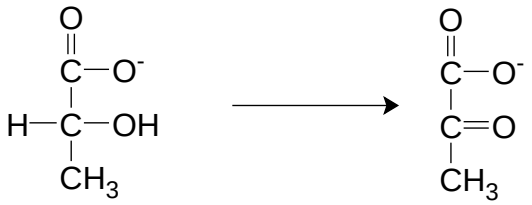
5

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



1 **2**

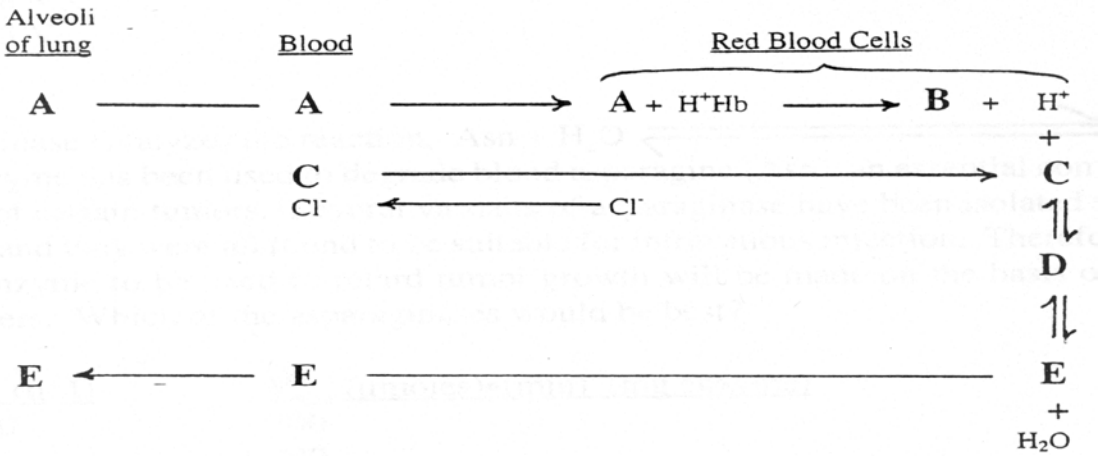
9) In the reaction drawn above, what has happened to molecule 1 to convert it to molecule 2?

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 O_2 saturation curve while myoglobin exhibits a hyperbolic curve.
C) hemoglobin exhibits O_2 binding cooperativity while myoglobin does not.
D) hemoglobin exhibits a lower degree of O_2 saturation at all physiologically relevant partial pressures of O_2 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) P_{50} and oxygen affinity decrease.
B) P_{50} and oxygen affinity increase.
C) P_{50} decreases and oxygen affinity increases.
D) P_{50} increases and oxygen affinity decreases.
E) P_{50} 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?

	Patient	**Normal**
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 CO_2 at 37 ^oC.)

A) The narcotic overdose affected the kidney's ability to adjust to an increased $[HCO_3^-]$.
B) The narcotic overdose affected the kidney's ability to adjust to a decreased $[CO_2$ (d)].
C) The narcotic overdose led to a decreased respiratory rate, which in turn led to an increase in $[CO_2$ (d)].
D) The narcotic overdose led to an increased respiratory rate, which in turn led to a decrease in $[CO_2$ (d)].
E) Utilizing the value of total CO_2 content and the Henderson-Hasselbalch equation, one can conclude that there is an increase in $[HCO_3^-]$.

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)
pCO_2 = 60 mm Hg	(40 mm Hg)
$[HCO_3^-]$ = 31 mM	(24 mM)

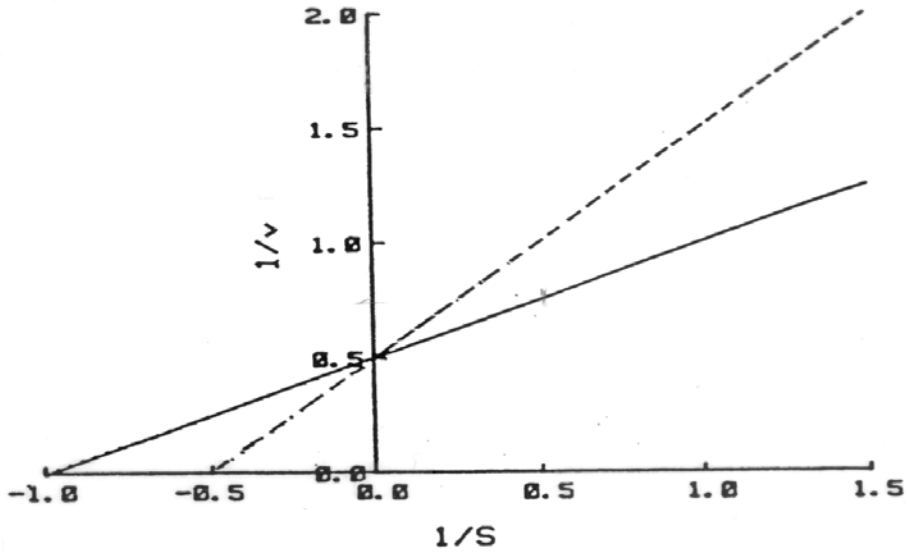
The problem is most likely due to:

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 μmol/min.
B) The K_m of the enzyme is 2 mM.
C) When [S] = 2 mM, v = 2 μmol/min.
D) V_{max}/K_m = 0.5 μmol/min $(mM)^{-1}$
E) When [S] = 1 mM, v = 1 μmol/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 <u>allosteric</u> 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"?

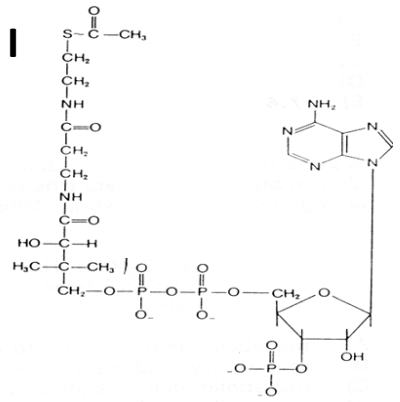
BMI = (weight in lbs x 704)/(Height in inches)^2

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

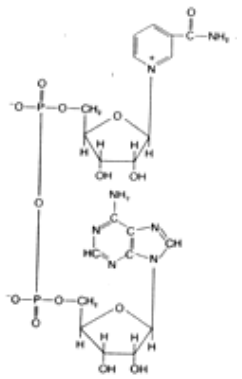
Classification	BMI
Underweight:	**below 18.5**
Normal:	**18.5 - 24.9**
Overweight:	**25 - 29.9**
Obese:	**above 30**

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

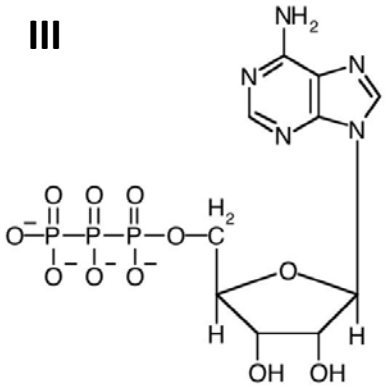
I



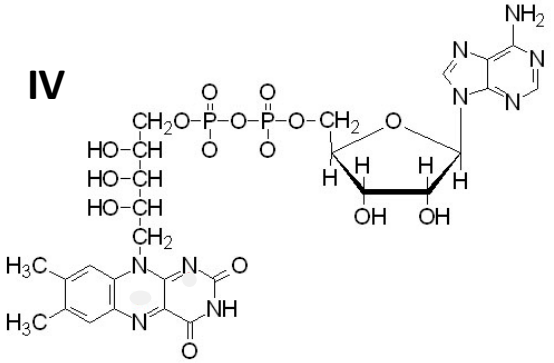
II



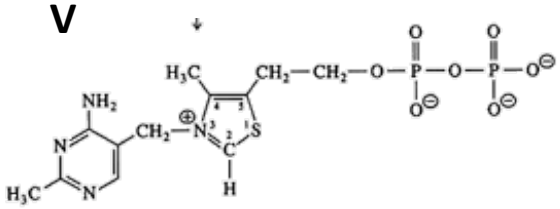
III



IV



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) Pellegra 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^{0}' of the reaction:

$ATP \Leftrightarrow Pi + ADP$

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

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:

$A \Leftrightarrow B \quad \Delta G^{o}' = +5.3$ kcal/mol
$C \Leftrightarrow D \quad \Delta G^{o}' = -0.8$ kcal/mol

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

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. _____	